ASSAM DON BOSCO UNIVERSITY

REGULATIONS AND SYLLABUS 2023

School of Technology

BTECH Bachelor of Technology

MTECH Master of Technology

MCA Master of Computer Applications

School of Commerce and Management

MCOM Master of Commerce

School of Fundamental and Applied Sciences

MSC Chemistry

MSC Mathematics

MSC Physics

School of Life Sciences

MSC Biochemistry

MSC Biotechnology

MSC Microbiology

MSC Botany

MSC Zoology

School of Humanities and Social Sciences

MA Economics

MA Education

MA English

MA Mass Communication

MSC Psychology

MA Public Administration

Master of Social Work - MSW

ASSAM DON BOSCO UNIVERSITY

REGULATIONS AND SYLLABUS
2023-2024

School of Technology
Bachelor of Technology- Computer Science and Engineering
Bachelor of Technology- Civil Engineering
Bachelor of Technology- Electrical and Electronics Engineering
Bachelor of Technology- Electronics and Communication Engineering
Bachelor of Technology- Mechanical Engineering

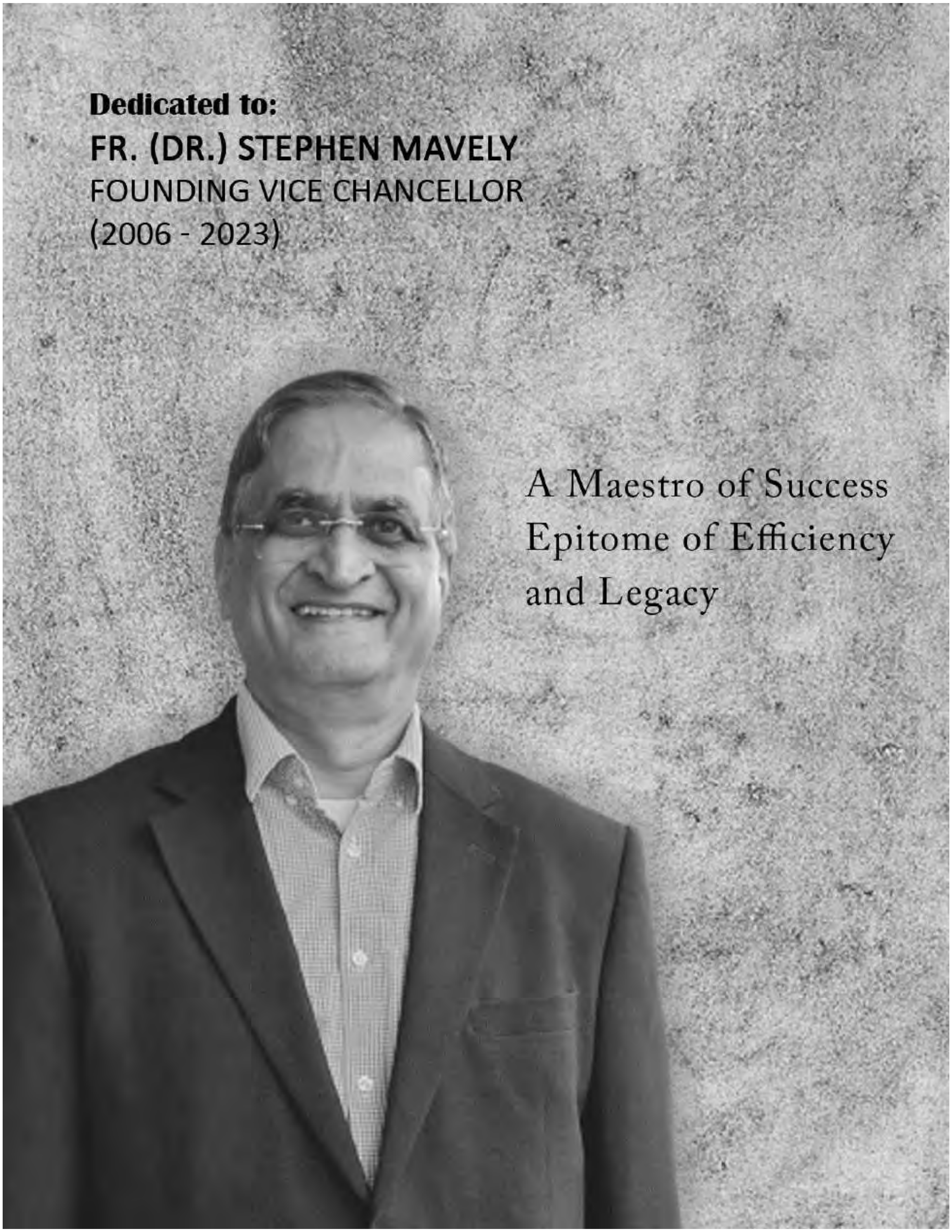
Master of Technology- Computer Science and Engineering
Master of Technology- Electrical and Electronics Engineering
Master of Technology- Electronics and Communication Engineering

School of Commerce and Management
Master of Commerce

School of Fundamental and Applied Sciences
Master of Science Chemistry
Master of Science Mathematics
Master of Science Physics

School of Life Sciences
Master of Science Biochemistry
Master of Science Biotechnology
Master of Science Microbiology
Master of Science Botany
Master of Science Zoology

School of Humanities and Social Sciences
Master of Arts Economics
Master of Arts Education
Master of Arts English
Master of Arts Mass Communication
Master of Science Psychology
Master of Arts Public Administration
Master of Social Work


Dedicated to:
FR. (DR.) STEPHEN MAVELY
FOUNDING VICE CHANCELLOR
(2006 - 2023)
A Maestro of Success
Epitome of Efficiency
and Legacy

ASSAM DON BOSCO UNIVERSITY

Tapesia Gardens, Sonapur, 782402 | Azara, Guwahati 781017 | Kharguli Campus, Guwahati 781004

NOTE

This handbook contains important information to help guide and inform you during your programme of study. We recommend that you keep this handbook for the duration of your studies in the University so that you can refer to it as needed. Please note that the onus of ignorance of the regulations and information contained in this handbook will be on the student and will not be ground for any consideration. You are also required to keep abreast of the amendments and additions to the regulations and syllabus that will be officially notified from time to time.

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REGULATIONS

ASSAM DON BOSCO UNIVERSITY REGULATIONS

BTECH -GRADUATE DEGREE PROGRAMME

The following are the regulations of the Assam Don Bosco University concerning the Graduate Programmes leading to the award of the Bachelor's Degree in various disciplines made subject to the provisions of its Statutes and Ordinances.

1.0 Academic Calendar

1.1 Each academic year is divided into two semesters of approximately 18 weeks duration: an Autumn Semester (July – December) and a Spring Semester (January – June). The Autumn Semester shall ordinarily begin in July for students already on the rolls and the Spring Semester shall ordinarily begin in January. However, the first semester (Autumn, for newly admitted students) may begin later depending on the completion of admission formalities.

1.2 The schedule of academic activities approved by the Academic Council for each semester, inclusive of the schedule of continuing evaluation for the semester, dates for the conduct of end-semester examinations, the schedule of publication of results, etc., shall be laid down in the Academic Calendar for the semester.

2.0 Duration of the Programme

2.1 The normal duration of the Graduate Programme shall be as per the table given below:

Programme	Number of Semesters	Number of Years
Bachelor of Technology (BTECH)	8	4

2.2 However, students who do not fulfil some of the requirements in their first attempt and have to repeat them in subsequent semesters may be permitted up to 4 more semesters (2 years) to complete all the requirements of the degree.

2.3 Under exceptional circumstances and depending on the merit of each case, a period of 2 more semesters (1 year) may be allowed for the completion of the programme.

3.0 Course Structure

3.1 The University follows Outcome Based Education with Choice Based Credit System (CBCS) for all the Graduate Degree Programmes. One credit is equivalent to 15 hours of lecture/tutorial or 30 hours of practical. The courses offered for the Graduate Degree Programmes are divided into two baskets – Core Courses and Elective Courses.

3.2 Core Courses: Core courses are those in the curriculum, the knowledge of which is deemed essential for students who are pursuing the said Degree Programme.

3.2.1 A student shall be required to take all the core courses offered for a particular programme.

3.2.2 The number of credits required from core courses shall be as prescribed by the competent academic authority.

3.2.3 For AICTE programmes, core courses include Professional Core Courses (DC), Engineering Science Courses (IC), Basic Science Courses (IC), Humanities and Social Science Courses (IC), Mandatory Courses (IC), Project Work, Seminar and Internship in Industry.

3.3 Elective Courses: These are courses in the curriculum which give the student opportunities for specialization and which cater to his/her interests and career goals. These courses may be selected by the student and/or offered by the department conducting the programme, from those listed in the curriculum according to the norms laid down by the competent academic authority.

3.3.1 The number of credits which may be acquired through elective courses shall be prescribed by the competent academic authority.

3.3.2 For AICTE programmes, elective courses include Professional Elective Courses and Open Elective Courses.

3.3.3 It shall be the prerogative of the department not to offer an elective course which has less than 5 students opting for it.

3.4 The schema of categorization of courses is given below:

Core Courses	
Professional Core (PC)	Core courses which are offered by the department conducting the programme
Elective Courses	
Professional Elective (PE)	Elective courses which are specific to the programme of study
Open Elective (OE)	Elective courses which are offered by departments of the University from departments other than the parent department

3.5 In order to qualify for a Graduate Degree, a student is required to complete the minimum credit requirements as prescribed by the competent academic authority.

3.6 In addition to the prescribed credit requirement, a student shall have to complete Institutional mandatory courses with Pass grade, as prescribed by the competent academic authority, from time to time, which shall be recorded in the Grade sheet but not taken into account for computing the SGPA and the CGPA.

3.7 **Audit Courses:** Students who secure a CGPA of at least 8 at the end of the 4th semester may opt to take one audit course per semester from any Department from the 5th semester onwards, provided the course teacher permits the auditing of the course. This shall be done under the guidance of the Departmental Faculty Advisor/mentor. The student is free to participate in the evaluation process for such courses. However, an attendance of 75% is necessary for obtaining a P grade for such courses. When auditing courses offered by other departments, it shall be the responsibility of the student to attend such courses without missing courses of one's own department and semester.

3.8 The medium of instruction shall be English and examinations and project reports shall be in English.

3.9 The course structure and syllabi of the Graduate Degree Programmes shall be approved by the Academic Council of the University. Departmental Boards of Studies (DBS) shall discuss and recommend the syllabi of all the courses offered by the department from time to time before forwarding the same to the School Board of Studies (SBS). The SBS shall consider the proposals from the departments and make recommendations to the Academic Council for consideration and approval.

3.10 The curriculum may include industry training and /or fieldwork for a specified time. This is to be satisfactorily completed before a student is declared eligible for the degree. There shall be credit allocation for such industrial training or fieldwork. Normally these activities shall be arranged by respective departments, even during semester breaks as approved by the School Board of Studies.

3.11 In addition, students may also opt for additional elective courses in consultation with their mentors (Cf. 3.12). Elective courses may also be chosen from SWAYAM/NPTEL. Students are required to participate in the evaluation process of such courses. The grades obtained for such courses shall be recorded in the grade sheet, but not taken into account for computing SGPA and CGPA.

3.12 Faculty Advisor/Mentor: A faculty advisor/mentor (and a co-mentor to perform the duties of a mentor during the absence of the mentor) shall be assigned for groups of students. Generally the faculty advisor/mentor shall be assigned by the concerned department, in consultation with the Director of the School concerned. (For the first year students of the BTECH programme, the Director of the School of Technology may assign the faculty advisor/ mentor from departments belonging to other Schools teaching at the SOT). Faculty advisors/ mentors shall help their mentees to plan their courses of study, advise them on matters relating to academic performance and personality development, and help them to overcome various problems and difficulties faced by them.

4.0 Admission

4.1 All admissions to the Graduate Degree Programmes of the University shall be on the basis of merit. There may, however, be provision for direct admission for a limited number of NRI/FN students.

4.2 **Eligibility Criteria**:

4.2.1 To be considered for admission to a Graduate Degree Programme a candidate should have passed the Higher Secondary examination of a recognized Board of Higher Secondary Education or an equivalent examination of any University / Board securing grades/marks as specified in the table below.

4.2.2 A candidate must also obtain qualifying marks required by the University in entrance tests/personal interview as the case may be. These marks shall be valid only for the academic year for which the test is held.

4.2.3 Admission will be on the basis of performance of the candidate at the qualifying examination, entrance test and/or personal interview.

Programme	**Grade /Marks requirement from qualifying examinations**	**Entrance Examinations / Personal Interview**
BTECH	Passed the qualifying examination with Physics/ Mathematics /Chemistry/ Computer Science/Electronics/Information Technology/ Biology/Informatics Practices/ Biotechnology/Technical Vocational subject/ Agriculture/ Engineering Graphics/ Business Studies/Entrepreneurship with 45% in the aggregate of all subjects and 45% in the aggregate of any of the three	National Entrance Test such as JEE / State leve entrance examination such as CEE or the ADBU Entrance Examination for Engineers

4.3 Reservation of seats for the programme shall be as per the guidelines laid out in the Statutes of the University.

4.4 Admissions shall ordinarily close after a specified period from the date of commencement of the first semester, through a notification. However, in exceptional cases, admission of a candidate after the last date may be recommended to the University with justification, by the School / Departments concerned. Under such an event, this period shall not exceed four weeks from the date of commencement of the first semester.

4.4.1 The attendance of such students shall be computed from the date of admission.

4.4.2 Such students may be offered the opportunity of taking part in in-semester assessment modules which may have already been completed.

4.5 All candidates shall be required to satisfy the norms prescribed by the University for Medical Fitness prior to admission.

4.6 **Anti-Ragging Affidavit:** Students and Parents Undertaking Affidavit In compliance of the UGC Regulations, it is compulsory for each student and every parent to submit an online Anti-Ragging undertaking affidavit every academic year. The Link to fill out the online undertaking affidavit by students and parents is:
www.antiragging.in/affidavit_registration_disclaimer.html
www.c4yindia.org/Home/Undertaking

4.7 BTECH Lateral Entry into Programmes

4.7.1 Polytechnic diploma holders in any branch of Engineering and Technology and B.Sc. Degree holders having Physics, Chemistry and Mathematics shall be eligible for admission to degree courses in Engineering and Technology in the third semester BTECH Programme against vacancies and/or seats in addition to the sanctioned intake in the first year.

4.7.2 Such diploma holders should have been bonafide students of polytechnics duly approved by the government and should have pursued an AICTE approved three-year diploma curriculum in an appropriate branch of Technology.

4.7.3 Only diploma holders who have secured a minimum of 45% in the aggregate in the relevant discipline and B.Sc. students who have secured a minimum of 45% marks in the aggregate shall be eligible for consideration for admission. The students belonging to B.Sc. Stream would have to clear the subjects: Engineering Graphics/Engineering Drawing and Engineering Mechanics of the First Year Engineering Programme along with the Second year subjects.

4.7.4 Such admissions shall be on the basis of merit in the ADBU entrance test and a personal interview.

4.8 Bridge Courses: The Departments shall make provision for Bridge Courses to facilitate admission of students from varied backgrounds to a programme of their choice.

4.9 Value-added Courses: Each department shall offer value-added courses, which are optional. Certificates will be awarded to those who successfully complete the course.

4.10 BTECH Honours

A student of BTech can obtain Honours by completing additional 18-20 credits in emerging areas of the same discipline of study. Departmental Board of Studies shall finalize the emerging areas of study. Students eligible for Honours programme shall have a CGPA of 6.5 till 2nd Semester. In case of lateral entry students, they should have 1st class in their qualifying examination. Students will be permitted to enroll for Honours in 3rd or 4th semester which may continue till 8th semester until they complete 18-20 credits. In any semester, they will be advised to take not more than 6 credits of courses.

Students may be allowed to opt from SWAYAM/NPTEL courses. Teaching and evaluation of the courses will be as per university norm followed for any other courses.

For the students, who opted for Honours but could not earn the minimum 18 credits till 8th semester examination, all the courses completed shall be printed in the Transcript to recognize the additional effort of the students. The opportunity of additional chance may be given to the willing students whose deficiency is marginal (at the most 6 credits).

4.11 BTECH Minor Engineering

A student of BTech can obtain Minor by completing additional 18-20 credits in emerging areas of another discipline of study. Departmental Board of Studies shall finalize the emerging areas of study. Students eligible for Honours programme shall have a CGPA of 6.5 till 2nd Semester. In case of lateral entry students, they should have 1st class in their qualifying examination. Students will be permitted to enroll for Minor in 3rd or 4th semester which may continue till 8th semester until they complete 18-20 credits. In any semester, they will be advised to take not more than 6 credits of courses.

Students may be allowed to opt from SWAYAM/NPTEL courses. Teaching and evaluation of the courses will be as per university norm followed for any other courses.

For the students, who opted for Minor but could not earn the minimum 18 credits till 8th semester examination, all the courses completed shall be printed in the Transcript to recognize the additional effort of the students. The opportunity of additional chance may be given to the willing students whose deficiency is marginal (at the most 6 credits).

5.0 University Registration

5.1 Candidates shall have to register as bona-fide students with the University as per the University regulations within a period specified by the University, by a formal application routed through the Director of the School concerned.

6.0 Attendance

6.1. To be permitted to appear for the end-semester examination of a particular course, a student is required to have a minimum attendance of 75% for that course.

6.2 Deficiency in attendance up to 10% may be condoned by the Director of the School in the case of leave taken for medical and other grievous reasons, which are supported by valid medical certificates and other requisite documents.

6.3 Some students, due to exceptional situations like their own serious sickness and hospitalization or death of members of the inner family circle (restricted to only father, mother, siblings), may have attendance below 65%. Such students may be given bonus attendance percentage for a particular course based on his/her attendance for that course during the remaining days of the current semester, as given in the following table:

Attendance during the remaining days of the current semester	**Bonus percentage available in the current semester**
95% or more	5
90% or more but less than 95%	4
85% or more but less than 90%	3
80% or more but less than 85%	2
75% or more but less than 80%	1

They shall be permitted to appear for the end-semester examination of the course if on the strength of this bonus attendance percentage, they obtain 65% attendance for that course.

6.4 If the sum of the credits of the courses for which a student is unable to appear at the end- semester examinations exceeds 50% of the total credits allotted for the semester, he/she shall not be permitted to appear for the entire end-semester examinations in view of clause 10.5 of these Regulations.

6.5 The School may propose to set aside a certain portion of the in-semester assessment marks for attendance. The number of marks and modalities of their allotment shall be made known to the students at the beginning of each semester.

6.6 Leave

6.6.1 Any absence from classes should be with prior sanctioned leave. The application for leave shall be submitted to the Office of the Director of the concerned School on prescribed forms, through proper channels, stating fully the reasons for the leave requested along with supporting documents.

6.6.2 In case of emergency such as sickness, bereavement or any other unavoidable reason for which prior application could not be made, the parent or guardian must promptly inform the office of the Director of the concerned School.

6.6.3 If the period of absence is likely to exceed 10 days, a prior application for grant of leave shall have to be submitted through the Director of the concerned School to the Registrar of the University with supporting documents in each case; the decision to grant leave shall be taken by the Registrar on the recommendation of the Director of the concerned School.

6.6.4 The Registrar may, on receipt of an application, also decide whether the student be asked to withdraw from the programme for that particular semester because of long absence.

6.7 It shall be the responsibility of the student to intimate the concerned teachers regarding his/her absence before availing the leave.

7.0 Grading System

7.1 Three types of courses are offered in the Graduate programmes:

- **Graded courses**: For the majority of the courses, students shall be assessed and given grades.
- **Pass/Non-Pass courses**: There are some courses for which the students are expected to obtain a P grade to be eligible for the degree.
- **Audit Courses**: A third category of courses are audit courses. These are optional. However, students who opt for these courses must have the required attendance to obtain a P grade in the course.

7.2 Based on the performance of a student, each student is awarded a final letter grade in each graded course at the end of the semester and the letter grade is converted into a grade point. The correspondence between percentage marks, letter grades and grade points is given in the table below:

Marks (x) obtained (%)	**Grade**	**Description**	**Grade Points**
$90 \geq x \leq 100$	O	Outstanding	10
$80 \geq x < 90$	A+	Excellent	9

70 ≥ x < 80	A	Very Good	8
60 ≥ x < 70	B+	Good	7
50 ≥ x < 60	B	Above Average	6
40 ≥ x < 50	C	Average	5
35 ≥ x < 40	P	Pass	4
x < 35	F	Fail	0
AB	Ab	Absent	0

In addition, a student may be assigned the grades 'P' and 'F' for pass marks and non- passing marks respectively, for Pass/No-pass courses, or the grade 'X' (not permitted).

7.2.1 A student shall be assigned the letter grade 'X' for a course if he/she is not permitted to appear for the end semester examination of that course due to lack of requisite attendance.

7.2.2 A letter grade 'F' or 'X' in any course implies failure in that course.

7.2.3 A student is considered to have completed a course successfully and earned the credits if she/he secures a letter grade other than 'F' or 'X'.

7.3 At the end of each semester, the following measures of the performance of a student in the semester and in the programme up to that semester shall be computed and made known to the student together with the grades obtained by the student in each course:

7.3.1 The Semester Grade Point Average (SGPA): From the grades obtained by a student in the courses of a semester, the SGPA shall be calculated using the following formula:

$$SGPA = \frac{\sum_{i=1}^{n} GP_i \text{ x } NC_i}{\sum_{i=1}^{n} NC_i}$$

Where GP_i = Grade points earned in the i^{th} course
NC_i = Number of credits for the i^{th} course
n = the number of courses in the semester

7.3.2 The Cumulative Grade Point Average (CGPA): From the SGPAs obtained by a student in the completed semesters, the CGPA shall be calculated using the following formula:

$$CGPA = \frac{\sum_{i=1}^{n} SGP_i \text{ x } NSC_i}{\sum_{i=1}^{n} NSC_i}$$

Where SGP_i = Semester Grade point of the i^{th} semester
NSC_i = Number of credits for the i^{th} semester
n = the number of semesters completed

7.3.3 The CGPA may be converted into a percentage by multiplying CGPA by 10.

7.4 Both the SGPA and CGPA shall be rounded off to the second place of decimal and recorded as such. Whenever these CGPA are to be used for official purposes, only the rounded off values shall be used.

7.5 There are academic and non-academic requirements for the Graduate programmes where a student shall be awarded the 'P' and 'F' grades. Non-credit courses such as Service Learning, Constitution of India and Essence of Indian Traditional Knowledge etc. belong to this category. No grade points are associated with these grades and these courses are not taken into account in the calculation of the SGPA or CGPA. However, the award of the degree is subject to obtaining a 'P' grade in all such courses.

7.6 In the case of an audit course, the letters "AU" shall be written alongside the course name in the Grade Sheet. A student is not required to register again for passing failed audit courses.

8.0 Assessment of Performance

8.1 A student's performance is evaluated through a continuous system of evaluation comprising tests, quizzes, assignments, seminars, minor projects, major projects and end-semester examinations.

8.2 Theory Courses: Theory courses shall have two components of evaluation – in- semester assessment of 40% weightage and an end-semester examination having 60% weightage.

8.2.1 The modalities of the conduct of in-semester assessment and weightages attached to its various components shall be as published by the School at the beginning of each semester.

8.3 Lab Courses: Lab courses (Laboratory, Drawing, Workshop, etc.) shall be evaluated on the basis of attendance, assessment of tasks assigned and end semester test/viva voce. The weightage assigned for these components of the evaluation is given in the following table:

Component	Weightage
Attendance	10
Assessment of Tasks Assigned	30
End-semester test / viva voce	60

8.3.1 The modalities of the conduct of evaluation under the heading "Assessment of tasks assigned", its components and the weightages attached to its various components shall be published by the department concerned at the beginning of each semester.

8.3.2 The evaluation of the end-semester test for a lab course may be done on the basis of criteria and weightage to be specified in the question paper, among which are included

- Organisation of the experiment
- Actual conduct of the experiment assigned and accuracy of the result
- Extent of completion
- A comprehensive viva-voce which examines the overall grasp of the subject

8.4 End-Semester examinations

8.4.1 End-semester examinations for the theory courses, generally of three hours' duration, shall be conducted by the University. The Director of the concerned school shall make the arrangements necessary for holding the examinations.

8.4.2 In the end-semester examinations, a student shall be examined on the entire syllabus of the courses.

8.4.3 A student shall not obtain a pass grade for a course without appearing for the end- semester examination in that course.

8.5 Industry Training/Internship Programme

8.5.1 Departments may require students to undergo industry training/internship programmes.

8.5.2 Departments are to notify the students at the beginning of their programmes about the details of industry training/internship.

8.5.3 After the Industry Training/Internship programme, the student shall furnish a certificate from the organisation where he/she underwent the programme as proof of successful completion.

8.5.4 The student shall submit a training/internship report to the department in a format to be laid down by the concerned department. He/she shall also give a seminar to present the learning outcomes of the programme in the presence of the faculty members and students of the department. The student shall be evaluated on the basis of the report, the seminar and interaction during the seminar and grades shall be assigned. These grades shall be given a weightage of two credits in the subsequent semester.

8.6 The Major Project

8.6.1 Students of the BTECH programme shall undertake a Major Project during the course of their graduate studies. The BTECH major project work is normally conducted in two phases during the seventh and eighth semesters of the programme and is to be done individually or in groups within the campus. A department may substitute this with two independent projects in the seventh and eighth semesters with prior permission from the statutory authority.

8.6.2 Each department shall constitute a Departmental Project Evaluation Committee (DPEC) consisting of the Head of the Department, Project Co-ordinator and two senior teachers from the department, with the Project Co-ordinator as the convenor. The DPEC shall co-ordinate the conduct and assessment of the project.

8.6.3 The DPEC shall notify the schedule and modalities for the following stages in the implementation of the project.

- Submission of the topic of the project
- Notification for assignment of project supervisors
- Submission of the synopsis
- Schedule and modality for the submission of weekly activity reports
- Schedule for the seminar presentation of synopsis
- Schedule for Progress Seminars, submission of progress reports and viva voce examination
- Date for the submission of the project report and a brief summary.
- Dates for the external evaluation of the project

In the case of the BTECH project, some of these activities may be performed during semester VII (Phase I) and others during Semester VIII (Phase II) as shall be notified by the DPEC.

8.6.4 The DPEC may ask a student to resubmit a synopsis if the same does not get its approval.

8.6.5 The Convenor of the DPEC shall submit to the Controller of Examinations a panel of at least three names of external examiners at least three weeks before the external examination. The Controller of Examinations shall appoint the external examiner(s) from this panel. The project supervisor shall be the internal examiner.

8.6.6 Each student shall submit to the DPEC three bound, typed copies of the project report, and prepared according to the prescribed format, after the pre-submission seminar, by the due date. The student shall also submit three copies of a brief

summary of the project that shall be forwarded to the concerned examiners.
8.6.7 The DPEC shall make the arrangements necessary to conduct the external evaluation in consultation with the examiner(s) appointed by the University, during the dates notified.
8.6.8 Phase I of the project shall be evaluated through in-semester assessment only. The modality and components of the assessment and their weightages shall be determined by the School and the same shall be notified at the beginning of each semester.
8.6.9 Phase II of the project shall be evaluated through in-semester and end-semester assessments of equal weightage. The in-semester assessment shall be done by the DPEC and the project supervisor and the end-semester assessment shall be done by the external examiner(s) and the project supervisor, assisted by the DPEC. The modality and components of the in-semester assessment and their weightages shall be determined by the school and the same shall be notified at the beginning of each semester.
8.6.10 The DPEC shall forward the in-semester assessment marks to the Controller of Examinations by the date specified by the Examination Department.
8.6.11 The end-semester assessment shall have the following components:

- Project implementation: 40 marks
- Seminar presentation: 20 marks
- Viva voce examination: 20 marks
- Project documentation: 20 marks

8.6.12 Independent projects as envisaged in clause 8.6.1 shall be evaluated in the same manner as Phase II of the major project.
8.6.13 Those who obtain an 'F' grade for the major project shall be required to re-enrol for it in the subsequent semesters.

8.7 Minor and Mini Projects

8.7.1 Students may be assigned minor and mini projects by the department from the fourth semester onwards to ensure that their learning becomes a hands-on experience. These projects shall be executed by the students individually or in groups under the guidance of faculty members appointed by the department.

8.7.2 The mode of evaluation of these projects shall follow the pattern of evaluation of Lab Courses (vide clause 8.3) and the modalities for the conduct of evaluation, its components and the weightages attached to these components shall be published by the department concerned at the beginning of each semester.

8.7.3 The students may be required to submit project reports in the format specified. The evaluation of the Minor and Mini Projects shall take into consideration these project reports.

8.8 The evaluation of performance in non-credit courses shall be done by the authorities conducting them and they shall communicate the grades to the Director of the concerned School who shall forward them to the Controller of Examinations.

8.9 The Director of the concerned School shall forward the marks obtained in the in- semester evaluation to the Controller of Examinations within the prescribed time as may be notified.

8.9.1 All evaluated work in a course except the end semester answer scripts shall be returned to the students promptly.

8.10 Eligibility for appearing in the end-semester examinations: A student shall be permitted to appear for the end-semester examinations, provided that

8.10.1 A student has not been debarred from appearing in the end semester examinations as disciplinary action for serious breach of conduct.

8.10.2 He/she has satisfactory attendance during the semester according to the norms laid out in section 6 of these regulations.

8.10.3 He/she has paid the prescribed fees or any other dues of the university within the date specified.

8.11 Registration for end-semester Examinations

8.11.1 The University shall, through a notification, invite applications from students to register for the end-semester examinations.

8.11.2 Students who have registered with the University (vide clause 5) and those who have applied for such registration may apply to appear for the end- semester examinations of the university, in response to the notification issued by the University, provided that they fulfil the eligibility norms as laid down in clause 8.10.

8.11.3 All eligible candidates shall be issued an admit card for the relevant examination and for specified courses. A student who does not have a valid admit card may not be permitted to write the end-semester examinations.

8.11.4 A student who secures an 'F' or 'X' grade in any course in a semester may register for the end-semester examination for that course in a subsequent semester when that course is offered again, within the maximum period of time allotted for the completion of the programme. The in-semester assessment marks obtained by him/ her in the last semester in which the said course was attended by him/her shall be retained.

8.11.5 Similarly, in case of an 'NP' grade in non-credit courses the student shall have to re-register for it in the appropriate semester of the next academic session.

8.11.6 When a student re-registers for the end semester examination of a course, in accordance with clause 8.11.4 above, the better of the two grades obtained (the old and the new) shall be considered for the calculation of SGPA and CGPA.

8.12 Conduct of Examinations: The University shall conduct the end-semester examinations in accordance with the applicable regulations on such dates as are set down in the Academic Calendar or as notified.

8.13 Declaration of Results: The University shall declare the results of a semester and make available to the students their grade sheets within the time-frame prescribed by the relevant regulations of the university and specified in the academic calendar.

8.14 The University may withhold the results of a student for any or all of the following reasons

- he/she has not paid his/her dues
- there is a disciplinary action pending against him/her
- he/she has not completed the formalities for University Registration according to the requirement of section 5 of these Regulations.

8.15 Re-examining of answer scripts

8.15.1 If a student feels that the grade awarded to him/her in a course is not correct, he/she may apply to the University for the re-examining of his/her answer script.

8.15.2 Re-examining of scripts may be of two different categories – scrutiny and re- evaluation.

8.15.3 Scrutiny: The activities under this category shall ordinarily be confined to checking

- correctness of the total marks awarded and its conversion into appropriate letter grades
- whether any part/whole of a question has been left unevaluated inadvertently
- correctness of transcription of marks on the tabulation sheet and the grade sheet issued in respect of the course under scrutiny.

8.15.4 Re-evaluation: Re-evaluation of the answer script by independent experts in the concerned subject(s).

8.15.5 Application for re-examining of answer scripts

- A student may apply for scrutiny or re-evaluation for one or more courses of the just-concluded end-semester examinations within seven calendar days from the date of publication of its results in the application form prescribed for this purpose.
- He/she shall pay the prescribed fee to the University as notified.
- A student applying for scrutiny/re-evaluation shall expressly state on the application form whether the application made is for Scrutiny or for Re- evaluation. In each case, the student may also request to see his/her answer script.
- All applications for scrutiny/re-evaluation must be routed through the Director of the concerned School.

8.15.6 If in the process of re-examining, the grade obtained in a course changes, the better of the two grades shall be assigned to the course. If there is a change, the new grade shall be recorded and a new grade sheet shall be issued to the student.

8.15.7 Without prejudice to any of the clauses of section 8.15, a student who has been found to have used unfair means during an examination shall not be eligible to apply for scrutiny or re-evaluation of answer scripts.

8.16 Repeat Examination: The University shall conduct repeat examination for those with F grade at a different time slot, as set down in the Academic Calendar or as notified. Such students should register for these examinations.

8.17 Improvement Examination

8.16.1 After the completion of the entire programme of study, a student may be allowed the provision of improvement examinations. These are to be availed of only once each in the Autumn and Spring semesters that immediately follow the completion of the programme, and within the maximum number of years permissible for a programme.

8.16.2 A student who has taken migration from the University shall not be eligible to appear for Improvement Examination.

8.16.3 A student may not choose more than the number of courses specified below for improvement examinations.

Programme	**Number of Courses for Improvement Examinations**		
	Autumn Semester	**Spring Semester**	**Total**
BTECH	6	6	12

8.16.4 After the improvement examination, the better of the two grades obtained (the old and the new) shall be considered for the calculation of SGPA and CGPA.

8.16.5 If the student improves his/her grades through the improvement examination, new grade sheets and comprehensive transcripts shall be issued to the student.

8.17 Special Examination

8.17.1 The University shall conduct Special Examinations to benefit the following categories of students:

8.17.1.1 Students who, on the completion of the final semester, have some 'F' graded courses in the two final semesters, but no 'F' or 'X' graded courses in any of the previous semesters

8.17.1.2 Students who have only one 'F' graded course in a semester other than the two final semesters and do not have 'F' or 'X' graded courses in the two final semesters.

8.17.2 The Special Examinations shall ordinarily be conducted each year within a month of the declaration of the results of the Spring Semester.

8.17.3 Students who fail to secure 50% of the credits offered in the final semester shall not be eligible to appear for the special examinations. Such students will be governed by the provisions of clause 10.5 of these regulations. However, this restriction shall not apply in the case of students who are unable to appear in the end semester examinations due to exceptional situations like their own serious illness and hospitalisation or death of members of the inner family circle (restricted to only father, mother, siblings).

8.17.4 Students who have 'X' graded courses only in the last two semesters may be offered the opportunity for participating in a Tutorial Programme which may be conducted during the semester break immediately following the end-semester examinations of the final semester and students who earn 85% attendance for the programme shall be permitted to appear for the Special Examinations. Separate fees shall be charged for the Tutorial Programme.

8.17.5 Students who do not obtain pass grades in any course at the special examinations shall have to apply in the prescribed format and appear for the end-semester examination of these courses when they are scheduled by the University during subsequent relevant end-semester examinations.

9.0 Change of Branch

9.1 Normally a student admitted to a particular branch of the BTECH programme shall continue studying in that branch till completion. However, in special cases the university may permit a student to change from one branch of studies to another after the first two semesters.

9.2 Students shall be allowed a change in branch subject to the limitation that the strength of a branch should not fall below the existing strength by more than ten percent and should not go above the sanctioned strength by more than ten percent.

9.3 Only those students shall be eligible for consideration of a change of branch, who have completed all the credits required in the first two semesters of their studies, in their first attempt.

9.4 Applications for a change of branch must be made by intending eligible students in the prescribed form. The Office of the Registrar shall call for applications at the beginning of the third semester and the completed forms must be submitted by the last date specified in the notification.

9.5 Students may enlist up to two choices of branch, in order of preference, to which they wish to change over. It shall not be permissible to alter the choice after the application has been submitted.

9.6 Change of branch shall be made strictly in order of merit of the applicants. For this purpose the CGPA obtained at the end of the second semester shall be considered. In case of a tie, the following shall be considered in the given order: the SGPA of the second semester, the SGPA of the first semester, grades obtained by the applicants in the courses of the second semester in an order to be determined by the Office of the Registrar.

9.7 A committee consisting of the Director and heads of departments of the concerned School, chaired by the Registrar shall examine the applications and consider them on the basis of the criteria laid out above.

9.8 The details of branch changes effected shall be notified to the students by the Registrar, within 7 days of the submission of applications.

9.9 All changes of branch shall be final and binding on the applicants. No student shall be permitted, under any circumstance, to refuse the change of branch offered.

9.10 All changes of branch made in accordance with the above rules shall be effective from the third semester of the applicants concerned. No change of branch shall be permitted after this.

10.0 Enrolment (for semesters other than the first)

10.1 Every student is required to enrol for the relevant courses before the commencement of each semester within the dates fixed for such enrolment and notified by the Registrar.

10.2 Students who do not enrol within the dates announced for the purpose may be permitted late enrolment up to the notified date on payment of a late fee.

10.3 Only those students shall be permitted to enrol who have

- cleared all University, Departmental, Hostel and Library dues and fines (if any) of the previous semester,
- paid all required University, Departmental and Hostel fees for the current semester, and
- not been debarred from enrolling on any specific ground.

10.4 No student may enrol for a semester if he/she has not appeared, for whatever reason, in the end semester examinations of the previous semester.

10.5 A student who fails to obtain 50% of the credits offered in the third and subsequent semesters shall not be permitted to enrol for the next semester and shall have to re-enrol for and attend all the courses of the said semester in the following academic year. Students who due to X grade (lack of due attendance) have been debarred from exams in any semester (including first and second) will have to re-enrol for the same.

11.0 Eligibility for the Award of the Graduate Degree

11.1 A student shall be declared to be eligible for the award of the Graduate Degree for which he/she has enrolled if he/she has

11.1.1 completed all the credit requirements for the degree with grade ‘C’ or higher grade in each of the mandatory graded courses and grade ‘P’ in all mandatory non-graded courses;

11.1.2 satisfactorily completed all the non-credit requirements for the degree viz., Extra Academic Activities, Industry Training, Field Work, Internship Programme, etc. (if any);

11.1.3 obtained a CGPA of 5.00 or more at the end of the semester in which he/she completes all the requirements for the degree;

11.1.4 owes no dues to the University, School, Department, Hostels; and

11.1.5 has no disciplinary action pending against him/her.

11.2 The award of the Graduate Degree must be recommended by the Academic Council and approved by the Board of Management of the University.

12.0 Termination from the Programme

12.1 If more than the number of years permitted for the completion of a programme have elapsed since the student was admitted, and the student has not become eligible for the award of Degree, the student shall be removed from the programme.

12.2 A student may also be required to leave the Programme on disciplinary grounds on the recommendations of the Students' Disciplinary Committee of the concerned School.

ASSAM DON BOSCO UNIVERSITY REGULATIONS

POST GRADUATE DEGREE PROGRAMMES

SCIENCE AND TECHNOLOGY

The following are the regulations of the Assam Don Bosco University concerning the Post- Graduate Programmes leading to the award of the Master's Degree in the disciplines of Science and Technology made subject to the provisions of its Statutes and Ordinances.

1.0 Academic Calendar

1.1 Each academic year is divided into two semesters of approximately 18 weeks duration: an Autumn Semester (July – December) and a Spring Semester (January – June). The Autumn Semester shall ordinarily begin in July for students already on the rolls and the Spring Semester shall ordinarily begin in January. However, the first semester (Autumn, for newly admitted students) may begin later depending on the completion of admission formalities.

1.2 The schedule of academic activities approved by the Academic Council for each semester, inclusive of the schedule of continuing evaluation for the semester, dates for the conduct of end-semester examinations, the schedule of publication of results, etc., shall be laid down in the Academic Calendar for the semester.

2.0 Duration of the Programme

2.1 The normal duration of the Post Graduate Programme shall be as per the table given below:

Programme	**Number of Semesters**	**Number of Years**
Master of Technology (MTECH)	4	2
Master of Science (MSc)	4	2

2.2 However, students who do not fulfill some of the requirements in their first attempt and have to repeat them in subsequent semesters may be permitted up to 4 more semesters (2 years) to complete all the requirements of the degree.

2.3 Under exceptional circumstances and depending on the merit of each case, a period of 2 more semesters (1 year) may be allowed for the completion of the programme

3.0 Course Structure

3.1 The University follows Outcome Based Education with Choice Based Credit System (CBCS) for all the Post Graduate Degree Programmes. One credit is equivalent to 15 hours of lecture/tutorial or 30 hours of practical. The courses offered for the Post Graduate Degree Programmes are divided into two baskets – Core Courses and Elective Courses.

3.2 Core Courses: Core courses are those in the curriculum, the knowledge of which is deemed essential for students who are pursuing the said Post Graduate Degree Programme.

3.2.1 A student shall be required to take all the core courses offered for a particular programme.

3.2.2 The number of credits required from core courses shall be as prescribed by the competent academic authority.

3.3. Elective Courses: These are courses in the curriculum which give the student opportunities for specialization and which cater to his/her interests and career goals. These courses may be selected by the student and/or offered by the department conducting the programme, from those listed in the curriculum according to the norms laid down by the competent academic authority.

3.3.1 The number of credits which may be acquired through elective courses shall be prescribed by the competent academic authority.

3.3.2 It shall be the prerogative of the department not to offer an elective course which has less than 5 students opting for it.

The schema of categorisation of courses into baskets is as given below:

Core Courses	
Departmental Core (DC)	Core courses which are offered by the department conducting the programme
School Core (SC)	Core courses which are offered by a department other than the department conducting th programme, from within the same School
Institutional Core (IC)	Core courses which are offered by departments of the University from Schools other than the parei School
Elective Courses	

Departmental Elective (DE)	Elective courses which are offered by the department conducting the programme
School Elective (SE)	Elective courses which are offered by a department other than the department conducting th programme, from within the same School
Institutional Elective (IE)	Elective courses which are offered by departments of the University from Schools others than th parent School

***UGC Equivalent Courses**- Core Paper (DC), Ability Enhancement Compulsory Course (IC/SC), Skill Enhancement Course (IE), General Elective (IE/SE), Discipline Specific Elective (DE)

***AICTE Equivalent Courses** - Basic Science Course (IC), Engineering Science Course(IC), Open Elective Course (IC), Humanities and Social Science Courses (IC),Mandatory Course (IC), Professional Core Course (DC), Professional Elective Course (DE)

3.6 In order to qualify for a Post Graduate Degree, a student is required to complete the minimum credit requirements as prescribed by the competent academic authority.

3.7 In addition to the prescribed credit requirement, a student shall have to complete Institutional mandatory courses with Pass grade, as prescribed by the competent academic authority, from time to time, which shall be recorded in the Grade sheet but not taken into account for computing the SGPA and the CGPA.

3.8 **Audit Course:** Students who secure a CGPA of at least 8 at the end of the first may opt to take one audit course per semester from any Department from the second semester onwards, provided the course teacher permits the auditing of the course. This shall be done under the guidance of the Departmental Faculty Advisor/mentor. The student is free to participate in the evaluation process for such courses. However, an attendance of 75% is necessary for obtaining a P grade for such courses. When auditing courses offered by other departments, it shall be the responsibility of the student to attend such courses without missing courses of one's own department and semester.

3.9 In addition, students may also opt for additional elective courses in consultation with their mentors. Students are required to participate in the evaluation process of such courses. The grades obtained for such courses shall be recorded in the grade sheet, but not taken into account for computing SGPA and CGPA.

3.10 It shall be the prerogative of the department to not offer an elective course which has less than 5 students opting for it.

3.11 The medium of instruction shall be English and examinations and project reports shall be in English.

3.12 The course structure and syllabi of the Post Graduate Degree Programmes shall be approved by the Academic Council of the University. Departmental Boards of Studies (DBOS) shall discuss and recommend the syllabi of all the courses offered by the department from time to time before forwarding the same to the School Board of Studies (SBOS). The SBOS shall consider the proposals from the departments and make recommendations to the Academic Council for consideration and approval.

3.13 The curriculum may include industry training and /or fieldwork for a specified time. This is to be satisfactorily completed before a student is declared eligible for the degree. There shall be credit allocation for such industrial training or fieldwork. Normally these activities shall be arranged during convenient semester breaks as shall be determined by the School Board of Studies.

3.14 **Faculty Advisor/Mentor:** A faculty advisor/mentor (and a co-mentor to perform the duties of a mentor during the absence of the mentor) to shall be assigned for groups of students. Faculty advisors/mentors shall help their mentees to plan their courses of study, advise them on matters relating to academic performance and personality development, and help them to overcome various problems and difficulties faced by them.

4.0 Admission

4.1 All admissions to the Post Graduate Degree Programmes of the University shall be on the basis of merit. There may, however, be provision for direct admission for a limited number of NRI/FN students.

4.2 Eligibility Criteria

4.2.1 To be considered for admission to a Post Graduate Degree Programme a candidate should have passed a Bachelor's Degree (or equivalent) programme of a recognised university securing grades/marks as specified in the table below.

4.2.2 Admission will be on the basis of the performance of the candidate at the graduate level, the Post Graduate Entrance Test conducted by the university and/or a personal interview. Candidates for MTECH who have a valid GATE score may be exempted from the entrance test.

Programme	Grade /Marks requirement from qualifying examinations	Entrance Examinations / Personal Interview
MTECH	Completed a Bachelor's Degree programme in the appropriate stream of technology from a recognised university successfully with a minimum CGPA of 6.5 (or equivalent). The Academic Council may establish other eligibility criteria for M Tech in a particular discipline.	Post Graduate Entrance Test of Assam Don Bosco University
MCA	Completed a Bachelor's Degree programme in any stream of a recognised university successfully with a minimum of 50 % marks in the aggregate. In addition, the candidate must have passed Mathematics or equivalent at the higher secondary level or above.	Post Graduate Entrance Test of Assam Don Bosco University
MSc	Completed a Bachelor's Degree programme in Science of a recognised university successfully with a minimum aggregate, specified by the competent academic body.	Satisfactory performance in the Personal Interview

4.3 Reservation of seats for the programme shall be as per the guidelines laid out in the Statutes of the University.

4.4 Admissions shall ordinarily close after a specified period from the date of commencement of the first semester, through a notification. However, in exceptional cases, admission of a candidate after the last date may be recommended to the University with justification, by the School / Departments concerned. Under such an event, this period shall not exceed four weeks from the date of commencement of the first semester.

4.4.1 The attendance of such students shall be computed from the date of admission.

4.4.2 Such students may be offered the opportunity of taking part in in-semester assessment modules which may have already been completed.

4.5 All candidates shall be required to satisfy the norms prescribed by the University for medical fitness prior to admission.

4.6 Candidates may be required to furnish a certificate of good conduct from the institution last attended.

4.7 Bridge Courses: The Departments shall make provision for Bridge Courses to facilitate admission of students from varied backgrounds to a programme of their choice.

4.8 Value-added Courses: Each department shall offer value-added courses, which are optional. Certificates will be awarded to those who successfully complete the course.

4.9 Anti-Ragging Affidavit: Students and Parents Undertaking Affidavit In compliance of the UGC Regulations, it is compulsory for each student and every parent to submit an online Anti-Ragging undertaking affidavit every academic year. The Link to fill out the online undertaking affidavit by students and parents is:
www.antiragging.in/affidavit_registration_disclaimer.html
www.c4yindia.org/Home/Undertaking

5.0 University Registration

5.1 Candidates shall have to register as bona-fide students with the University as per the University regulations within a period specified by the University, by a formal application routed through the Director of the School concerned.

6.0 Attendance

6.1 To be permitted to appear for the end-semester examination of a particular course, a student is required to have a minimum attendance of 75% for that course.

6.2 Deficiency in attendance up to 10% may be condoned by the Director of the School in the case of leave taken for medical and other grievous reasons, which are supported by valid medical certificates and other requisite documents.

6.3 Some students, due to exceptional situations like their own serious sickness and hospitalization or death of members of inner family circle (restricted to only father, mother, siblings), may have attendance below 65%. Such students may be given bonus attendance percentage for a particular course based on his/her attendance for that course during the remaining days of the current semester, as given in the following table:

Attendance during the remaining days of the current semester	Bonus percentage available in the current semester
95% or more	5
90% or more but less than 95%	4
85% or more but less than 90%	3
80% or more but less than 85%	2
75% or more but less than 80%	1

They shall be permitted to appear for the end-semester examination of the course if, on the strength of this bonus attendance percentage, they obtain 65% attendance for that course.

6.4 If the sum of the credits of the courses for which a student is unable to appear at the end- semester examinations exceeds

50% of the total credits allotted for the semester, he/she shall not be permitted to appear for the entire end-semester examinations in view of clause 9.5 of these Regulations.

6.5 The School may propose to set aside a certain portion of the in-semester assessment marks for attendance. The number of marks and modalities of their allotment shall be made known to the students at the beginning of each semester.

6.6 Leave

6.6.1 Any absence from classes should be with prior sanctioned leave. The application for leave shall be submitted to the office of the Director of the concerned School on prescribed forms, through proper channels, stating fully the reasons for the leave requested along with supporting documents.

6.6.2 In case of emergency such as sickness, bereavement or any other unavoidable reason for which prior application could not be made, the parent or guardian must promptly inform the office of the Director of the concerned School.

6.6.3 If the period of absence is likely to exceed 10 days, a prior application for grant of leave shall have to be submitted through the Director of the concerned School to the Registrar of the University with supporting documents in each case; the decision to grant leave shall be taken by the Registrar on the recommendation of the Director of the concerned School.

6.6.4 The Registrar may, on receipt of an application, also decide whether the student be asked to withdraw from the programme for that particular semester because of long absence.

6.7 It shall be the responsibility of the student to intimate the concerned teachers regarding his/her absence before availing the leave.

7.0 Grading System

7.1 Three types of courses are offered in the Post Graduate programmes:

- **Graded courses:** For the majority of the courses, students shall be assessed and given grades.
- **Pass/No-Pass courses**: There are some courses for which the students are expected to obtain a P grade to be eligible for the degree.
- **Audit Courses**: A third category of courses are audit courses. These are optional.

However, students who opt for these courses must have the required attendance to obtain a P grade in the course.

7.2 Based on the performance of a student, each student is awarded a final letter grade in each graded course at the end of the semester and the letter grade is converted into a grade point. The correspondence between percentage marks, letter grades and grade points is given in the table below:

Marks (x) obtained (%)	**Grade**	**Description**	**Grade Points**
$90 \geq x \leq 100$	O	Outstanding	10
$80 \geq x < 90$	A+	Excellent	9
$70 \geq x < 80$	A	Very Good	8
$60 \geq x < 70$	B+	Good	7
$50 \geq x < 60$	B	Above Average	6
$40 \geq x < 50$	C	Average	5
$35 \geq x < 40$	P	Pass	4
$x < 35$	F	Fail	0
AB	Ab	Absent	0

In addition, a student may be assigned the grades ‘P’ and ‘NP’ for pass marks and non- passing marks respectively, for Pass/No-pass courses, or the grade ‘X’ (not permitted).

7.2.1 A student shall be assigned the letter grade ‘X’ for a course if he/she is not permitted to appear for the end semester examination of that course due to lack of requisite attendance.

7.2.2 A letter grade ‘F’ or ‘X’ in any course implies failure in that course.

7.2.3 A student is considered to have completed a course successfully and earned the credits if she/he secures a letter grade other than ‘F’ or ‘X’.

7.3 At the end of each semester, the following measures of the performance of a student in the semester and in the programme up to that semester shall be computed and made known to the student together with the grades obtained by the student in each course:

7.3.1 The Semester Grade Point Average (SGPA): From the grades obtained by a student in the courses of a semester, the SGPA shall be calculated using the following formula:

$$SGPA = \frac{\sum_{i=1}^{n} GP_i \text{ x } NC_i}{\sum_{i=1}^{n} NC_i}$$

Where GP_i = Grade points earned in the i^{th}course
NC_i = Number of credits for the i^{th}course
n = the number of courses in the semester

7.3.2 The Cumulative Grade Point Average (CGPA): From the SGPAs obtained by a student in the completed semesters, the CGPA shall be calculated using the following formula:

$$CGPA = \frac{\sum_{i=1}^{n} SGP_i \text{ x } NSC_i}{\sum_{i=1}^{n} NSC_i}$$

Where SGP_i = Semester Grade point of the i^{th} semester
NSC_i = Number of credits for the i^{th} semester
n = the number of semesters completed

7.3.3 The CGPA may be converted into a percentage by multiplying CGPA by 10.

7.4 Both the SGPA and CGPA shall be rounded off to the second place of decimal and recorded as such. Whenever these CGPA are to be used for official purposes, only the rounded off values shall be used.

7.5 There are academic and non-academic requirements for the Graduate programmes where a student shall be awarded the ‘P’ and ‘NP’ grades. Non-credit courses such as Extra Academic Programmes belong to this category. No grade points are associated with these grades and these courses are not taken into account in the calculation of the SGPA or CGPA. However, the award of the degree is subject to obtaining a ‘P’ grade in all such courses.

7.6 In the case of an audit course, the letters “AU” shall be written alongside the course name in the Grade Sheet. A student is not required to register again for passing failed audit courses.

8.0 Assessment of Performance

8.1 A student’s performance is evaluated through a continuous system of evaluation comprising tests, quizzes, assignments, seminars, minor projects, major projects and end-semester examinations.

8.2 Theory Courses: Theory courses shall have two components of evaluation – in- semester assessment of 40% weightage and an end-semester examination having 60% weightage.

8.2.1 The modalities of the conduct of in-semester assessment and weightages attached to its various components shall be as published by the School/Department at the beginning of each semester.

8.3 Lab Courses: Lab courses (Laboratory, Drawing, Workshop, etc.) shall be evaluated on the basis of assessment of tasks assigned and end semester test/viva voce. The weightage assigned for these components of the evaluation is given in the following table:

Component	**Weightage**
Assessment of Tasks Assigned	40
End-semester test / Viva voce	60

8.3.1 The modalities of the conduct of evaluation under the heading “Assessment of tasks assigned”, its components and the weightages attached to its various components shall be published by the department concerned at the beginning of each semester.

8.3.2 The evaluation of the end-semester test for a lab course may be done on the basis of criteria and weightage to be specified in the question paper, among which are included

- Organisation of the program/experiment
- Coding, freedom from logical and syntactical errors, and accuracy of the result obtained / conduct of the experiment assigned and accuracy of the result
- Extent of completion
- A comprehensive viva-voce which examines the overall grasp of the subject

8.4 End-Semester examinations

8.4.1 End-semester examinations for the theory courses, generally of three hours’ duration, shall be conducted by the University. The Director of the concerned school shall make the arrangements necessary for holding the examinations.

8.4.2 In the end-semester examinations, a student shall be examined on the entire syllabus of the courses.

8.4.3 A student shall not obtain a pass grade for a course without appearing for the end- semester examination in that course.

8.5 Research Seminar

8.5.1 During the course of the Post Graduate programme students may be required to conduct research seminars on a regular basis. The purpose of these research seminars is to encourage the students to conduct literature survey on the recent trends and developments in a chosen area of the discipline.

8.5.2 The literature survey conducted in preparation for these seminars may lead the students to the development of a project model to be executed during the final semesters of the programme.

8.5.3 The Research Seminars shall be evaluated on the basis of a presentation, a report and a viva voce examination.

8.6 The Major Project / Research Project / Dissertation

8.6.1 Students of the Post Graduate Programme shall undertake a Major Project / Research Project / Dissertation during the course of their Post Graduate studies. The Major Project / Research Project / Dissertation (to be referred to as Major Project henceforth) is normally conducted in two phases during the last two semesters of the programme.

8.6.2 The Major Project may be a software project, a research oriented project or research work which leads to a dissertation, as may be relevant to the discipline in which the work is undertaken. If it is a research oriented work, it should expose the students to the current state of research in a chosen area of the discipline and lead to new developments in the area.

8.6.3 The Major Project is to be undertaken individually in the campus or outside as may be specified by the department.

8.6.4 Each department shall constitute a Departmental Project Evaluation Committee (DPEC) consisting of the Director of the School (Chairperson), Head of the Department (Vice Chairperson), Project Co-ordinator and two senior teachers from the department, with the Project Co-ordinator as the convenor. The DPEC shall co-ordinate the conduct and assessment of the project.

8.6.4.1 The DPEC will notify the schedule and modalities for the following stages in the implementation of the project.

- Submission of the topic of the project.
- Notification for assignment of project supervisors.
- Submission of the synopsis
- Schedule for the seminar presentation of synopsis.
- Schedule for Progress Seminars, submission of progress reports and viva voce examination.
- Date for the submission of the project report and a brief summary.
- Dates for the end semester evaluation of the project.

8.6.5 The DPEC may ask a student to resubmit a synopsis if the same does not get its approval.

8.6.6 The project supervisor may be from outside the department or university. Such a supervisor should be approved by the DPEC and jointly supervise a project with a faculty member of the department.

8.6.7 The minimum qualification of a project supervisor shall be laid down by the DPEC in consultation with the Director of the School and authorities of the University.

8.6.8 The Chairperson of the DPEC will submit to the Controller of Examinations a panel of at least three names of external examiners at least three weeks before the end semester examination. The Controller of Examinations will appoint the external examiner(s) from this panel.

8.6.9 Each student shall submit to the DPEC four bound, printed copies of the project report, prepared according to the prescribed format made available, by the due date. The student will submit also three copies of a brief summary of the project that will be forwarded to the concerned examiners.

8.6.10 The DPEC will make the arrangements necessary to conduct the end semester evaluation in consultation with the examiners appointed by the University, during the dates notified.

8.6.11 The project will be evaluated through in-semester and end-semester assessments of equal weightage. The in-semester assessment will be done by the DPEC and the project supervisor. The end-semester assessment will be done by the external examiner(s), the project supervisor and a member of the DPEC appointed by it for the purpose. The weightages attached to their respective evaluations shall be 60:20:20.

8.6.12 The DPEC will forward the in-semester assessment marks to the Controller of Examinations by the date specified by the Examination Department.

8.6.13 Given below are the suggested components of Internal assessment and respective marks assigned:

- Synopsis: 15 marks
- Seminar presentation of the synopsis: 15 marks
- Project implementation: 40 marks
- Pre-submission presentation: 15 marks
- Pre-submission viva voce: 15 marks

8.6.14 Given below are the suggested components of External assessment and respective marks assigned:
- Project implementation: 40 marks
- Seminar presentation: 25 marks
- Viva voce examination: 20 marks
- Project documentation: 15 marks

8.6.15 Publication of papers and registering of patents are encouraged during the Post Graduate programme. Papers published or patents obtained may be awarded extra weightage during the evaluation of the project.

8.6.16 Those who obtain an 'F' grade for the major project will be required to re-enrol for it in the subsequent semester and pay the prescribed fees.

8.7 The Director will forward the marks obtained in the in-semester evaluation to the Controller of Examinations within the prescribed time as may be notified.

8.8 All evaluated work in a subject except the end semester answer scripts will be returned to the students promptly.

8.9 Eligibility for appearing in the end-semester examinations: A student shall be permitted to appear for the end-semester examinations, provided that

8.9.1 A student has not been debarred from appearing in the end semester examinations as disciplinary action for serious breach of conduct.

8.9.2 He/she has satisfactory attendance during the semester according to the norms laid out in section 6 of these regulations.

8.9.3 He/she has paid the prescribed fees or any other dues of the university within the date specified.

8.10 Registration for end-semester Examinations

8.10.1 The University shall, through a notification, invite applications from students to register for the end-semester examinations.

8.10.2 Students who have registered with the University (vide clause 5) and those who have applied for such registration may apply to appear for the end- semester examinations of the university, in response to the notification issued by the University, provided that they fulfil the eligibility norms as laid down in clause 8.9.

8.10.3 All eligible candidates shall be issued an admit card for the relevant examination and for specified courses. A student who does not have a valid admit card may not be permitted to write the end-semester examinations.

8.10.4 A student who secures an 'F' or 'X' grade in any course in a semester may register for the end-semester examination for that course in a subsequent semester when that course is offered again, within the maximum period of time allotted for the completion of the programme. The in-semester assessment marks obtained by him/ her in the last semester in which the said course was attended by him/her shall be retained.

8.10.5 Similarly, in case of an 'NP' grade in Extra Academic Programmes the student shall have to re-register for it in the appropriate semester of the next academic session.

8.10.6 When a student re-registers for the end semester examination of a course, in accordance with clause 8.10.4 above, the better of the two grades obtained (the old and the new) shall be considered for the calculation of SGPA and CGPA.

8.11 **Conduct of Examinations**: The University shall conduct the end-semester examinations in accordance with the applicable regulations on such dates as are set down in the Academic Calendar or as notified.

8.12 **Declaration of Results:** The University shall declare the results of a semester and make available to students their grade sheets within the time-frame prescribed by the relevant regulations of the university and specified in the academic calendar.

8.13 The University may withhold the results of a student for any or all of the following reasons
- he/she has not paid his/her dues
- there is a disciplinary action pending against him/her
- he/she has not completed the formalities for University Registration according to the requirement of section 5 of these Regulations.

8.14 Re-examining of answer scripts

8.14.1 If a student feels that the grade awarded to him/her in a course is not correct, he/she may apply to the University for the re-examining of his/her answer script.

8.14.2 Re-examining of scripts may be of two different categories – scrutiny and re- evaluation.

8.14.3 Scrutiny: The activities under this category shall ordinarily be confined to checking
- correctness of the total marks awarded and its conversion into appropriate letter grades
- whether any part/whole of a question has been left unevaluated inadvertently
- correctness of transcription of marks on the tabulation sheet and the gradesheet issued in respect of the course

under scrutiny.

8.14.4 Re-evaluation: Re-evaluation of the answer script by independent experts in the concerned subject(s).

8.14.5 Application for re-examining of answer scripts

- A student may apply for scrutiny or re-evaluation for one or more courses of the just-concluded end-semester examinations within seven calendar days from the date of publication of its results in the application form prescribed for this purpose.
- He/she shall pay the prescribed fee to the University as notified.
- A student applying for scrutiny/re-evaluation shall expressly state on the application form whether the application made is for Scrutiny or for Re- evaluation. In each case, the student may also request to see his/her answer script.
- All applications for scrutiny/re-evaluation must be routed through the Director of the concerned School.

8.14.6 If in the process of re-examining, the grade obtained in a course changes, the better of the two grades shall be assigned to the course. If there is a change, the new grade shall be recorded and a new grade sheet shall be issued to the student.

8.14.7 Without prejudice to any of the clauses of section 8.14, a student who has been found to have used unfair means during an examination shall not be eligible to apply for scrutiny or re-evaluation of answer scripts.

8.15 Repeat Examination: The University shall conduct repeat examination for those with F grade at a different time slot, as set down in the Academic Calendar or as notified. Such students should register for these examinations.

8.16 Improvement Examination

8.16.1 After the completion of the entire programme of study, a student may be allowed the provision of improvement examinations. These are to be availed of only once each in the Autumn and Spring semesters that immediately follow the completion of the programme, and within the maximum number of years permissible for a programme.

8.16.2 A student who has taken migration from the University shall not be eligible to appear for Improvement Examination.

8.16.3 A student may not choose more than the number of courses specified in the table below for improvement examinations.

Programme	**Number of Courses for Improvement Examinations**		
	Autumn Semester	Spring Semester	Total
MCA	3	3	6
MSc	3	3	6
MTECH	2	2	4

8.16.4 After the improvement examination, the better of the two grades obtained (the old and the new) shall be considered for the calculation of SGPA and CGPA.

8.16.5 If the student improves his/her grades through the improvement examination, new grade sheets and comprehensive transcripts shall be issued to the student.

8.17 Special Examination

8.17.1 The University shall conduct Special Examinations to benefit the following categories of students:

8.17.1.1 Students who, on the completion of the final semester, have some ‘F’ graded courses in the two final semesters, but no ‘F’ or ‘X’ graded courses in any of the previous semesters

8.17.1.2 Students who have only one ‘F’ graded course in a semester other than the two final semesters and do not have ‘F’ or ‘X’ graded courses in the two final semesters.

8.17.2 The Special Examinations shall ordinarily be conducted each year within a month of the declaration of the results of the Spring Semester.

8.17.3 Students who fail to secure 50% of the credits offered in the final semester shall not be eligible to appear for the special examinations. Such students will be governed by the provisions of clause 9.5 of these regulations. However, this restriction shall not apply in the case of students who are unable to appear in the end semester examinations due to exceptional situations like their own serious illness and hospitalisation or death of members of inner family circle (restricted to only father, mother, siblings).

8.17.4 Students who have ‘X’ graded courses only in the last two semesters may be offered the opportunity for participating in a Tutorial Programme which may be conducted during the semester break immediately following the end- semester examinations of the final semester and students who earn 85% attendance for the programme shall be permitted to appear for the Special Examinations. Separate fees shall be charged for the Tutorial Programme.

8.17.5 Students who do not obtain pass grades in any course at the special examinations shall have to apply in the prescribed format and appear for the end-semester examination of these courses when they are scheduled by the University during subsequent relevant end-semester examinations.

9.0 Enrolment (for semesters other than the first)

9.1 Every student is required to enrol for the relevant courses before the commencement of each semester within the dates fixed for such enrolment and notified by the Registrar.

9.2 Students who do not enrol within the dates announced for the purpose may be permitted late enrolment up to the notified date on payment of a late fee.

9.3 Only those students shall be permitted to enrol who have

- cleared all University, Departmental, Hostel and Library dues and fines (if any) of the previous semester,
- paid all required University, Departmental and Hostel fees for the current semester, and
- not been debarred from enrolling on any specific ground.

9.4 No student may enrol for a semester if he/she has not appeared, for whatever reason, in the end semester examinations of the previous semester.

9.5 A student who fails to obtain 50% of the credits offered in the third and subsequent semesters shall not be permitted to enrol for the next semester and shall have to re-enrol for and attend all the courses of the said semester in the following academic year. Students who due to X grade (lack of due attendance) have been debarred from exams in any semester (including first and second) will have to re-enrol for the same.

10.0 Eligibility for the Award of the Post Graduate Degree

10.1 A student shall be declared to be eligible for the award of the Post Graduate Degree for which he/she has enrolled if he/she has

10.1.1 completed all the credit requirements for the degree with grade 'C' or higher grade in each of the mandatory graded courses and grade 'P' in all mandatory non-graded courses.

10.1.2 satisfactorily completed all the non-credit requirements for the degree viz., Extra Academic Activities, Industry Training, field work, internship programme, etc. (if any);

10.1.3 obtained a CGPA of 5.00 or more at the end of the semester in which he/she completes all the requirements for the degree;

10.1.4 owes no dues to the University, School, Department, Hostels; and

10.1.5 has no disciplinary action pending against him/her.

10.2 The award of the Post Graduate Degree must be recommended by the Academic Council and approved by the Board of Management of the University.

11.0 Termination from the Programme

11.1 If more than the number of years permitted for the completion of a programme have elapsed since the student was admitted, and the student has not become eligible for the award of Degree, the student shall be removed from the programme.

11.2 A student may also be required to leave the Programme on disciplinary grounds on the recommendations of the Students' Disciplinary Committee of the concerned School.

ASSAM DON BOSCO UNIVERSITY REGULATIONS

POST GRADUATE DEGREE PROGRAMMES

HUMANITIES AND SOCIAL SCIENCES & COMMERCE AND MANAGEMENT

The following are the regulations of the Assam Don Bosco University concerning the Post- Graduate Programmes leading to the award of the Master's Degree in the disciplines of Humanities and Social Sciences & Commerce and Management made subject to the provisions of its Statutes and Ordinances:

The Master's Degree Programmes of Assam Don Bosco University consist of theory and practicum components, taught and learned through a combination of lectures, field work/field visit and research projects.

1.0 Academic Calendar

1.1 Each academic year is divided into two semesters of approximately 18 weeks duration: an Autumn Semester (July – December) and a Spring Semester (January – June). The Autumn Semester shall ordinarily begin in July for students already on the rolls and the Spring Semester shall ordinarily begin in January. However, the first semester (Autumn, for newly admitted students) may begin later depending on the completion of admission formalities.

1.2 The schedule of academic activities approved by the Academic Council for each semester, inclusive of the schedule of continuing evaluation for the semester, dates for end-semester examinations, the schedule of publication of results, etc., shall be laid down in the Academic Calendar for the semester.

2.0 Duration of the Programme

2.1 The normal duration of the Post Graduate Programme in the disciplines of Humanities and Social Sciences & Commerce and Management shall be 4 semesters (2 years).

2.2 However, students who do not fulfil some of the requirements in their first attempt and have to repeat them in subsequent semesters may be permitted up to 4 more semesters (2 years) to complete all the requirements of the degree.

2.3 Under exceptional circumstances and depending on the merit of each case, a period of 2 more semesters (1 year) may be allowed for the completion of the programme

3.0 Course Structure

3.1 The choice based credit system shall be followed for the Masters Degree Programmes. Credits are allotted to the various courses depending on the number of hours of lecture/practicum/Field work assigned to them using the following general pattern:

3.1.1 Lecture: One hour per cycle/week is assigned 1 credit.

3.1.2 Practicum/fieldwork: Two hours per cycle/week is assigned 1 credit.

3.2 The courses are divided into two baskets – core courses and elective courses. (Core courses will include "Core Courses" and "Ability Enhancement Courses" mentioned in CBCS guidelines. Elective Courses will include "Discipline Specific Electives", "Generic Electives", optional "Dissertation or Project", and "Skill Enhancement Courses")

3.3 Core Courses: Core courses are those in the curriculum, the knowledge of which is deemed essential for students who are pursuing the programme.

3.3.1 A student shall be required to take all the core courses offered for a particular programme.

3.3.2 The number of credits required from core courses shall be as prescribed by the competent academic authority.

3.4 Elective Courses: These are courses in the curriculum which give the student opportunities for specialisation and which cater to his/her interests and career goals. These courses may be selected by the student and/or offered by the department conducting the programme, from those listed in the curriculum according to the norms laid down by the competent academic authority.

3.4.1 The number of credits which may be acquired through elective courses shall be prescribed by the Board of studies pertaining to the programme.

3.5 These categories of courses may further be subdivided into departmental, school or institutional, depending on the department which offers the course. The schema of categorisation of courses into baskets is as given below:

***Core Courses**	
Departmental Core (DC)	Core courses which are offered by the department which conducts the programme
School Core (SC)	Core courses which are offered by a department other than the department which conducts the programme, from within the same School
Institutional Core (IC)	Core courses which are offered by departments of the University from Schools other than the parent School

*Elective Courses	
Departmental Elective (DE)	Elective courses which are offered by the department which conducts the programme
School Elective (SE)	Elective courses which are offered by a department other than the department which conducts the programme, from within the same School
Institutional Elective (IE)	Elective courses which are offered by departments of the University from Schools others than the parent School

***UGC Equivalent Courses** - Core Paper (DC), Ability Enhancement Compulsory Course (IC/ SC), Skill Enhancement Course (IE), General Elective (IE/SE), Discipline Specific Elective (DE)

3.6 In order to qualify for a Master's Degree, a student is required to complete the credit requirement as prescribed in the curriculum.

3.7 In addition to the prescribed credit requirement, a student shall have to complete the requirements of Extra Academic Programmes (EAP) as may be prescribed by the Department. Students shall be awarded P/NP grades for the EAP, which shall be recorded in the Gradesheet, but not taken into account for computing the SGPA and the CGPA.

3.8 Students who secure a CGPA of at least 7.5 at the end of the 2nd semester may opt to take one audit course per semester from any Department from the 3rd semester onwards, provided the course teacher permits the auditing of the course. This shall be done under the guidance of the Departmental Faculty Advisor/mentor. The student is free to participate in the evaluation process for such courses. However, an attendance of 75% percentage is necessary for obtaining a P grade for such courses. When auditing courses offered by other departments, it shall be the responsibility of the student to attend such courses without missing courses of one's own department and semester.

3.9 In addition, students may also opt for additional elective courses in consultation with their mentors. Students are required to participate in the evaluation process of such courses. The grades obtained for such courses shall be recorded in the gradesheet, but not taken into account for computing SGPA and CGPA.

3.10 It shall be the prerogative of the department to not offer an elective course which has less than 5 students opting for it.

3.11 The medium of instruction shall be English and examinations and project reports shall be in English.

3.12 The course structure and syllabi of the Post Graduate Degree Programmes shall be approved by the Academic Council of the University. Departmental Boards of Studies (DBOS) shall discuss and recommend the syllabi of all the courses offered by the department from time to time before forwarding the same to the School Board of Studies (SBOS). The SBOS shall consider the proposals from the departments and make recommendations to the Academic Council for consideration and approval.

3.13 The curriculum may include fieldwork / institutional visits / internship for a specified time. These are to be satisfactorily completed before a student is declared eligible for the degree. There shall be credit allocation for such activities. These activities may be arranged during the semester or during convenient semester breaks as shall be determined by the School Board of Studies.

3.14 Faculty Advisor/Mentor: A faculty advisor/mentor shall be assigned for groups of students. Faculty advisors/mentors shall help their mentees to plan their courses of study, advise them on matters relating to academic performance and personality development, and help them to overcome various problems and difficulties faced by them.

PROGRAMME SPECIFIC CURRICULAR ASPECTS

4.0 MASTER OF SOCIAL WORK (MSW)

4.1 Area of Concentration: The third and fourth semesters shall have courses from a chosen Area of Concentration (AoC) from among those offered by the department. The AoC is to be opted for at the end of the second semester and will be confirmed by the department depending on the availability of seats and the aptitude and ability of the student. An AoC will be offered by the department only if a minimum of ten students opt for it. The fieldwork and research project of the third and fourth semesters will be based on the AoC.

4.2 Concurrent and Continuous Fieldwork

Fieldwork shall be an essential part of the course structure in all the semesters of the programme. The field work practice in the first semester shall consist of orientation visits, sessions for skills training and placement. In the first year, the focus of the field work shall be the community and in the second year the focus shall be based on the specialisation chosen by the students. In the first semester,, students shall be placed in communities, NGOs,service organizations and government agencies working with communities, and in those settings where they can be exposed to the community and community issues. The students get a close feel of the community and community settings, understand the dynamics and issues in the community and become aware of the sensitivities of people while working with them. They also get a firsthand experience of the programmes and projects implemented in the communities by NGOs and government agencies and the impact that these have on the community. They shall also interact with the personnel from organisations and the community members to understand the tension between tradition and change that the communities in the region are likely to experience, and how it is handled. They shall, with the help of the organisation and the field work supervisor, identify an issue and work on it following the principles of community organization. The students are expected to be creative and innovative in assisting the agency and community in whatever way possible.

The field work practice in the second semester will consist of lab sessions for skills training and placement. The focus will be on the practice of social case work and Group works. The students shall be placed in NGOs, and government service organizations and government agencies working with individuals and families, and in those settings where they can be exposed to issues related to individuals and groups.

4.2.1 Normally a student shall spend fifteen hours over two days per week in field work. However, keeping in mind the peculiar situation of transport and communications in the region and the expenses involved, the field work practice may be arranged in other convenient ways as the institution deems fit.

4.2.2 The student is required to submit the report on the field work and the field work diary to the field work supervisor, before the commencement of classes on the first day of class following the field work days. The supervisor shall conduct regular field work conferences

4.2.3 A student is expected to have 100 percent attendance in field work. Any shortage shall be compensated by him/her.

4.2.4 At the end of the semester the student shall submit a summary report of the field work for the semester and a viva voce examination shall be conducted.

4.2.5 The field work practice in the Third and Fourth Semesters shall focus upon the Area of Concentration chosen by the students. The students shall be placed in the field for twenty five days of consecutive field work. The field work settings shall be communities, NGOs, service organizations, hospitals, clinics and governmental agencies. Those students who are specializing in Community Development will either be placed in an urban or rural community setting that is identified by the Department. Students who are specializing in Medical and Psychiatric Social Work will be exposed to either a Medical or a Psychiatric setting.

4.3 Rural Camp

Students shall organise and participate in a rural camp during the first / second semester. The duration of the rural camp shall generally be ten days excluding days of travel.

4.3.1 The objectives of the rural camp are:

- To apply the acquired skills of group work and community organisation in communities.
- To understand and assess the problems faced by the rural population.
- To involve oneself positively in the communities to help to remove some of these problems.

4.3.2 At the end of the camp each student shall submit a written report to the department in a specified format. Performance at the Rural Camp shall be considered for the evaluation of the Field Work during the second semester.

4.3.3 The Rural Camp shall be credited along with the fieldwork of the semester along with which it can be conveniently coupled.

4.4 Study Tour

During the programme the students shall undertake a study tour along with the assigned faculty members to a place approved by the department. The places are to be so chosen as to be of educational benefit to students. During the tour, the focus shall be on visiting and interacting with as many NGOs/ state/national/international organisations involved in developmental work as possible. A report of the learning outcomes shall be submitted to the department at the end of the tour. The Study Tour shall be a Pass/No Pass course.

4.5 Block Placement

After the examinations at the end of the fourth semester, the students shall be placed with an NGO or Agency for a period of not less than one month for practical experience and application of their skills. While the Block Fieldwork is not credited, it is mandatory for the completion of the MSW programme. The student shall contact an agency of his/her choice and get the choice of agency approved by the department. Students shall endeavour to choose an agency that is primarily in tune with their AoC and which has credentials in the concerned field. At the end of every week the student shall send a brief report to the supervisor and at the end of the Block Field Work period a summary report shall be submitted. The summary report shall contain a short description of the Agency, the social service skills applied in his/her work and the student’s learning outcomes. The report shall be submitted in a format prescribed by the department and shall be submitted together with a certificate from the agency confirming his/her field work, in a prescribed format.

4.6 Research Project Work

Every student shall undertake a research project work which has bearing on his/her AoC and present a written thesis on the research work under the supervision and guidance of a faculty member. The preliminary work may begin at the end of the second semester. The students are expected to complete the data collection before the fourth semester. The thesis is to be submitted to the department before the date notified. The student shall write a dissertation of the research thesis and appear for a viva voce examination on the research done. The mode and components of evaluation of the research work and the weightages attached to them shall be published by the Department/Institute at the beginning of the semester.

4.7 Assignments

Assignments are an essential part of learning. The faculty shall engage students in a minimum of one individual and one group assignment per course, per semester. A group assignment shall be accompanied by a common presentation.

5.0 MASTER OF SCIENCE (MSC) PSYCHOLOGY

5.1 Field Work

Students shall take part in field work during the first three semesters in mental health agencies, medical institutions, educational institutions etc., under the supervision of professional counsellors and psychologists, where the student of psychological counselling can get a first-hand experience of the application of the learning derived from the classroom. The field work shall be credited and shall be evaluated using norms laid down by the department.

5.2 Study Tour

During the programme the students shall undertake a study tour, along with the faculty members, to a place approved by the department. The places are to be so chosen as to be of educational benefit to students. During the tour, the focus shall be to visit and interact with NGOs, hospitals, state/national/international organisations involved in psychological counselling. A report of the learning outcomes shall be submitted to the department at the end of the tour followed by a presentation. The Study Tour shall be a Pass/No Pass course.

5.3 Summer Internship

Students are required to undergo a summer internship of two weeks' during the semester break between the second and third semesters. It is a P/NP course and shall be recorded in the third semester. The Summer Internship gives students an opportunity to apply the theories and principles that they have learnt in class room courses to the "real world" of social service agencies, medical institutions, the criminal justice system, business, and industry. During the internship, students can explore career interests, develop professional skills, learn how community organizations work and expand their clinical and interpersonal skills. The summer internship enriches the students' academic experience while making a valuable contribution to the community and utilizing the vacation optimally.

5.4 Supervised Internship

Each student shall perform a supervised internship for a period of 90 days (spread across semester three and four with 45days in each semester) in two organizations which offers counselling help to clients. The supervised internship is a credited course and the report for each internship shall be submitted by the students at the end of each semester followed by a presentation on the same. It shall be the prerogative of the department to propose the number of institutions where a student is expected to perform supervised internship. Supervision shall be provided for by the university in collaboration with the organisation where the student performs the internship. Evaluation of the internship shall be based on the documentation, reports from the organisation, report of the supervisor and the presentation and the viva voce examination of the student at the end of the period of Internship.

5.5 Research Project Work

A research project shall be undertaken during the course of the third and the fourth semesters. The topic of the research shall be so chosen that it will be possible for the student to pursue and complete the research work in the institution/hospital where the student is placed for the supervised internship. The preliminary work may begin at the end of the second semester. The students are expected to complete the data collection before the fourth semester. The thesis is to be submitted to the department before the date notified. The student shall write a dissertation of the research thesis and appear for a viva voce examination on the research done. The mode and components of evaluation of the research work and the weightages attached to them shall be published by the Department/ Institute at the beginning of the semester.

5.6 Assignments

Assignments are an essential part of learning. The faculty shall engage students in a minimum of one individual and one group assignment per course, per semester. A Group assignment shall be accompanied by a common presentation.

6.0 MASTER OF ARTS (MA) EDUCATION

6.1 Specialisations

The Master's Degree Programme in Education offers a number of specialisations, of which a student shall be required to choose a specialization after the completion of the first semester. The department shall have the prerogative of not offering a specialisation if a sufficient number of students do not opt for it.

6.2 Educational Seminar

During the course of the programme, students are expected to present a series of seminars which will address fundamental intellectual, conceptual and practical issues in current educational philosophy and application. They may also deal with other relevant topics which may be suggested by the department. Students shall be assisted through guest lectures, discussions, field work in education related institutions and active engagement with faculty members. During these interactions students shall be provided with an opportunity to explore how best to bring new interdisciplinary scholarship, technology and critical thinking into the development of the chosen seminar area. They shall also consider alternative pedagogic strategies, teaching techniques and technologies. Students shall prepare and present a final paper based on these seminars. Students shall be evaluated on the basis of the seminars and the final paper.

6.3 Assignments

Assignments are an essential part of learning. The faculty shall engage students in a minimum of one individual and one group assignment per course, per semester. A group assignment shall be accompanied by a common presentation.

6.4 Research Project Work

Every student shall undertake a research project work which has bearing on his/her field of specialisation and present a written thesis on the research work under the supervision and guidance of a faculty member. The Research Project shall be undertaken individually, in two phases during the third and fourth semesters. Students are expected to make presentations to the department at different stages of the research work. The student shall write a dissertation of the research thesis, submit it to the department and appear for a viva voce examination at times to be notified by the department. The mode and components of evaluation of the research work and the weightages attached to them shall be published by the Department/Institute at the beginning of the semester.

6.5 School Visits

The students of the Masters Programme in Education shall be engaged in regular school visits with the purpose of understanding and evaluating the process of teaching, learning and evaluation as well as the exigencies of administration of the school.

6.6 Internship

During the final semester of the programme, a student is required to undergo an internship for a period of one month. The internship provides an opportunity for students to experience the ground reality and connect it with the theoretical and methodological perspectives the student has studied and interiorized. During the internship the student will be monitored and guided by his/her supervisor and faculty members. The student will be required to maintain a journal and at the end of the period of internship, submit a written report and to make a presentation of his/her experiences and learnings at the internship. The student will be required also to submit a report from the head of the institution regarding his/her performance there.

The evaluation of the student shall be based on the level of his/her engagement during the internship in addition to his/her ability to communicate this engagement in the journal, the report and the presentation. The journal and the report are to be submitted within a month of the completion of the internship. The department shall specify the criteria for evaluating the journal, the report and the presentation.

6.7 Journaling

During the 1st semester, students shall maintain a reflective journal, to develop within them a reflection that can be described as an inner dialogue, using visible thinking routine (Harvard), as a critical structure for guiding their journal writing. Journaling has to be done six days a week. At the end, the student will be awarded grade/marks after assessing their learning.

7.0 MASTER OF ARTS (MA) MASS COMMUNICATION

7.1 Specialisations

The Master’s Degree Programme in Mass Communication offers a number of specialisations, of which a student shall be required to choose a specialisation after the completion of the first semester. The department shall have the prerogative of not offering a specialisation if a sufficient number of students do not opt for it.

7.2 Media House Visits

During the course of the programme, students shall be required to visit a variety of Media Houses in small groups constituted by the department. The purpose of these Media House Visits shall be to gain exposure to the best practices among the day-to- day activities of the media house. A report of the visit is to be submitted in the format specified within two days of the visit. The Media House visit shall be a graded course and grades shall be awarded on the basis of the written reports of the media house visits.

7.3 Research Project Work

Every student shall undertake a research project work which has a bearing on his/her field of specialisation and present a written thesis on the research work under the supervision and guidance of a faculty member. The Research Project shall be undertaken individually, in two phases during the course of two semesters as shall be laid down in the course structure of the programme. Students are expected to make presentations to the department at different stages of the research work. The student shall write a dissertation of the research thesis, submit it to the department and appear for a viva voce examination at times to be notified by the department. The mode and components of evaluation of the research work and the weightages attached to them shall be published by the Department/Institute at the beginning of the semester.

7.4 Assignments

Assignments are an essential part of learning. The faculty shall engage students in a minimum of one individual and one group assignment per course, per semester. A group assignment shall be accompanied by a common presentation.

7.5 Internship

All students shall undergo an internship involving media related activities of four weeks' duration. The purpose of the internship is to give the students an opportunity to have a hands-on field experience to effectively put into practice the theoretical and practical learning from the programme in an area of interest. Students may undergo their internship in a media house of their choice. The student shall be required to discuss the choice of media house with the department and obtain its consent. Before going for the internship, a Letter of Consent from the concerned media house, in the prescribed format, shall be submitted by the student to the Department. After returning from the internship each student shall have to submit a detailed report in a prescribed format. Each student shall also make a presentation of the internship experience and learning in the Department and submit a certificate of successful completion of the internship from the designated authority of the concerned media house. The schedule of the conduct, report submission and evaluation of the internship shall be as notified by the Department. The components of evaluation of the Internship and their weightages shall be as notified by the department at the beginning of the semester.

7.6 Final Project

As a Final Project the students are required to create a Social Awareness and Community Development oriented multi-media project which shall culminate in a Media Event. The purpose of the final project is to showcase all the skills that the students have acquired during the course of the programme as well as demonstrate their Media and Event Management, and Media Entrepreneurship abilities and at the same time use these skills for the service and upliftment of the community. The Final Project shall essentially be a group project and the number of groups shall be specified by the department. The groups shall perform their activities under the guidance of faculty members who shall be assigned to guide each group. The last dates for the submission of the project proposal and the conduct of the event shall be notified by the Department well in advance. The components of evaluation of the Final Project and their weightages shall be as notified by the department at the beginning of the semester.

8.0 MASTER OF ARTS (MA) ENGLISH

8.1 Specialisations

The Master's Degree Programme in English offers a number of specialisations, of which a student shall be required to choose a specialisation after the completion of the second semester. The department shall have the prerogative of not offering a specialisation if a sufficient number of students do not opt for it.

8.2 Educational Seminar

During the course of the programme, students are expected to present a series of seminars related to English literature. They may also deal with other relevant topics which may be suggested by the department. Students shall prepare and present a final paper based on these seminars. Students shall be evaluated on the basis of the seminars and the final paper.

8.3 Assignments

Assignments are an essential part of learning. The faculty shall engage students in a minimum of one individual and one group assignment per course, per semester. A group assignment shall be accompanied by a common presentation.

8.4 Dissertation

Students will be required to write a dissertation in the 4th semester.

9.0 MASTER OF (MA) PUBLIC ADMINISTRATION

9.1 Specialisations

The Master's Degree Programme in Public Administration offers a number of specialisations, of which a student shall be required to choose a specialisation. The department shall have the prerogative of not offering a specialisation if a sufficient number of students do not opt for it.

9.2 Project Work/Dissertation

The Master's Degree Programme in Public Administration will require students to do Project work in the 3rd and 4th semesters. The mode and components of evaluation of the project work and the weightages attached to them shall be published by the department at the beginning of the semester.

9.3 Assignments

Assignments are an essential part of learning. The faculty shall engage students in a minimum of one individual and one group assignment per course, per semester. A group assignment shall be accompanied by a common presentation.

9.0 MASTER OF COMMERCE (MCOM)

9.1 Specialisations

The Master's Degree Programme in Commerce offers a number of specialisations, of which a student shall be required to choose a specialisation after the completion of the second semester. The department shall have the prerogative of not offering a specialisation if a sufficient number of students do not opt for it.

9.2 Project Work/Dissertation

The Master's Degree Programme in Commerce will require students to do Project work in the 3rd and 4th semesters. The mode and components of evaluation of the project work and the weightages attached to them shall be published by the department at the beginning of the semester.

9.3 Assignments

Assignments are an essential part of learning. The faculty shall engage students in a minimum of one individual and one group assignment per course, per semester. A group assignment shall be accompanied by a common presentation.

10.0 Admission

10.1 All admissions to the Post Graduate Degree Programmes of the University shall be on the basis of merit. There may, however, be provision for direct admission for a limited number of NRI/FN students.

10.2 Eligibility Criteria

10.2.1. To be considered for admission to a Post Graduate Degree Programme a candidate should have passed a Bachelor's Degree (or equivalent) programme of a recognised university securing 50% of the grades/marks.

10.2.2. Admission will be on the basis of the academic records of the candidate, and taking into consideration his/her performance in any or all of the following:

- Written test
- Group Discussion
- Personal Interview

10.3 Candidates whose results for the qualifying examination are not yet declared may be provisionally admitted provided she/he submits proof of fulfilment of the eligibility criteria by 31 October of the year of provisional admission.

10.4 Bridge Courses: The Departments shall make provision for Bridge Courses to facilitate admission of students from varied backgrounds to a programme of their choice.

10.5 Value-added Courses: Each department shall offer value-added courses, which are optional. Certificates will be awarded to those who successfully complete the course.

10.6 Anti-Ragging Affidavit: Students and Parents Undertaking Affidavit In compliance of the UGC Regulations, it is compulsory for each student and every parent to submit an online Anti-Ragging undertaking affidavit every academic year. The Link to fill out the online undertaking affidavit by students and parents is:

www.antiragging.in/affidavit_registration_disclaimer.html
www.c4yindia.org/Home/Undertaking

11.0 University Registration

11.1 Candidates shall have to register as bona-fide students with the University as per the University regulations within a period specified by the University, by a formal application routed through the Director.

12.0 Attendance

12.1 To be permitted to appear for the end-semester examination of a particular course, a student is required to have a minimum attendance of 75% for that course.

12.2 Deficiency in attendance up to 10% may be condoned by the Director in the case of leave taken for medical and other grievous reasons, which are supported by valid medical certificates and other requisite documents.

12.3 Some students, due to exceptional situations like their own serious sickness and hospitalization or death of members of inner family circle, may have attendance below 65%. Such students may be given bonus attendance percentage for a particular course based on his/her attendance for that course during the remaining days of the current semester, as given in the following table:

Attendance during the remaining days of the current semester	Bonus percentage available in the current semester
95% or more	5
90% or more but less than 95%	4
85% or more but less than 90%	3
80% or more but less than 85%	2
75% or more but less than 80%	1

They shall be permitted to appear for the end-semester examination of the course if on the strength of this bonus attendance percentage, they obtain 65% attendance for that course.

12.4 If the sum of the credits of the courses for which a student is unable to appear at the end- semester examinations exceeds 50% of the total credits allotted for the semester, he/she shall not be permitted to appear for the entire end-semester examinations in view of clause 13.5 of these Regulations.

12.5 The School may decide to set aside a certain portion of the in-semester assessment marks for attendance. The number of marks and modalities of their allotment shall be made known to the students at the beginning of each semester.

12.6 Leave

12.6.1 Any absence from classes should be with prior sanctioned leave. The application for leave shall be submitted to the Office of the Director of the School on prescribed forms, through the Head of the Department, stating fully the reasons for the leave requested along with supporting documents.

12.6.2 In case of emergency such as sickness, bereavement or any other unavoidable reason for which prior application could not be made, the parent or guardian must inform the office of the Director promptly.

12.6.3 If the period of absence is likely to exceed 10 days, a prior application for grant of leave shall have to be submitted through the Director to the Registrar with supporting documents in each case; the decision to grant leave shall be taken by the Registrar on the recommendation of the Director.

12.6.4 The Registrar may, on receipt of an application, also decide whether the student be asked to withdraw from the programme for that particular semester because of long absence.

12.6.5 It shall be the responsibility of the student to intimate the concerned teachers regarding his/her absence before availing of the leave.

13.0 Grading System

13.1 Based on the performance of a student, each student is awarded a final letter grade in each graded course at the end of the semester and the letter grade is converted into a grade point. The correspondence between percentage marks, letter grades and grade points is given in the table below:

Marks (x) obtained (%)	Grade	Description	Grade Points
90 ≥ x ≤ 100	O	Outstanding	10
80 ≥ x < 90	A+	Excellent	9
70 ≥ x < 80	A	Very Good	8
60 ≥ x < 70	B+	Good	7
50 ≥ x < 60	B	Above Average	6
40 ≥ x < 50	C	Average	5
35 ≥ x < 40	P	Pass	4
x < 35	F	Fail	0
AB	Ab	Absent	0

In addition, a student may be assigned the grades ‘P’ and ‘F’ for pass marks and non- passing marks respectively, for Pass/No-pass courses, or the grade ‘X’ (not permitted).

13.1.1 A student shall be assigned the letter grade ‘X’ for a course if he/she is not permitted to appear for the end semester examination of that course due to lack of requisite attendance.

13.1.2 A letter grade ‘F’ or ‘X’ in any course implies failure in that course.

13.1.3 A student is considered to have completed a course successfully and earned the credits if she/he secures a letter grade other than ‘F’ or ‘X’.

13.2 At the end of each semester, the following measures of the performance of a student in the semester and in the programme up to that semester shall be computed and made known to the student together with the grades obtained by the student in each course:

13.2.1 The Semester Grade Point Average (SGPA): From the grades obtained by a student in the courses of a semester, the SGPA shall be calculated using the following formula:

$$SGPA = \frac{\sum_{i=1}^{n} GP_i \text{ x } NC_i}{\sum_{i=1}^{n} NC_i}$$

Where GP_i = Grade points earned in the i^{th}course
NC_i = Number of credits for the i^{th}course
n = the number of courses in the semester

13.2.2 The Cumulative Grade Point Average (CGPA): From the SGPAs obtained by a student in the completed semesters, the CGPA shall be calculated using the following formula:

$$CGPA = \frac{\sum_{i=1}^{n} SGP_i \text{ x } NSC_i}{\sum_{i=1}^{n} NSC_i}$$

Where SGP_i = Semester Grade point of the i^{th} semester
NSC_i = Number of credits for the i^{th} semester
n = the number of semesters completed

13.2.3 The CGPA may be converted into a percentage by multiplying CGPA by 10.

13.3 Both the SGPA and CGPA will be rounded off to the second place of decimal and recorded as such. Whenever these CGPA are to be used for official purposes, only the rounded off values will be used.

13.4 There are academic and non-academic requirements for the programme where a student will be awarded the 'P' and 'NP' grades. All non-credit courses (such as Study Tour and Extra Academic Activities) belong to this category. No grade points are associated with these grades and these courses are not taken into account in the calculation of the SGPA or CGPA. However, the award of the degree is subject to obtaining a 'P' grade in all such courses.

14.0 Assessment of Performance

14.1 A student's performance is evaluated through a continuous system of evaluation comprising tests, quizzes, assignments, seminars, projects, research work, concurrent and block field work performance and end-semester examinations.

14.2 Theory Courses: Theory courses will have two components of evaluation – in-semester assessment of 40% weightage and an end-semester examination having 60% weightage.

14.2.1 The modalities of conduct of in-semester evaluation, its components and the weightages attached to its various components shall be published by the department concerned at the beginning of each semester.

14.3 Practicum/Field Work/Lab: These courses shall be evaluated on the basis of attendance, performance of tasks assigned and an end semester test/viva voce examination. The weightage assigned to these components of the evaluation is given in the following table:

Component	**Weightage**
Attendance	10
Performance of tasks assigned	30
End-semester test / viva voce examination	60

14.4 End-Semester examinations

14.4.1 End-semester examinations, generally of three hours' duration, shall be conducted by the University for the theory courses. However, the Director of the Institute shall make the arrangements necessary for holding the examinations.

14.4.2 In the end-semester examinations, a student shall be examined on the entire syllabus of the courses.

14.4.3 A student shall not obtain a pass grade for a course without appearing for the end- semester examination in that course.

14.5The evaluation of performance in Co-curricular Activities will be done by the authorities conducting them and they will communicate the grades to the Director who will forward them to the Controller of Examinations of the University.

14.6 The Director will forward the marks obtained in the in-semester evaluation to the Controller of Examinations within the prescribed time as may be notified.

14.7 All evaluated work in a subject except the end semester answer scripts will be returned to the students promptly. They should be collected back after the students have examined them, and preserved for a period of one semester.

14.8 Eligibility for appearing in the end-semester examinations: A student will be permitted to appear for the end-semester examinations, provided that

14.8.1 A student has not been debarred from appearing in the end semester examinations as disciplinary action for serious breach of conduct.

14.8.2 He/she has satisfactory attendance during the semester according to the norms laid out in section 9 of these regulations.

14.8.3 He/she has paid the prescribed fees or any other dues of the university, institute and department within the date specified.

14.9 Registration for end-semester Examinations

14.9.1 The University shall, through a notification, invite applications from students to register for the end-semester examinations.

14.9.2 Students who have registered with the University and those who have applied for such registration may apply to appear for the end-semester examinations of the university, in response to the notification issued by the University, provided that they fulfil the eligibility norms as laid down in clause 14.8.

14.9.3 All eligible candidates shall be issued an admit card for the relevant examination and for the specified courses. A student who does not have a valid admit card may not be permitted to write the end-semester examinations.

14.9.4 A student who secures an 'F' or 'X' grade in any course in a semester may register for the end-semester examination for that course in a subsequent semester when that course is offered again, within the maximum period of time allotted for the completion of the programme. The in-semester assessment marks obtained by him/her in the last semester in which the said course was attended by him/her shall be retained.

14.9.5 Similarly, in case of an 'NP' grade in Extra Academic Programmes the student shall have to re-register for it in the appropriate semester of the next academic session.

14.9.6 When a student re-registers for the end semester examination of a course, in accordance with clause 14.9.4 above, the better of the two grades obtained (the old and the new) shall be considered for the calculation of SGPA and CGPA.

14.10 Conduct of Examinations: The University shall conduct the end-semester examinations in accordance with the applicable regulations on such dates as are set down in the Academic Calendar or as notified.

14.11 Declaration of Results: The University shall declare the results of a semester and make available to the students their grade sheets within the time-frame prescribed by the relevant regulations of the university and specified in the academic calendar.

14.11.1 The University may withhold the results of a student for any or all of the following reasons

- he/she has not paid his/her dues
- there is a disciplinary action pending against him/her
- he/she has not completed the formalities for University Registration according to the requirement of section 6 of these Regulations.

14.12 Re-examining of answer scripts

14.12.1 If a student feels that the grade awarded to him/her in a course is not correct, he/she may apply to the University for the re-examining of his/her answer script.

14.12.2 Re-examining of scripts may be of two different categories – scrutiny and re-evaluation.

14.12.3 Scrutiny: The activities under this category shall ordinarily be confined to checking

- correctness of the total marks awarded and its conversion into appropriate letter grades
- whether any part/whole of a question has been left unevaluated inadvertently
- correctness of transcription of marks on the tabulation sheet and the grade sheet issued in respect of the course under scrutiny.

14.12.4 e-evaluation: Re-evaluation of the answer script by independent experts in the concerned subject(s).

14.12.5 Application for re-examining of answer scripts

- A student may apply for scrutiny or re-evaluation for one or more courses of the just- concluded end-semester examinations within seven calendar days from the date of publication of its results in the application form prescribed for this purpose.
- He/she shall pay the prescribed fee to the University as notified.
- A student applying for scrutiny/re-evaluation shall expressly state on the application form whether the application made is for Scrutiny or for Re- evaluation. In each case, the student may also request to see his/her answer script.
- All applications for scrutiny/re-evaluation must be routed through the Director of the Institute.

14.12.6 If in the process of re-examining, the grade obtained in a course changes, the better of the two grades shall be assigned to the course. If there is a change, the new grade shall be recorded and a new grade sheet shall be issued to the student.

14.12.7 Without prejudice to any of the clauses of section 14.12, a student who has been found to have used unfair means during an examination shall not be eligible to apply for scrutiny or re-evaluation of answer scripts.

14.13 Repeat Examination: The University shall conduct repeat examination for those with F grade at a different time slot, as set down in the Academic Calendar or as notified. Such students should register for these examinations.

14.14 Improvement Examination

14.14.1 After the completion of the entire programme of study, a student may be allowed the provision of improvement examinations. These are to be availed of only once each in the Autumn and Spring semesters that immediately follow the completion of the programme, and within the maximum number of years permissible for the programme.

14.14.2 A student may choose no more than six courses (three in the Autumn semester and three in the Spring semester) for improvement examinations.

14.14.3 After the improvement examination, the better of the two grades obtained (the old and the new) shall be considered for the calculation of SGPA and CGPA.

14.14.4 If the student improves his/her grades through the improvement examination, new grade sheets and comprehensive transcripts shall be issued to the student.

14.15 Special Examination

14.15.1 The University shall conduct Special Examinations to benefit the following categories of students:

14.15.1.1 Students who, on the completion of the final semester, have some 'F' graded courses in the two final semesters, but no 'F' or 'X' graded courses in any of the previous semesters

14.15.1.2 Students who have only one 'F' graded course in a semester other than the two final semesters and do not have 'F' or 'X' graded courses in the two final semesters.

14.15.2 The Special Examinations shall ordinarily be conducted each year within a month of the declaration of the results of the Spring Semester.

14.15.3 Students who fail to secure 50% of the credits offered in the final semester shall not be eligible to appear for the special examinations. Such students will be governed by the provisions of clause 15.5 of these regulations. However, this restriction shall not apply in the case of students who are unable to appear in the end semester examinations due to exceptional situations like their own serious illness and hospitalisation or death of members of inner family circle (restricted to only father, mother, siblings).

14.15.4 Students who have 'X' graded courses only in the last two semesters may be offered the opportunity for participating in a Tutorial Programme which may be conducted during the semester break immediately following the end- semester examinations of the final semester and students who earn 85% attendance for the programme shall be permitted to appear for the Special Examinations. Separate fees shall be charged for the Tutorial Programme.

14.15.5 Students who do not obtain pass grades in any course at the special examinations shall have to apply in the prescribed format and appear for the end-semester examination of these courses when they are scheduled by the University during subsequent relevant end-semester examinations.

15.0 Enrolment (for semesters other than the first)

15.1 Every student is required to enrol for the programme through the designated officer at the commencement of each semester on the days fixed for such enrolment and notified in the Academic Calendar.

15.2 Students who do not enrol on the days announced for the purpose may be permitted late enrolment up to the notified day in the Academic Calendar on payment of a late fee.

15.3 Only those students will be permitted to enrol who have

15.3.1 cleared all University, Institute, Department, Hostel and Library dues and fines (if any) of the previous semester,

15.3.2 paid all required University, Institute, Department and Hostel fees for the current semester, and

15.3.3 not been debarred from enrolling on any specific ground.

15.4 No student may enrol for a semester if he/she has not appeared, for whatever reason, in the end semester examinations of the previous semester.

15.5 A student who fails to obtain 50% of the credits offered in the third and subsequent semesters shall not be permitted to enrol for the next semester and shall have to re-enrol for and attend all the courses of the said semester in the following academic year. Students who due to X grade (lack of due attendance) have been debarred from exams in any semester (including first and second) will have to re-enrol for the same.

16.0 Eligibility for the Award of Degree

16.1 A student shall be declared to be eligible for the award of the degree if he/she has

16.1.1 completed all the credit requirements for the degree with grade 'C' or higher grade in each of the graded courses and grade 'P' in all the non-graded courses.

16.1.2 satisfactorily completed all the non-credit requirements for the degree (if any);

16.1.3 obtained a CGPA of 5.00 or more at the end of the semester in which he/she completes all the requirements for the degree;

16.1.4 owes no dues to the University, Institute, Department, Hostels; and

16.1.5 has no disciplinary action pending against him/her.

16.2 The award of the degree must be recommended by the Academic Council and approved by the Board of Management of the University.

17.0 Termination from the Programme

17.1 If more than the number of years permitted for the completion of a programme have elapsed since the student was admitted, and the student has not become eligible for the award of Degree, the student shall be removed from the programme.

17.2 A student may also be required to leave the Programme on disciplinary grounds on the recommendations of the Students' Disciplinary Committee of the concerned School.

SCHEME OF IN-SEMESTER ASSESSMENT

BACHELOR OF TECHNOLOGY (BTECH) DEGREE PROGRAMME

THEORY COURSES

For theory courses, in-semester assessment carries 40% weightage. Different components along with the weightage of each are given in the table below:

Component	Weightage	Remarks
Class Test (Two Class tests of one and a half hour duration)	20	Average of the two marks shall be considered
Assignment (Individual and Group)	10	Group assignments for two courses and individual assignments for the remaining courses
Non-formal evaluation	5	Based on response and interaction in class, quizzes, open book tests, etc.
Attendance	5	For norms regarding attendance cfr. clause 6 of the Regulations for Undergraduate Programmes

There shall be no re-test for In-semester assessment under any circumstance. The original marks of all the In-semester assessment components shall be retained for all further repeat examinations.

ATTENDANCE

Marks for attendance will be given according to the following scheme:

Attendance Percent (x)	Marks Allotted	
	Theory	Lab
75 <= x < 80	2	4
80 <= x < 90	3	6
90 <= x < 95	4	8
95 <= x 100	5	10

EVALUATION OF LABORATORY COURSES, DRAWING AND WORKSHOP

All Laboratory courses are evaluated on the basis of attendance, performance of tasks assigned and end semester test/viva voce examination. The distribution of marks within these components will be specified by individual departments along the lines of the break-up given below:

Component	Weightage
Attendance	10
assessment of tasks assigned	30
End Semester Test and/or Viva-Voce Examination	60
Total	100

In-Semester Evaluation of Minor and Mini Projects

The guidelines for the conduct and evaluation of Minor and Mini Projects shall be laid down by the Department. The components of evaluation and allotment of marks may be as follows:

In Semester Evaluation	Marks	End Semester Evaluation (weightage 40)	Marks
Synopsis	10	Project Implementation	16
Seminar presentation of synopsis (Analysis and Design)	15	Seminar Presentation	8
Progress Seminar (Implementation)	15	Viva Voce Examination	16
Project Documentation	10		
Attendance	10		
Total	60		40

In-Semester Evaluation of BTECH Major Project Phase I and Phase II

The in-semester evaluation of Major Project Phase I and Phase II shall have 60% weightage. The modality and conduct of the in-semester evaluation of the Major Project Phase I, and their weightages shall be declared by the DPEC of each department at the beginning of the semester. The following aspects are to be assessed, among others:

Synopsis presentation Progress seminars Progress reports Weekly activity reports

SCHEME OF IN-SEMESTER EVALUATION

POST GRADUATE DEGREE PROGRAMMES

MCA, MSW, MSC (Psychology), MA English, MA Education, MCOM
THEORY COURSES

The different components of the scheme of in-semester for the theory courses are given in the table below:

Component	**Weightage**
Class Test (Two class tests of equal weightage)	20
Assignments, Group Presentations/Seminar	10
Non-formal evaluation	5
Attendance	5
Total	**40**

Non-formal Evaluation

Non-formal evaluation may be done using a combination of quizzes, unannounced tests, open book tests, library work reports, class room interaction and participation, etc. The scheme of non- formal evaluation shall be announced by every teacher in the beginning of the semester.

Attendance

Marks for attendance will be given according to the following scheme:

Attendance Percent (x)	**Marks Allotted**
75 <= x < 80	2
80 <= x < 90	3
90 <= x < 95	4
95 <= x 100	5

NB: There shall be no re-test for in-semester Assessment under any circumstance. The original marks of all the in-semester Assessment components shall be retained for all further repeat examinations.

MCA Minor Project

The guidelines for the conduct and evaluation of the MCA Minor Project shall be laid down by the Department. The components of evaluation and allotment of marks will be as follows:

In Semester Evaluation	**Marks**	**End Semester Evaluation (Weightage 40)**	**Marks**
Synopsis	10	Project Implementation	16
Seminar presentation of synopsis (Analysis and Design)	15	Seminar Presentation	8
Progress Seminar (Implementation)	15	Viva Voce Examination	16
Project Documentation	10		
Attendance	10		
Total	60		40

In-Semester Evaluation of MCA Major Project

The in-semester evaluation of the MCA Major Project shall have 60% weightage. The Internal Evaluation of the Major project will be done through two seminar sessions:

Synopsis	:	20
Seminar Presentation of Synopsis (Analysis and Design)	:	30
Progress Seminar (Implementation)	:	30
Project Documentation	:	20

External Evaluation of all Major projects will follow the guidelines laid down in the Regulations.

MSW, MSc Psychology Field Work

The components of evaluation and their weightages for the concurrent/continuous fieldwork are as follows:

Component	Weightage
Field Work Diary	10
Agency Evaluation	15
Faculty Evaluation	20
Attendance	5
Viva Voce Examination	50
Total	100

Practicum

Field Report	:	15
Presentation	:	15
Administration of tests	:	10
Faculty Evaluation	:	10
Viva Voce Examination	:	50

MSW, MSc Psychology Research Project

Phase I

Literature Survey Presentation	:	40
Synopsis Presentation	:	60

Phase II

Examination of Thesis	:	50
Presentation and Viva Voce Exam	:	50

MTECH, MSC (Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Botany, Zoology)

THEORY COURSES

For theory courses, in-semester assessment carries 40% weightage. Different components along with the weightage of each are given in the table below:

Component	Weightage	Remarks
Class Test (Two Class tests of one and a half hour duration)	20	Average of the two marks shall be considered
Assignments	15	Written Assignments/Seminar on course Topics/ Technical Paper Review
Non-formal evaluation	5	Based on response and interaction in class, quizzes, open book tests, etc.
Total	40	

There shall be no re-test for In-semester assessment under any circumstance. The original marks of all the In-semester assessment components shall be retained for all further repeat examinations.

In-Semester Evaluation of Project (Phase I) / Research Project (Phase I) / Dissertation (Phase I)

The in-semester evaluation of Project Phase I / Research Project (Phase I) / Dissertation (Phase I) shall have 60% weightage. It shall be evaluated in the following seminar sessions having equal weightage:

Seminar 1: Presentation of the synopsis

Synopsis	:	30%
Seminar presentation of the synopsis	:	50%
Viva voce examination	:	20%

Seminar 2: Progress Seminar

Progress report	:	30%
Progress seminar	:	50%
Viva voce Examination	:	20%

In-Semester Evaluation of Project (Phase II) / Research Project (Phase II) / Dissertation (Phase II)

The in-semester evaluation of Project Phase II / Research Project (Phase II) / Dissertation (Phase II) shall have 60% weightage. The in-semester evaluation will be done through two seminar sessions having equal weightage. Each seminar will be evaluated using the following components.

Progress Report	:	30
Progress Seminar	:	50
Viva Voce Examination	:	20

External Evaluation of the project / Research Project / Dissertation shall follow the guidelines laid down in the Regulations.

RULES, PROCEDURES AND BEHAVIOURAL GUIDELINES

1. Dress Code and Identity Card

1.1 The dress code of the University consists of shirt / top (of the prescribed colour and material), trousers (of the prescribed colour and material), shoes (black) and socks (dark grey), a belt (black/dark brown, if required) and a tie (blue, with diagonal stripes). Students are required to come to the University following this dress code. The tie will be required to be worn only on formal occasions. An apron (of the prescribed colour) is to be worn in the Chemistry Lab and during Workshop Practice. During winter, students may wear only a blazer and/or a sweater (full sleeve or sleeveless) of the prescribed colour and material.

1.2 The Student Identity Card is to be brought to the University every day and is to be produced whenever asked for. Entry to the University campus shall be only on production of the Identity Card. The Identity Card is also the Library Card.

1.3 All students should wear the ID card around the neck from entry in the morning to exit in the evening.

2. Morning Assembly

2.1 The morning assembly is a daily programme in the university on all class days during which all members, i.e., students, faculty, staff and management meet together. The assembly starts at the prescribed time. During the assembly, important announcements are made and a thought or insight is shared. The assembly is concluded with an invocation to God to bless the activities of the day. Note that any announcement made at the morning assembly is considered as being equivalent to notifying the same in the notice boards. All students should reach the assembly venue before prescribed time. Immediately after assembly all should proceed to the classroom to start class. Any change in procedures will be notified by the concerned School at the beginning of the Semester.

2.2 One of the following prayers may be used to conclude the Morning Assembly:

The Our Father
Our Father, who art in heaven,
Hallowed be thy name, Thy kingdom come, Thy will be done on earth as it is in heaven.
Give us this day, our daily bread
And forgive us our trespasses
As we forgive those who trespass against us. And lead us not into temptation,
But deliver us from all evil, Amen.

Or

Prayer for Peace
Lord, make me an instrument of your peace,
where there is hatred, let me sow love;
where there is injury, pardon;
where there is doubt, faith;
where there is despair, hope;
where there is darkness, light;
where there is sadness, joy;
O Divine Master, grant that I may not so much seek to be consoled as to console;
to be understood as to understand;
to be loved as to love.
For it is in giving that we receive;
it is in pardoning that we are pardoned;
and it is in dying that we are born to eternal life. Amen

3. Punctuality in Attending Classes

3.1 All are expected to be at their respective assembly venues five minutes before assembly time.

3.2 Normally no student shall leave the University before all the classes are over. In case of an emergency, a student may leave with proper written permission from the HOD of the concerned department.

4. Make-up Classes, Leave of Absence and Earned Attendance

4.1 If any student misses any laboratory class due to illness or other grievous problems, he/she is required to meet the concerned teacher for completing the experiments as soon as possible. Such make-up attendance will be taken into consideration at the end of the semester if attendance is less than 75%. At most two make-up attendances may thus be earned by any student.

4.2 Any student who is required to be engaged in a University activity or a pre-planned training and placement activity during class hours, may apply for the grant of an ‘earned attendance’ from the concerned HODs in the prescribed form available at the Reception. Such applications must be forwarded by the Activity In-Charge. For club related activities, Faculty Advisor of the concerned club will be the Activity In- Charge. In all other cases, Faculty In-Charge or Assistant Faculty In-Charge of Student Affairs will be the Activity In-Charge. Filled up forms shall be submitted preferably before or in case of emergency, immediately after the activity for which earned attendance is to granted.

4.3 Any student going to participate in any activity or competition outside the University must apply to the Faculty In-Charge of student Affairs using the prescribed form which must be forwarded by the Assistant Faculty In-Charge of Student Affairs in consultation with respective Club Advisers. On return, these students must report back to the Assistant Faculty In-Charge of Student Affairs for recording the outcome.

4.4 Any student who is not able to attend classes due to medical or other grievous reasons are required to apply for leave in the prescribed form along with valid medical certificates and other requisite documents, to the Faculty In-charge, students' affairs within seven days of joining back. Such applications must be signed by a parent of the student and forwarded by the mentor of the concerned student and the HOD of the concerned department. Only these students will be considered for condonement of deficiency in attendance.

5. Discipline

5.1 Personal, academic and professional integrity, honesty and discipline, a sense of responsibility and a high degree of maturity is expected of all students inside and outside the campus. Integrity calls for being honest in examinations and assignments, avoiding plagiarism and misrepresentation of facts.

5.2 Indulging in acts of violence, riotous or disorderly behaviour directed towards fellow students, faculty members or other employees of the institution/hostel in the campus or outside is considered to be a serious breach of discipline and will attract penalty.

5.3 Respect for Common Facilities: Care and respect for common facilities and utilities are an essential component of social responsibility. Any willful damage to University property must be made good by the persons concerned. Further, maintaining cleanliness of the classrooms and the entire campus is everyone's responsibility.

5.4 Substance Abuse: Chewing of tobacco, betel nut and the likes, smoking and the use of other addictive substances and alcoholic drinks are strictly prohibited. These should not be brought into or used within the campus of the University. Violation of this norm will lead to stern action.

5.5 Use of Cell Phones: Cell phones may be used in the University lawns, canteens andother open areas. However, the use of cell phones in classrooms and labs are strictly prohibited except when used for teaching/learning purposes with the explicit permission of the teacher concerned. The cell phone of anyone found violating this rule shall be confiscated and his/ her SIM card shall be taken away and retained in the University office for 7 days. If a person violates the norm for a second time, his/her mobile will be confiscated and retained in the University office till the end of the semester.

5.6 Use of Internet: The entire campus is wi-fi enabled and the students may use the Internet freely for educational purposes. Students may also use the Computing Centre for browsing the Net. However, the use of Internet to access unauthorized and objectionable websites is strictly prohibited.

5.7 All cases of indiscipline will be brought before the Students' Disciplinary Committee and the decisions made by the Committee for dealing with such cases shall be final.

6. Class Tests and Examinations

6.1 The conduct of examinations will be governed by the norms of the University.

6.2 The Student Identity Card shall be the Admit Card for the class tests

6.3 During class tests, all students are expected to enter the venue of the class test 15 minutes before the scheduled time of commencement. However, no one will be permitted into the examination hall after 15 minutes of the commencement of the class test and No one will be allowed to leave the examination hall until an hour has elapsed from the commencement of the class test.

6.4 No one is to leave the hall during examination for any purpose, except in case of an emergency.

6.5 Malpractices during class tests and examinations will not be tolerated and will attract stern action.

7. Ragging

Ragging and eve-teasing are activities which violate the dignity of a person and they will be met with zero tolerance. Anti-ragging norms have been given to each student at the time of admission and all students and parents have signed the anti-ragging affidavit. Any case of ragging and eve-teasing must be reported to the anti-ragging squad. All cases of violation of anti-ragging norms will be taken up by the anti-ragging Committee and punished according to the norms.

8. Grievance Redressal

The University has constituted a Grievance Redressal Cell to redress any genuine grievance students may have. Any student having a genuine grievance may make a representation to the Grievance Redressal Cell through his/her mentor. The representation should be accompanied by all relevant documents in support of the genuineness of the grievance.

9. School Association

9.1 The School Association is an association of the representatives of the various stake holders of the School – students, staff, faculty and management. It is the responsibility of the School Association to take charge of organizing most of the co-curricular activities such as the annual festivals, quizzes, debates, competitions and social events.

9.2 A male and a female student are elected by the students of each class as "class representatives" to represent them in the School Association. Class representatives are expected to be outstanding students who are academically competent and having qualities of leadership.

10. Participation in University Activities

10.1 In order to provide opportunities for the holistic development of the human person, a large number of co-curricular and extra-curricular activities are designed and implemented under the banner of the University Association and student clubs. Some of the most important activities are D'VERVE & BOSCOSIADE (intra- University sports and cultural festival during University Week), PRAJYUKTTAM (the inter-University technical festival). All students are expected to take part actively in such activities to showcase their talents, to develop leadership qualities and to gain the experience of working in groups.

10.2 **Training and Placement Activities:** The training and Placement Cell of DBCET has been incorporated with the objective of minimizing the gap between industry and academia and giving the students training and exposure so that they can capitalize on every opportunity for placement. It is the prime responsibility of the cell to look after all matters concerning 'Training to enhance employability' and 'guiding students for placement'. In the first two semesters, students are trained for communication skills development under the department of Humanities and Social Sciences, and personal development programmes under the department of campus ministry. From the third semester onwards, in every semester, students are given systematic training in aptitude tests, communication skills, group discussion, etc. They are also made to undergo mock HR and Technical Interviews. These activities of the training and placement cell find a place in the curriculum as Extra Academic Programmes (EAP) and all students are required to get a P grade for these activities by taking an active part in these activities regularly.

Other departments of the University offer customised services in training and placement of their students.

11. Free Time

Some hours without class may be available for some students during the day. Students are expected to use such 'free time' for visiting the library, meeting teachers and mentors, self- study, carrying out lab or project related activities, etc.

12. Faculty Performance Feedback

In order to improve the teaching and learning process in the University, students will be required to give feedback about the performance of their teachers from time-to-time. All students are expected to participate in the online feedback sessions concerning their teachers with sincerity and responsibility.

13. Mentoring

All students are assigned mentors from among the faculty members for their guidance. Directors of Schools in collaboration with the Heads of Departments will take care of assigning mentors. Mentors shall help the students to plan their courses of study, advise them on matters relating to academic performance and personality development, and help them to overcome various problems and difficulties faced by them. Although students should meet their mentors on a regular basis to get timely help, specific days have been set aside in the calendar for meeting mentors to ensure proper documentation of achievements, activities, shortcomings and problems faced by the students. Every student must meet the mentor during these days.

14. Interaction Meet with Parents

The University organises interaction meetings with parents once a year in which the parents are invited to interact with teachers and management to appraise themselves about the performance of their ward and also to offer their suggestions for the betterment of the institution. It is the responsibility of the students too to invite their parents to come and participate in the event and make the event meaningful.

SCHOOL OF TECHNOLOGY

Abbreviations used:	
Basic Science Course/IC	BS/IC
Engineering Science Course/IC	ES/IC
Mandatory Course/IC	MC/IC
Humanities & Social Sciences including Management/IC	HS/IC
Professional Core Courses/DC	PC/DC
Professional Elective Courses/DE	PE/DE
Open Elective Courses/IE	OE/IE
Project/DC	PR/DC

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

PROGRAMME: BACHELOR OF TECHNOLOGY (BTECH) - COMPUTER SCIENCE AND ENGINEERING

Type	Type of Course/ Category	Course Code	Course Title	L-T-P	Credits	Page
SEMESTER I						
Theory	BS/IC	PSPT0038	Physics for Technologists	3-1-0	4	502
	BS/IC	MACL0012	Mathematics I - Calculus and Linear Algebra	3-1-0	4	494
	ES/IC	CSPS0079	Programming for Problem Solving	3-0-0	3	84
Lab	BS/IC	PSTC6016	Physics for Technologists- Lab	0-0-4	2	506
	ES/IC	CSPL6069	Programming for Problem Solving Lab	0-0-4	2	167
	ES/IC	CVED6024	Engineering Graphics and Design	1-0-4	3	238
	MC/IC	BTUH0001	Universal Human Values I: Student Induction Program	0-0-0	NC	517
Total Credits					**18**	
SEMESTER II						
Theory	BS/IC	CHEC0027	Engineering Chemistry	3-1-0	4	
	BS/IC	MAIN0013	Mathematics II- Multiple Integrals, Numerical Methods and Differential Equations	3-1-0	4	
	ES/IC	EEBE0038	Basic Electrical Engineering	3-1-0	4	256
	HS/IC	EGEH0111	English	2-0-0	2	508
Lab	BS/IC	CHCE6006	Engineering Chemistry Lab1	0-0-4	1	493
	HS/IC	EGOC6005	Oral Communication Practice Lab	0-0-2	1	509
	ES/IC	EEBL6027	Basic Electrical Engineering Laboratory	0-0-2	1	316
	ES/IC	MNWM6023	Workshop/Manufacturing Practice	1-0-4	3	480
Total Credits					20	
SEMESTER III						
Theory	BS/IC	MAPS0024	Mathematics III-Probability and Statistics	2-0-0	2	496
	ES/IC	ECEC0050	Analog Electronic Circuits	3-0-0	3	348
	PC/DC	CSOP0080	Object Oriented Programming	3-0-0	3	85
	PC/DC	CSDE0172	Digital Electronics	3-0-0	3	84
	PC/DC	CSDS0082	Data structure and Algorithm	3-0-0	3	85
Lab	ES/IC	ECEC6039	Analog Electronic Circuits Lab	0-0-2	1	429
	PC/DC	CSOP6070	Object Oriented Programming Lab	0-0-4	2	167
	PC/DC	CSDE6109	Digital Electronics Lab	0-0-4	2	168
	PC/DC	CSDS6072	Data Structure and Algorithm Lab	0-0-4	2	168
Internship		BTIA8	Internship Programme		2	
	(MC/IC)	BTUH0002	Universal Human Values II: Understanding Harmony		3	517
Total Credits					**26**	
SEMESTER IV						
Theory	PC/DC	MADM0025	Discrete Mathematics with Applications	3-1-0	4	164
	PC/DC	CSOA0083	Computer Organization & Architecture	3-0-0	3	87
	PC/DC	CSRD0084	Database Management Systems	3-0-0	3	88
	PC/DC	CSAD0085	Design and Analysis of Algorithms	3-0-0	3	89
	HS/IC	MTOB0086	Organisational Behaviour	3-0-0	3	511
Lab	PC/DC	CSOA6073	Computer Organization & Architecture Lab	0-0-4	2	168
	PC/DC	CSRD6074	Database Management Systems Lab	0-0-4	2	169
	PC/DC	CSAD6075	Design and Analysis of Algorithms Lab	0-0-4	2	170
	MC/IC	CHES0029	Environmental Science		0	
	MC/IC	EDCI0200	Constitution of India	0-0-0	NC	
		CBUI104T	Understanding India	0-0-1		520

Total Credits					**22**	
SEMESTER V						
Theory	PC/DC	CSFA0122	Formal Language & Automata Theory	3-0-0	3	122
	PC/DC	CSOS0123	Operating Systems	3-0-0	3	123
	PC/DC	CSDC0124	Data Communication	3-0-0	3	125
	PE/IC	CSAA0103	Advanced Algorithms	3-0-0	3	105
		CSSE0127	Software Engineering			125
		CSAI0143	Artificial Intelligence			137
	HS/IC	MTEE0104	Economics for Engineers	3-0-0	3	512
Lab	PC/DC	CSOS6082	Operating Systems Lab	0-0-4	2	173
	PC/DC	CSDC6083	Data Communication Lab	0-0-4	2	174
Project	PR/IC	CSMI6084	Mini Project I	0-0-2	1	174
			Value Added Course		0	
Internship		BTIP13	Internship Seminar		3	
Total Credits					**23**	
SEMESTER VI						
Theory	PC/DC	CSCD0128	Compiler Design	3-0-0	3	127
	PC/DC	CSNT0129	Computer Networks	3-0-0	3	128
	PE/DE	CSPD0144	Parallel and Distributed Algorithms	3-0-0	3	138
		CSAP0145	Advanced Computer Architecture	3-0-0	3	139
		CSML0146	Machine Learning	3-0-0	3	140
			Robotics Process Automation	3-0-0	3	
	PE/DE	CSCC0147	Computational Complexity	3-0-0	3	141
		CSDS0148	Distributed Systems	3-0-0	3	142
		CSDM0149	Data Mining	3-0-0	3	142
	OE/IE	MTPO0106	Production and Operations Management	3-0-0	3	515
			Soft skills			
			Course from Swayam			
Lab	PC/DC	CSCD6085	Compiler Design Lab	0-0-4	2	166
	PC/DC	CSNT6086	Computer Networks Lab	3-0-0	2	166
	PE/DE	CSPP6094	Parallel and Distributed Algorithms Lab	0-0-2	1	175
		CSAC6095	Advanced Computer Architecture Lab			176
		CSML6096	Machine Learning Lab			176
			Robotics Process Automation Lab			
	PE/DE	CSCC6097	Computational Complexity Lab	0-0-2	1	177
		CSDS6098	Distributed Systems Lab			178
		CSDM6099	Data Mining Lab			178
Project	PE/DE	CSMI6091	Mini Project II	0-0-2	1	175
Total Credits					**22**	
SEMESTER VII						
Theory	BS/IC	BOBY0003	Biology	2-0-0	2	506
	PE/DE	CSCG0150	Computational Geometry	3-1-0	4	143
		CSOS0151	Advanced Operating Systems	3-1-0	4	144
		CSSN0152	Speech and Natural Language Processing	3-1-0	4	145
	PE/DE	CSCY0153	Computational Number Theory	3-0-0	3	146
		CSRT0154	Real Time Systems	3-0-0	3	147
		CSIR0155	Information Retrieval	3-0-0	3	147
	OE/IE	CSEC0163	E-Commerce and Cyber Security	3-0-0	3	154
		CSIC0164	ICT for development	3-0-0	3	154
			Course from Swayam			
Lab	PE/DE	CSCG6100	Computational Geometry Lab	0-0-2	1	177
		CSAS6101	Advanced Operating Systems Lab			179
		CSSN6102	Speech and Natural Language Processing Lab			180
	PR/IC	CSMP6103	Major Project- Phase I	0-0-4	2	181

			Value Added Course	0-0-0	NC	
Internship	PR/IC	BTIP15	Industrial Training		3	
Total Credits					18	
SEMESTER VIII						
Theory	PE/IC	CSQC0156	Quantum Computing	3	DE	148
		CSAD0157	Ad Hoc and Sensor Networks	3	DE	149
		CSNN0158	Neural Networks and Deep Learning	3	DE	150
		CSBF0159	Blockchain Fundamentals	3	DE	151
	OE/IE	CSCM0160	Cloud Computing	3	IE	151
		CACB0165	Cyber law and ethics	3	IE	155
			Course from Swayam	3	IE	
	OE/IE	CSBA0161	Business Analytics	3	IE	152
		CSNT0162	Computer Networks			153
			Course from Swayam			
Project	PR/IC	CSMP6104	Major Project- Phase II	3	DC	181
		PYTK0103	Essence of Indian Traditional Knowledge	0	NC	519
Total Credits				**12**		
Total Programme Credits				**161**		

Note: BTIP12 - Credits Recognized & Forwarded from Diploma/BSc- 3 Credits for CSE, EE, CVE and ECE BTECH Programmes

LIST OF OPEN ELECTIVES

Type	Course code	Course Name	L-T-P	Credits
Semester VII				
Open Elective –I	CSEC0163	E-Commerce and Cyber Security		3
	CSIC0164	ICT for development	154	3
		Course from Swayam		3
Semester VIII				
Open Elective –II	CSCM0160	Cloud Computing		3
	CACB0165	Cyber law and ethics	155	3
		Course from Swayam		3
Open Elective –III	CSBA0161	Business Analytics		3
	CSNT0162	Computer Networks		3
		Course from Swayam		3

LIST OF VALUE ADDED COURSES

1	CSCS6106	Introduction to Cyber security (Page 182)	2-0-0
2	CSDM6107	3D Designing. Modeling and printing	2-0-0

PROGRAMME: BTECH (HONOURS) - COMPUTER SCIENCE AND ENGINEERING

For B.Tech (Honors) in CSE students will have to earn extra 18 Credits in addition to the regular BTECH courses. There are two Specializations for BTECH (Honors) in CSE for a student to opt for.

Specialization: Data Science

Sl. No.	Course Name	Semester	Credits	Page
SYJP0001	Joy of Computing using Python	3	4	
CSID0166	Introduction to Data Science	4	4	156
CSMF0086	Mathematical Foundation for Computer Science	5	4	90
CSDV0171	Data Visualization	6	2	
CSDV6107	Data Visualization Lab	6	2	
CSDA0176	Data Analytics	7	4	163
		Total	**20**	

Specialization: Internet of Things

Sl. No.	Course Name	Semester	Credits	Page No
SYJP0001	Joy of Computing using Python	3	4	
CSII0167	Introduction to IoT	4	4	157
CSRA0173	Introduction to Raspberry Pi and Arduino	5	2	161
CSRA6108	Introduction to Raspberry Pi and Arduino Lab	5	2	161
CSIP0174	IoT Platform and System Design	6	4	162
CSSS0175	Smart Sensors and Sensor Networking	7	4	163
		Total	**20**	

PROGRAMME: (BTECH MINOR) - COMPUTER SCIENCE AND ENGINEERING

For BTECH Minor in CSE, a student must earn a **minimum of 18 credits** in addition to the regular BTECH courses, by choosing a combination of courses from the list below:

Semester	Course Codes	Course Name	Credits	Page
Sem III	CSDA0168	Data Structures and Algorithms (Theory)	4	157
	CSDA6105	Data Structures and Algorithms (Lab)	1	
Sem IV	CSOA0169	Computer Organisation and Architecture / Course from Swayam	4	158
Sem V		Formal language and automata theory/ Course from Swayam	3	
Sem VI		Database management systems / Course from Swayam	3	
		Database management systems Lab	1	
Sem VII	CSOS0170	Operating systems / Course from Swayam	4	159
		Total Credits	**20**	

PROGRAMME: MASTER OF TECHNOLOGY (MTECH) COMPUTER SCIENCE AND ENGINEERING

SEMESTER I						
Type	**Category**	**Course Code**	**Course Name**	**L-T-P**	**Credits**	**Page**
	Specialization: Data Science					
Theory	Core 1	CSMF0086	Mathematical foundations of Computer Science	3-0-0	3	90
	Core 2	CSDT0087	Advanced Data Structures	3-0-0	3	91
	Core 3	ECRM0042	Research Methodology and IPR	2-0-0	2	341
	Prog. Specific Elective I	CSSC0088	Data Science	3-0-0	3	92
		CSDI0089	Distributed Systems	3-0-0	3	93
		CSDP0090	Data Preparation and Analysis	3-0-0	3	94
	Prog. Specific Elective II	CSRS0091	Recommender System	3-0-0	3	94
		CSML0092	Machine Learning	3-0-0	3	96
		CSTN0093	Data Storage Technologies and Networks	3-0-0	3	97
Lab	Lab1	CSDT6076	Advanced Data Structures Lab	0-0-4	2	170
	Lab2	CSML6077	Machine Learning Lab	0-0-4	2	170
	Specialization: Internet of Things					
Theory	Core 1	CSMF0086	Mathematical foundations of Computer Science	3-0-0	3	90
	Core 2	CSDT0087	Advanced Data Structures	3-0-0	3	91
	Core 3	ECRM0042	Research Methodology and IPR	2-0-0	2	341
	Prog. Specific Elective I	CSSC0088	Data Science	3-0-0	3	92
		CSWA0094	Wireless Access Technologies	3-0-0	3	97
		CSMS0095	Mobile Applications and Services	3-0-0	3	98
	Prog. Specific Elective II	CSML0092	Machine Learning	3-0-0	3	96
		CSSI0096	Smart Sensors and Internet of Things	3-0-0	3	99
		CSLF0097	Logic and Functional programming	3-0-0	3	100
Lab	Lab1	CSDT6076	Advanced Data Structures Lab	0-0-4	2	170
	Lab 2	CSML6077	Machine Learning Lab	0-0-4	2	170

	Specialization: Information Security					
Theory	Core 1	CSMF0086	Mathematical foundations of Computer Science	3-0-0	3	90
	Core 2	CSDT0087	Advanced Data Structures	3-0-0	3	91
	Core 3	ECRM0042	Research Methodology and IPR	2-0-0	2	341
	Prog. Specific Elective I	CSDF0098	Digital Forensics	3-0-0	3	101
		CSEH0099	Ethical Hacking	3-0-0	3	102
		CSID0100	Intrusion Detection	3-0-0	3	103
	Prog. Specific Elective II	CSMR0101	Malware Analysis & Reverse Engineering	3-0-0	3	104
		CSSC0102	Secure Software Design and Enterprise Computing	3-0-0	3	105
		CSML0092	Machine Learning	3-0-0	3	96
Lab	Lab1	CSDT6076	Advanced Data Structures Lab	0-0-4	2	170
	Lab2	CSML6077	Machine Learning Lab	0-0-4	2	170
Audit	Audit 1	EGRW0015	English for Research Paper Writing	2-0-0	0	508
Total Credits					18	
SEMESTER II						
	Specialization: Data Science					
Theory	Core 3	CSAA0103	Advance Algorithms	3-0-0	3	105
	Core 4	CSSP0104	Soft Computing	3-0-0	3	106
	Prog. Specific Elective III	CSDV0105	Data Visualization	3-0-0	3	107
		CSBD0106	Big Data Analytics	3-0-0	3	108
		CSDD0107	Data Warehouse and Data Mining	3-0-0	3	109
	Prog. Specific Elective IV	CSDS0108	Data Security and Access Control	3-0-0	3	110
		CSWD0109	Web Analytics and Development	3-0-0	3	111
		CSKD0110	Knowledge Discovery	3-0-0	3	112
		CSNL0111	Natural Language Processing	3-0-0	3	113
Lab	Lab3	CSAA6078	Advanced Algorithm Lab	0-0-2	2	171
	Lab4	CSDV6079	Data Visualisation Lab	0-0-2	2	171
	Specialization: Internet of Things					
Theory	Core 3	CSAA0103	Advance Algorithms	3-0-0	3	105
	Core 4	CSSP0104	Soft Computing	3-0-0	3	106
	Prog. Specific Elective III	CSNI0112	Sensor Networks and Internet of Things	3-0-0	3	113
		CSDV0105	Data Visualization			107
		CSAC0113	IoT Application and Communication Protocols			114
	Prog. Specific Elective IV	CSBD0106	Big Data Analytics	3-0-0	3	108
		CSNY0114	Network Security			115
		CSAM0115	Advanced Machine Learning			116
Lab	Lab3	CSAA6078	Advanced Algorithm Lab	0-0-2	2	171
	Lab4	CSDV6079	Data Visualisation Lab	0-0-2	2	171
	Specialization: Information Security					
Theory	Core 3	CSAA0103	Advance Algorithms	3-0-0	3	105
	Core 4	CSSP0104	Soft Computing	3-0-0	3	106
	Prog. Specific Elective III	CSEC0116	Data Encryption & Compression	3-0-0	3	117
		CSSW0117	Steganography & Digital Watermarking			118
		CSIT0118	Information Theory & Coding			119
	Prog. Specific Elective IV	CSRA0119	Security Assessment and Risk Analysis	3-0-0	3	120
		CSCD0120	Secure Coding			121
		CSBI0121	Biometrics			122
Lab	Lab3	CSAA6078	Advanced Algorithm Lab	0-0-2	2	171
	Lab4	CSEN6080	Data Encryption & Compression Lab	0-0-2	2	172
Project		CSMI6081	Mini Project with Seminar	0-0-2	2	173
Audit	Audit 2 (MOOCs)	EDCI0100	Constitution of India	0-0-0	0	
		CBUI104T	Understanding India	0-0-1		520
Total Credits					18	
SEMESTER III						
	Specialization: Data Science					

Theory	Prog. Specific Elective V	CSCG0134	GPU Computing	3-0-0	3	129
		CSCL0135	Cloud Computing			130
		CSDD0136	Distributed Databases			131
	Specialization: Internet of Things					
	Prog. Specific Elective V	CSCL0135	Cloud Computing	3-0-0	3	132
		CSIS0137	IOT and Smart Cities			133
		CSEM0138	Emulation and Simulation Methodologies			134
	Specialization: Information Security					
	Prog. Specific Elective V	CSDM0139	Data Warehousing & Mining	3-0-0	3	134
		CSWI0140	Web Search & Information Retrieval			135
		CSDY0141	Database Security and Access Control			136
	Open Elective	CSBA0142	Business Analytics	3-0-0	3	136
Project	Dissertation	CSDI6092	Dissertation Phase – I	0-0-20	10	175
Total Credits				**6-0-20**	16	
SEMESTER IV						
	Specialization: Data Science					
Project	Dissertation	CSDI6093	Dissertation Phase – II	0-0-32	16	175
	Specialization: Internet of Things					
	Dissertation	CSDI6093	Dissertation Phase – II	0-0-32	16	175
	Specialization: Information Securities					
	Dissertation	CSDI6093	Dissertation Phase – II	0-0-32	16	175
Total Credits				0-0-32	16	

Note: Mandatory Course EDPC0201: Indian Polity and Constitution

DEPARTMENT OF CIVIL ENGINEERING

PROGRAMME: BACHELOR OF TECHNOLOGY (BTECH)- CIVIL ENGINEERING

Type	Type of Course/ Category	Course Code	Course Name	L-T-P	Credits	Page No
SEMESTER I						
Theory	BS/IC	CHCE0027	Engineering Chemistry	3-1-0	4	
	BS/IC	MACL0012	Mathematics I - Calculus and Linear Algebra	3-1-0	4	494
	ES/IC	EEBE0038	Basic Electrical Engineering	3-1-0	4	256
Lab	BS/IC	CHCE6007	Engineering Chemistry Lab	0-0-2	2	493
	ES/IC	EEBL6027	Basic Electrical Engineering Laboratory	0-0-2	1	316
	ES/IC	MNWM6023	Workshop/Manufacturing Practice	1-0-4	3	480
	MC/IC	BTUH0001	Universal Human Values I: Student Induction Program	0-0-0	NC	517
Total Credits					18	
SEMESTER II						
Theory	BS/IC	PSEP0039	Engineering Physics: Mechanics	3-1-0	4	503
	BS/IC	MAIN0013	Mathematics II-Multiple Integrals, Numerical Methods and Differential Equations	3-1-0	4	495
	ES/IC	CSPS0079	Programming for Problem Solving	3-0-0	3	84
	HS/IC	EGEH0111	English	2-0-0	2	508
Lab	BS/IC	PSEG6017	Physics Lab for Engineers	0-0-2	1	506
	ES/IC	CVED6024	Engineering Graphics and Design	1-0-4	3	238
	HS/IC	EGOC6005	Oral Communication Practice Lab	0-0-2	1	509
	ES/IC	CSPL6069	Programming for Problem Solving Lab	0-0-4	2	167
	MC/IC	EDCI0100	Constitution of India	0-0-0	NC	
		CBUI104T	Understanding India	0-0-1		520
Total Credits					**20**	
SEMESTER III						
Theory	ES/IC	ECBE0051	Basic Electronics	1-0-0	1	349
	BS/IC	BOBE0002	Biology for Engineering	3-0-0	3	
	ES/IC	MNEM0034	Engineering Mechanics	3-1-0	4	444
	ES/IC	CVES0046	Energy science and Engineering	1-1-0	2	189
	BS/IC	MATD0028	Mathematics III- Transform Calculus and Discrete Mathematics	2-0-0	2	499
	HS/IC	CVIC0054	Introduction to Civil Engineering	3-0-0	3	
Lab	ES/IC	ECBE6040	Basic Electronics Lab	0-0-2	1	429
	ES/IC	CVCA6025	Computer Aided Civil Engineering Drawing Lab	1-0-2	2	239
Internship		BTIA8	Internship Activity	0-0-2	2	
	MC/IC	BTUH0002	Universal Human Values II: Understanding Harmony	3-0-0	3	517
Total Credits					**23**	
SEMESTER IV						
Theory	ES/DC	MNME0041	Elements of Mechanical Engineering	2-1-1	3	
	PC/IC	CVIS0053	Instrumentation and sensor Technologies for Civil Engineering Applications	1-1-0	2	
	PC/IC	CVEG0047	Engineering Geology	1-0-0	1	190
	PC/IC	CVDP0048	Disaster Preparedness & Planning	1-1-0	2	191
	PC/IC	CVFM0049	Introduction to Fluid Mechanics	2-0-0	2	192
	PC/IC	CVSM0050	Introduction to Solid Mechanics	2-0-0	2	193
	PC/IC	CVSG0051	Surveying & Geomatics	1-1-0	2	194
	PC/IC	CVMT0052	Materials, Testing and Evaluation	1-1-0	2	196

Lab	PC/IC	CVIS6031	Instrumentation & Sensor Technologies for Civil Engineering Applications Lab	0-0-2	1	197
	PC/IC	CVEG6026	Engineering Geology Lab	0-0-2	1	240
	PC/IC	CVFM6027	Introduction to Fluid Mechanics Lab	0-0-2	1	240
	PC/IC	CVSM6028	Introduction to Solid Mechanics Lab	0-0-2	1	240
	PC/IC	CVSG6029	Surveying & Geomatics Lab	0-0-2	1	241
	PC/IC	CVMT6030	Materials, Testing and Evaluation Lab	0-0-2	1	241
	MC/IC	MTOB0086	Organizational Behaviour	3-0-0	0	511
Total Credits					**22**	
SEMESTER V						
Theory	PC/IC	CVMM0056	Mechanics of Materials	3-0-0	3	199
	PC/IC	CVHE0057	Hydraulic Engineering	2-0-0	2	200
	PC/IC	CVSE0058	Structural Engineering	2-1-0	3	202
	PC/IC	CVGE0059	Geotechnical Engineering	2-0-0	2	203
	PC/IC	CVHW0060	Hydrology & Water Resources Engineering	2-1-0	3	205
	PC/IC	CVEE0061	Environmental Engineering	2-0-0	2	206
	PC/IC	CVTE0062	Transportation Engineering	2-0-0	2	207
	HS /IC	MTPP0105	Professional Practice, Law & Ethics	2-0-0	2	513
	MC/IC	CVSL0200	Service Learning - Theory	2-0-0	NC	245
Lab	PC/IC	CVHE6031	Hydraulic Engineering Lab	0-0-2	1	242
	PC/IC	CVGE6032	Geotechnical Engineering Lab	0-0-2	1	243
	PC/IC	CVEE6033	Environmental Engineering Lab	0-0-2	1	243
	PC/IC	CVTE6034	Transportation Engineering Lab	0-0-2	1	244
Internship		BTIP13	Internship Seminar	0-0-2	2	
Total Credits					25	
SEMESTER VI						
Theory	PC/IC	CVCM0063	Construction Engineering & Management	2-1-0	3	208
	PC/IC	CVEC0064	Engineering Economics, Estimation & Costing	2-1-0	3	210
	PE/ DE Elective-I	CVCS0065	Design of Concrete Structures I	3-0-0	3	211
		CVED0066	Civil Engineering Design I			212
	PE/ DE Elective-II	CVSA0068	Structural Analysis I	3-0-0	3	213
		CVBP0069	Building Construction Practice			214
		CVGI0070	Geographic Information Systems and Science			215
	OE/IC Open Elective-I (HS)	CVIC0071	Soft Skills and Interpersonal Communication	3-0-0	3	216
	PE/ DC Elective-III	CVSS0072	Design of Steel Structures	3-0-0	3	217
		CVRS0073	Repairs and Rehabilitation of Structures	3-0-0	3	218
		CVPT0074	Physio Chemical Process of Water and Waste Water Treatment	3-0-0	3	219
	PE/ DE Elective-IV	CVRE0075	Railway Engineering	3-0-0	3	219
		CVOC0076	Open Channel Flow	3-0-0	3	220
		CVSM0077	Soil Mechanics II	3-0-0	3	221
		CVEG0108	Elements of Geoinformatics	3-0-0	3	
Lab	PC/DC	CVEC6035	Engineering Economics, Estimation & Costing-Lab	0-0-4	2	244
Mandatory Course	(Activity Point Programme)	CVSL0200	Service Learning-Field Work	0-0-6	NC	245
	Internship	BTIP14	Internship (Survey Camp)	0-0-2	1	
Total Credits					24	
SEMESTER VII						
Theory	ES/IC	MBLS0001	Life Science	1-0-2	2	490
	PE/ DE	CVCS0090	Design of Concrete Structures II	3-0-0	3	221

	Elective V	CVHS0067	Design of Hydraulic Structures and Irrigation Engineering			
		CVPC0091	Prestressed Concrete			222
	PE/ DE Elective VI	CVSA0092	Structural Analysis II	3-0-0	3	223
		CVPH0093	Port and Harbor Engineering			224
		CVTM0094	Traffic Engineering and Management			224
	OE/IC Open Elective-II	CVMS0095	Metro Systems and Engineering	3-0-0	3	225
		CVRG0103	Remote Sensing and GIS			232
	PR/IC	CVMP6049	Project I-Minor Project	0-0-2	1	245
	Internship	CVIT6041	Industrial Training		3	244
Total Credits					15	
SEMESTER VIII						
Theory	PE/ DE Elective VII	CVBE0096	Bridge Engineering	3-0-0	3	226
		CVBH0097	Basics of Computational Hydraulics			227
		CVSH0098	Solid and Hazardous Management			227
	PE/ DE Elective VIII	CVEE0099	Earthquake Engineering	3-0-0	3	228
		CVST0100	Structural Dynamics			229
		CVMM0107	Structural Analysis by Matrix Methods			233
	OE/IC Open Elective-III	CVEL0101	Environmental Laws and policy	3-0-0	3	230
	OE/IC Open Elective-IV	CVSE0102	Sustainable engineering and Technology	3-0-0	3	231
	PR/IC	CVPJ6043	Project-II	0-0-8	4	245
		PYTK0103	Essence of Indian Traditional Knowledge	0-0-0	NC	519
Total Credits					**16**	
Total Programme Credits					**163**	

Note: BTIP12 - Credits Recognized & Forwarded from Diploma/BSc- 3 Credits for CSE, EE, CVE and ECE BTECH Programmes

LIST OF PROFESSIONAL ELECTIVE COURSES/OPEN ELECTIVE COURSES

I. PROFESSIONAL ELECTIVE COURSES

	Course code	Course Name	L-T-P	Credits
Semester VI				
Elective I	CVCS0065	Design of Concrete Structures I	3-0-0	3
	CVED0066	Civil Engineering Design I		
Elective II	CVSA0068	Structural Analysis I	3-0-0	3
	CVBP0069	Building Construction Practice		
	CVGI0070	Geographic Information Systems and Science		
Elective III	CVSS0072	Design of Steel Structures	3-0-0	3
	CVRS0073	Repairs and Rehabilitation of Structures		
	CVPT0074	Physico-chemical Processes of Water and Wastewater Treatment		
Elective IV	CVRE0075	Railway Engineering	3-0-0	3
	CVOC0076	Open Channel Flow		
	CVSM0077	Soil Mechanics II		
Semester VII				
Elective V	CVCS0090	Design of Concrete Structures II	3-0-0	3
	CVPC0091	Prestressed Concrete		
	CVHS0067	Design of Hydraulic Structures and Irrigation Engineering		
Elective VI	CVSA0092	Structural Analysis II	3-0-0	3
	CVPH0093	Port and Harbor Engineering		
	CVTM0094	Traffic Engineering and Management		
Semester VIII				
Elective VII	CVBE0096	Bridge Engineering	3-0-0	3

Elective VIII	CVBH0097	Basics of Computational Hydraulics	3-0-0	3
	CVSH0098	Solid and Hazardous Waste Management		
	CVEE0099	Earthquake Engineering		
	CVST0100	Structural Dynamics		
	CVMM0107	Structural Analysis by Matrix Methods		

I. OPEN ELECTIVE COURSES

	Course code	Course Name	L-T-P	Credits
Semester VI Open Elective I	CVIC0071	Soft Skills and Interpersonal Communication	3-0-0	3
Semester VII Open Elective II	CVMS0095	Metro Systems and Engineering	3-0-0	3
	CVRG0103	Remote Sensing and GIS		
Semester VIII Open Elective III	CVEL0101	Environmental Law and Policy	3-0-0	3
Semester VIII Open Elective IV	CVSE0102	Sustainable Engineering and Technology	3-0-0	3

PROGRAMME: BTECH (HONOURS) - CIVIL ENGINEERING

For B.Tech (Honors) in Civil Engineering, students will have to earn extra 18 Credits in addition to the regular BTECH courses.

There are two domains for BTECH (Honors) in Civil Engineering for a student to opt for.

LIST OF COURSES FOR HONOURS

Domain 1) Environmental Engineering

Sl. No.	Course Name	Credits	Link
1	Plastic Waste Management	2	https://nptel.ac.in/courses/105/105/105105184/
2	Electronic Waste Management	1	https://nptel.ac.in/courses/105/105/105105169/
3	Applied Environmental Microbiology	3	https://nptel.ac.in/courses/105/107/105107173/
4	Water and Wastewater Treatment	3	https://nptel.ac.in/courses/105/105/105105178/
5	Water Supply Engineering	3	https://nptel.ac.in/courses/105/105/105105201/
6	Environmental Remediation	3	https://nptel.ac.in/courses/105/107/105107181/
7	Environmental Chemistry and Microbiology	3	https://nptel.ac.in/courses/102/105/102105087/
8	Applied Environmental Microbiology	3	https://nptel.ac.in/courses/105/107/105107173/
9	Integrated Waste Management for a Smart City	3	https://onlinecourses.nptel.ac.in/noc21_ce46/preview -3rd semester students
10	Wastewater Treatment and Recycling	3	https://onlinecourses.nptel.ac.in/noc21_ce49/preview -5th Sem students

Domain 2) Construction Technology

Sl. No.	Course Name	Credits	Link
1	Land Scape Architecture and Site Planning-Basic Fundamentals	2	https://nptel.ac.in/courses/124/105/124105001/
2	Maintenance and Repair of Concrete Structures	3	https://nptel.ac.in/courses/105/106/105106202/
3	Basic Construction Materials	3	https://onlinecourses.nptel.ac.in/noc21_ce10/preview
4	Safety in Construction	2	https://nptel.ac.in/courses/105/102/105102206/
5	Development and Application of Special Concrete	3	https://nptel.ac.in/courses/105/104/105104206/
6	Principles of Construction Management	2	https://nptel.ac.in/courses/105/104/105104161/
7	Construction Methods and Equipment	2	https://nptel.ac.in/courses/105/103/105103206/

	Management		
8	Concrete Technology	3	https://nptel.ac.in/courses/105/102/105102012/ https://nptel.ac.in/courses/105/104/105104030/ https://nptel.ac.in/courses/105/106/105106176/
9	Project Planning & Control	3	https://onlinecourses.nptel.ac.in/noc21_ce50/preview
10	Hydration, Porosity & Strength of Cementitious Materials - for 3rd Semester	3	https://onlinecourses.nptel.ac.in/noc21_ce66/preview
11	Elastic Stability of Structures	3	https://onlinecourses.nptel.ac.in/noc22_ce91/preview
12	Plates and shells	3	https://onlinecourses.nptel.ac.in/noc22_ce80/preview

PROGRAMME: BTECH (MINOR) - CIVIL ENGINEERING

For BTECH Minor in Civil Engineering, a student must earn a **minimum of 18 credits** in addition to the regular BTECH courses, by choosing a combination of courses from the list below

LIST OF MINOR COURSES OFFERED

Sl. No.	Course Name	Credits	Link
1	Basic Construction Materials	3	https://nptel.ac.in/courses/105/106/105106206/ https://nptel.ac.in/courses/105/102/105102088/
2	Geographic Information System	3	https://nptel.ac.in/courses/105/107/105107155/ https://nptel.ac.in/courses/105/107/105107206/
3	Geomorphology	3	https://nptel.ac.in/courses/105/107/105107200/
4	Maintenance and Repair of Concrete Structures	3	https://nptel.ac.in/courses/105/106/105106202/
5	Remote Sensing-Principles and Applications	3	https://nptel.ac.in/courses/105/101/105101206/ https://nptel.ac.in/courses/105/103/105103193/ https://nptel.ac.in/courses/105/107/105107201/ https://nptel.ac.in/courses/105/108/105108077/ https://nptel.ac.in/courses/105/107/105107160/
6	Strategies for Sustainable Design	3	https://nptel.ac.in/courses/124/106/124106157/
8	Introduction to Civil Engineering Profession	2	https://nptel.ac.in/courses/105/106/105106201/
9	Architectural Conservation and Historic Preservation	2	https://nptel.ac.in/courses/124/105/124105003/
10	Safety in Construction	2	https://nptel.ac.in/courses/105/102/105102206/
11	Natural Hazards	2	Https://nptel.ac.in/courses/105/104/105104183/

LIST of VALUE-ADDED COURSES offered by CIVIL ENGINEERING DEPARTMENT

SNO	Course Code	Course name	Credits	Page
1	CVAD6046	Training on Computer Aided Drafting	2-0-0	247
2	CVBA6047	Training on Building Modeling and analysis using STAAD Pro	2-0-0	247
3	CVMA6048	Training on Modeling and analysis using ABACUS	2-0-0	248
4	CVCR6050	Detailing and Drafting of Concrete Reinforcement	2-0-0	248

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAMME: BACHELOR OF TECHNOLOGY (BTECH) – ELECTRICAL AND ELECTRONICS ENGINEERING

SEMESTER I						
Type	**Type of Course/ Category**	**Course Code**	**Course Name**	**L-T-P**	**Credits**	**Page**
Theory	BS/IC	PSPT0038	Physics for Technologists	3-1-0	4	502
	BS/IC	MACL0012	Mathematics I - Calculus and Linear Algebra	3-1-0	4	494
	ES/IC	CSPS0079	Programming for Problem Solving	3-0-0	3	84
Lab	BS/IC	PSTC6016	Physics for Technologists- Lab	0-0-4	2	506
	ES/IC	CSPL6069	Programming for Problem Solving Lab	0-0-4	1	167
	ES/IC	CVED6024	Engineering Graphics and Design	1-0-4	3	238
	MC/IC	BTUH0001	Universal Human Values I: Student Induction Program	0-0-0	NC	517
Total Credits					18	
SEMESTER II						
Theory	BS/IC	CHCE0027	Engineering Chemistry	3-1-0	4	492
	BS/IC	MAIN0013	Mathematics II-Multiple Integrals, Numerical Methods and Differential Equations	3-1-0	4	495
	ES/IC	EEBE0038	Basic Electrical Engineering	3-1-0	4	256
	HS/IC	EGEH0111	English	2-0-0	2	508
Lab	BS/IC	CHEC6006	Engineering Chemistry Lab1	0-0-4	1	
	ES/IC	EEBL6027	Basic Electrical Engineering Laboratory	0-0-2	1	316
	ES/IC	MNWM6023	Workshop/Manufacturing Practice	1-0-4	3	480
	HS/IC	EGOC6005	Oral Communication Practice Lab	0-0-2	1	509
Total Credits					20	
SEMESTER III						
Theory	PC/DC	EECA0041	Electrical Circuit Analysis	3-1-0	4	256
	PC/DC	EEAE0042	Analog Electronics	3-0-0	3	257
	PC/DC	EEMC0044	Electrical Machines – I	3-0-0	3	259
	PC/DC	EEDE0045	Digital Electronics	3-0-0	3	261
	HS/IC	MTEC0074	Economics for Engineers	2-0-0	2	
Lab	PC/DC	EEAE6028	Analog Electronics Lab	0-0-2	1	316
	PC/DC	EEMC6029	Electrical Machines Lab - I	0-0-2	1	317
	PC/DC	EEDE6030	Digital Electronics Lab	0-0-2	1	318
	MC/IC	EDCI0100	Constitution of India		NC	
		CBUI104T	Understanding India	0-0-1		520
	MC/IC	CHES0029	Environmental Science		NC	491
	Internship	BTIA8	Internship Activity		3	
	MC/IC	BTUH0002	Student Induction Program: Understanding Harmony	0-0-0	NC	517
Total Credits					21	
SEMESTER IV						
Theory	ES/IC	MNEE0042	Engineering Mechanics for Electronics and Electricals	3-1-0	4	453
	PC/DC	EEMS0046	Electrical Machines – II	3-0-0	3	262
	PC/DC	EEEF0043	Electromagnetic Fields	3-0-0	3	258
	PC/DC	EEPE0047	Power Electronics	3-0-0	3	262
	BS/IC	MACS0027	Mathematics III – Complex Variable, Transform Calculus and Probability and Statistics	3-1-0	4	498
	BS/IC	BOBI0001	Biology	2-1-0	3	488

	HS/IC	MTOB0069	Introduction to Organisational Behaviour	2-0-0	2	511
Lab	PC/DC	EEMS6031	Electrical Machines – II Lab	0-0-2	1	318
	PC/DC	EEPE6032	Power Electronics Laboratory	0-0-2	1	319
Total Credits					**24**	
SEMESTER V						
Theory	PC/DC	EEPS0072	Power Systems -I	3-0-0	3	282
	PC/DC	EECS0073	Control Systems	3-0-0	3	283
	PC/DC	EEMM0074	Microprocessors and Microcontrollers	3-0-0	3	284
	PC/DC	EESS0075	Signals and Systems	3-0-0	3	285
	PE/DE	EEED0076	Electrical Machine Design	2-0-0	2	286
		EEEW0077	Electromagnetic Waves	2-0-0	2	287
	OE/SE/IE	EEED0078	Electronic Devices	3-0-0	3	255
Lab	PC/DC	EEMM6042	Microprocessors and Microcontrollers Laboratory	0-0-2	1	323
	PC/DC	EERS6043	Power Systems Laboratory - I	0-0-2	1	324
	PC/DC	EECS6044	Control Systems Laboratory	0-0-2	1	324
Project	PC/DC	EEMI6045	Mini Project-I	0-0-2	1	325
Internship		BTIP13	Internship Seminar		3	
Total Credits					24	
SEMESTER VI						
Theory	PC/DC	EEPS0079	Power Systems - II	3-0-0	3	288
	PC/DC	EEMI0080	Measurements and Instrumentation	2-0-0	2	289
	HS/IC	MTPO0106	Production and Operations Management	3-0-0	3	515
	PE/DE	EEED0082	Electrical Drives	3-0-0	3	289
		EEHV0083	High Voltage Engineering	3-0-0	3	290
	PE/DE	EEDS0084	Digital Control Systems	3-0-0	3	291
		EEDP0085	Digital Signal Processing	3-0-0	3	292
	OE/SE/IE		Embedded Systems(ECE) Numerical Methods and Optimization (MNE)	3-0-0	3	
Lab	PC/DC	EEPS6046	Power Systems Laboratory - II	0-0-2	1	325
	PC/DC	EEMI6047	Measurements and Instrumentation Lab	0-0-2	1	326
	PC/DC	EEED6048	Electronic Design Laboratory	1-0-4	3	326
Project	PC/DC	EEMI6049	Mini Project-II	0-0-2	1	327
Total Credits					23	
SEMESTER VII						
	HS/IC	MTFC0107	Financial Management and Accounting		2	516
	PC/DC	EEAD0093	Analog and digital Communications		3	296
	PE/IC	EESP0094	Power System Protection		3	296
		EERE0095	Renewable Energy			297
	OE/SE/IE		Power Plant Engineering(MNE) Introduction to Artificial Intelligence and Machine Learning (ECE) ICT for development (CSE) E commerce and cyber security (CSE) Metro Systems Engineering(CVE) Remote sensing and GIS (CVE)		3	
	PC/DC	EEIT6052	Industrial Training		3	
	PC/DC	EEMP6053	Major Project Phase-I		1	328
Total Credits					18	
SEMESTER VIII						
Theory	PE/IC	EEPQ0096	Power Quality and FACTS		3	298
		EESD0116	Power System Dynamics and Control			313
	PE/IC	EEIS0097 EECA0098	Industrial Electrical Systems Electrical Energy Conservation and Auditing		3	299 300

	OE/SE/IE		Internet of things (ECE) Bioinformatics (ECE) Cloud computing (CSE) Business Analytics (CSE) Robotics and Automation (MNE) Numerical Methods and Optimization (MNE)		3	
	MC/IC	PYTK0103	Essence of Indian Traditional Knowledge		NC	519
Project	PC/IC	EEMP6054	Major Project Phase II and Viva		3	329
Total Credits					12	
Total Programme Credits					160	

Note: BTIP12 - Credits Recognized & Forwarded from Diploma/BSc- 3 Credits for CSE, EE, CVE and ECE BTECH Programmes

OPEN ELECTIVE COURSES – BTECH (EEE)

Semester V						
Type	**Type of Course/ Category**	**Course Code**	**Course Title**	**L-T-P**	**Credits**	**Page**
Theory	OE/SE/IE	EEEL0096	Electrical Machines (L-T-P is different from "Electrical Machines (minor)" offered for BTECH Minor)	3-0-0	3	314
		EEWE0092	Waste to Energy	3-0-0		
Semester VI						
Type	**Type of Course/ Category**	**Course Code**	**Course Title**	**L-T-P**	**Credits**	**Page**
Theory	OE/SE/IE	EEOD0099	Optoelectronic Devices	3-0-0	3	301
		EEEL0100	Electrical and Electronics Materials			302
Semester VII						
Type	**Type of Course/ Category**	**Course Code**	**Course Title**	**L-T-P**	**Credits**	**Page**
Theory	OE/SE/IE	EESS0075	Signals and Systems	3-0-0	3	
		EEOT0101	Optimization Techniques			304
Semester VIII						
Type	**Type of Course/ Category**	**Course Code**	**Course Title**	**L-T-P**	**Credits**	**Page**
Theory	OE/SE/IE	EEGE0102	Green Energy	3-0-0	3	304
Total Credits					**12**	

PROGRAMME: BTECH (HONOURS) – ELECTRICAL AND ELECTRONICS ENGINEERING

For B.Tech (Honors) in EEE, students will have to earn extra 18 Credits in addition to the regular BTECH courses.
There are two domains for BTECH (Honors) in EEE for a student to opt for.
In each domain, courses for 12 credits will be taught in the physical classroom and 6 credits will be earned from NPTEL/SWAYAM courses in self-learning mode

Sl. No.	**Domain**	**Course Code**	**Courses**	**L-T-P**	**Credit**	**Semester**	**Learning Mode**
1	**Power Systems**	EEEU0103	Energy Efficiency in Electrical Utilities	4-0-0	4	4	Taught Pg (305)
2		EEED0104	Electrical Distribution System Analysis	4-0-0	4	5	Taught (Pg 306)
3			Ongoing NPTEL/SWAYAM courses	4-0-0	3	6	NPTEL/SWAYAM
4			Ongoing NPTEL/SWAYAM courses	4-0-0	3	7	NPTEL/SWAYAM
5		EEDM0105	DC Microgrid	4-0-0	4	8	Taught (Pg 307)

Total Credits					**18**		
1	**Control Systems**	EEPO0106	Practical Applications of Op-Amp	4-0-0	4	4	Taught (Pg 308)
2			Ongoing NPTEL/SWAYAM courses	4-0-0	3	5	NPTEL/SWAYAM
3			Ongoing NPTEL/SWAYAM courses	4-0-0	3	6	NPTEL/SWAYAM
4		EESD0107	Sensors and Transducers	4-0-0	4	7	Taught (Pg 309)
5		EEPI0108	Process Control and Instrumentation	4-0-0	4	8	Taught (Pg 310)
Total Credits					**18**		

PROGRAMME: BTECH (MINOR) – ELECTRICAL AND ELECTRONICS ENGINEERING

For BTECH Minor in EEE, a student must earn a **minimum of 18 credits** in addition to the regular BTECH courses, by choosing a combination of courses from the list below:

Semester III						
Type	**Type of Course/ Category**	**Course Code**	**Course Title**	**L-T-P**	**Credits**	**Page**
Theory		EEEM0109	Electrical Machines (Minor)	3-0-0	3	311
		EEEW0110	Electrical Wiring	2-0-2		312
Semester IV						
Type	**Type of Course/ Category**	**Course Code**	**Course Title**	**L-T-P**	**Credits**	**Page**
Theory		EEMI0080	Measurements and Instrumentation	2-0-2	3	
		EEEL0100	Electrical and Electronics Materials	3-0-0		
Semester V						
Type	**Type of Course/ Category**	**Course Code**	**Course Title**	**L-T-P**	**Credits**	**Page**
Theory		EEAE0042	Analog Electronics	3-0-0	3	
		EECS0073	Controls System			
		EEWE0092	Waste to Energy			
Semester VI						
Type	**Type of Course/ Category**	**Course Code**	**Course Title**	**L-T-P**	**Credits**	**Page**
Theory		EEOD0099	Optoelectronic Devices	3-0-0	3	
		EEBC0111	Basic Communication Systems			312
Semester VII						
Type	**Type of Course/ Category**	**Course Code**	**Course Title**	**L-T-P**	**Credits**	**Page**
Theory		EEPS0072	Power Systems-I	3-0-0	3	
		EEED0078	Electronic Devices			255
Semester VIII						
Type	**Type of Course/ Category**	**Course Code**	**Course Title**	**L-T-P**	**Credits**	**Page**
Theory		EEIS0097	Industrial Electrical Systems	3-0-0	3	
		EECA0098	Electrical Energy Conservation and Auditing			
Total Credits					**18**	

VALUE ADDED COURSES BY ELECTRICAL AND ELECTRONICS ENGINEERING DEPARTMENT

Semester	Course Code	Course Title	L-T-P	Credits	Page
6	EEAR0112	Introduction to Arduino and Raspberry Pi	0-1-2	2	330
7	EEAL0113	AutoCAD Electrical	0-1-2	2	330
7	EEEL0114	Electrical Wiring	0-1-2	2	331
8	EEPY0115	Python for Electrical Engineering	0-1-2	2	332

PROGRAMME: MASTER OF TECHNOLOGY (MTECH) - ELECTRICAL AND ELECTRONICS ENGINEERING

SEMESTER I						
Type	**Course Type/Category**	**Course Code**	**Course Name**	L-T-P	**Credits**	**Page**
	Specialization: Power Systems					
Theory	Core 1	EESA0048	Power System Analysis	3-0-0	3	263
	Core 2	EESD0049	Power System Dynamics-I	3-0-0	3	264
	Core	ECRM0042	Research Methodology and IPR	2-0-0	2	341
	Programme Specific Elective I	EEHP0050	High Power Converters	3-0-0	3	265
		EEWS0051	Wind and Solar Systems			266
	Programme Specific Elective II	EEPD0052	Electrical Power Distribution System	3-0-0	3	267
		EEMM0053	Mathematical Methods for Power Engineering			268
Lab	Lab1	EESS6033	Power System Steady State Analysis Lab	0-0-4	2	320
	Lab2	EERE6034	Renewable Energy Lab	0-0-4	2	320
		Specialization: Control Systems				
Theory	Core 1	EEMC0054	Mathematical Methods in Control	3-0-0	3	269
	Core 2	EENS0055	Non-Linear Systems	3-0-0	3	269
	Core	ECRM0042	Research Methodology and IPR	2-0-0	2	341
	Programme Specific Elective I		Robotics and Automation	3-0-0	3	
		EECL0056	Digital Control			270
		EENC0057	Non-Linear Control			271
	Programme Specific Elective II		Systems Biology	3-0-0	3	
		EESC0058	SCADA system and Applications			271
		EEDA0059	Design Aspects in Control			272
Lab	Lab1	EECT6035	Control Lab 1	0-0-4	2	321
	Lab 2	EECL6036	Control Lab 2	0-0-4	2	321
Audit	Audit 1	EGRW0015	English for Research Paper Writing	2-0-0	0	508
Total Credits				**16-0-8**	18	
SEMESTER II						
	Specialization: Power Systems					
Theory	Core 3	EEDP0060	Digital Protection of Power System	3-0-0	3	273
	Core 4	EEPD0061	Power System Dynamics-II	3-0-0	3	274
	Programme Specific Elective III	EERP0062	Restructured Power Systems	3-0-0	3	274
		EEAS0063	Advanced Digital Signal Processing			275
	Programme Specific Elective IV	EEAS0064	Power System Transients	3-0-0	3	276
		EEFC0065	FACTS and Custom Power Devices			277
Lab	Lab3	EEPL6037	Power System Protection Lab	0-0-4	2	321
	Lab4	EEPA6038	Power Electronics Applications to Power Systems Lab	0-0-4	2	322

	Specialization: Control Systems					
Theory	Core 3	EEOC0066	Optimal Control Theory	3-0-0	3	278
	Core 4	EESF0067	Stochastic Filtering and Identification	3-0-0	3	279
	Programme Specific Elective III	EECS0068	Advance Control System	3-0-0	3	279
		EEAL0069	Adaptive Learning and Control	3-0-0	3	280
	Programme Specific Elective IV	EEMR0070	Model Reduction in Control	3-0-0	3	281
		EERC0071	Robust Control	3-0-0	3	282
			Networked and Multi agent Control Systems			
			Advanced DSP			
Lab	Lab3	EEAL6039	Advanced Control Lab 1	0-0-4	2	322
	Lab4	EEAC6040	Advanced Control Lab 2	0-0-4	2	323
Project		EEMP6041	Mini Project	0-0-4	2	323
Audit	Audit 2 (MOOCs)	EDCI0100	Constitution of India	0-0-4	2	
		CBUI104T	Understanding India	0-0-1		520
Total Credits				**14-0-12**	**18**	
SEMESTER III						
	Specialization: Power Systems					
Theory	Prog. Specific Elective V	EESC0058	SCADA System and Applications	3-0-0	3	271
		EEMC0087	Advanced Micro-Controller Based Systems	3-0-0	3	293
		EEPQ0088	Power Quality			294
	Specialization: Control Systems					
	Prog. Specific Elective V	EEMD0089	Modeling and Control of Distributed parameter system	3-0-0	3	
		EESC0090	Stochastic Control	3-0-0	3	
		EESC0091	Computational Methods	3-0-0	3	
	Open Elective	EEWE0091	1. Business Analytics	3-0-0	3	
			2. Industrial Safety	3-0-0	3	
			3. Operations Research	3-0-0	3	
			4. Cost Management of Engineering Projects	3-0-0	3	
			5. Composite Materials	3-0-0	3	
		EEWE0091	6. Waste to Energy	3-0-0	3	295
Project	Dissertation	EEDI6050	Dissertation Phase – I	0-0-20	10	327
Total Credits				**6-0-20**	**16**	
SEMESTER IV						
Project	**Specialization: Power Systems**					
	Dissertation	EEDI6051	Dissertation Phase – II	0-0-32	16	328
	Specialization: Control Systems					
	Dissertation	EEDI6051	Dissertation Phase – II	0-0-32	16	328

Note: Mandatory Course EDPC0201: Indian Polity and Constitution

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

PROGRAMME: BACHELOR OF TECHNOLOGY (BTECH) - ELECTRONICS AND COMMUNICATION ENGINEERING

Type	Type of Course/ Category	Course Code	Course Name	L-T-P	Credits	Page
SEMESTER I						
Theory	BS/IC	PSPT0038	Physics for Technologists	3-1-0	4	502
	BS/IC	MACL0012	Mathematics I - Calculus and Linear Algebra	3-1-0	4	494
	ES/IC	CSPS0079	Programming for Problem Solving	3-0-0	3	84
Lab	BS/IC	PSTC6016	Physics for Technologists- Lab	0-0-4	2	506
	ES/IC	CSPL6069	Programming for Problem Solving Lab	0-0-4	2	167
	ES/IC	CVED6024	Engineering Graphics and Design	1-0-4	3	238
		BTUH0001	Universal Human Values I: Student Induction Program			517
Total Credits					18	
SEMESTER II						
Theory	BS/IC	CHCE0027	Engineering Chemistry	3-1-0	4	493
	BS/IC	MAIN0013	Mathematics II-Multiple Integrals, Numerical Methods and Differential Equations	3-1-0	4	495
	ES/IC	EEBE0038	Basic Electrical Engineering	3-1-0	4	256
	HS/IC	EGEH0111	English	2-0-0	2	508
Lab	BS/IC	CHCE6006	Engineering Chemistry Lab1	0-0-4	1	
	ES/IC	EEBL6027	Basic Electrical Engineering Laboratory	0-0-2	1	316
	ES/IC	MNWM6023	Workshop/Manufacturing Practice	1-0-4	3	480
	HS/IC	EGOC6005	Oral Communication Practice Lab	0-0-2	1	509
Total Credits					20	
SEMESTER III						
Theory	PC/DC	ECED0043	Electronic Devices	3-0-0	3	341
	PE/ DE	ECSS0044	Signal and Systems	2-1-0	3	342
	PC/IC	ECNT0045	Network Theory	2-1-0	3	343
	PC/IC	ECDS0046	Digital System Design	3-0-0	3	344
	BS /SC	MATC0026	Mathematics III- Transform Calculus, Complex Variable and Probability and Statistics	2-1-0	3	497
	HS /IC	MTEC0074	Economics for Engineers	2-0-0	2	
	MC/IC	CHES0029	Environmental Science	0-0-0	NC	491
Lab	PC /DC	ECED6034	Electronic Devices Lab	0-0-2	1	427
	PC /DC	ECDS6035	Digital System Design Lab	0-0-2	1	427
Internship		BTIA8	Internship Activity		3	
	MC/IC	BTUH0002	Universal Human Values II: Understanding Harmony	0-0-3	3	517
Total Credits					25	
SEMESTER IV						
Theory	PC /DC	ECAC0047	Analog Circuits	3-0-0	3	345
	PC /DC	ECEL0048	Electronic Measurements	3-0-0	3	346
	BS/IC	BOBI0001	Biology	2-1-0	3	
	PC/DC	ECDP0049	Digital Signal Processing	2-1-0	3	347
	ES /IC	MNEE0042	Engineering Mechanics for Electronics and Electricals	3-1-0	4	453
	HS/IC	MTOB0069	Introduction to Organisational Behaviour	2-0-0	2	511
Lab	PC/DC	ECAC6036	Analog Circuits Lab	0-0-2	1	427
	PC /DC	ECEL6037	Electronic measurements Lab	0-0-2	1	428
	PC /DC	ECDP6038	Digital Signal Processing Lab	0-0-2	1	428

	MC/IC	EDCI0200	Constitution of India	2-0-0	NC	
		CBUI104T	Understanding India	0-0-1		520
Total Credits					21	
SEMESTER V						
Theory	PC/DC	ECAC0081	Analog and Digital Communication	3-0-0	3	378
	PC/DC	ECMM0082	Microprocessors and Microcontrollers	3-0-0	3	378
	PC/DC	ECCA0083	Computer Architecture	3-0-0	3	380
	PC/DC	ECPS0084	Probability Theory and Stochastic Processes	3-0-0	3	381
	PE /DE	ECPE0085	Power Electronics	3-0-0	3	382
		ECBE0086	Biomedical Electronics			383
		ECSS0087	Speech Signal Processing			384
	OE/SE	ECNT0088	Nanotechnology	3-0-0	3	384
Lab	PC/DC	ECAC6052	Analog and Digital Communication Lab	0-0-2	1	435
	PC/DC	ECMM6053	Microprocessor and Microcontroller Lab	0-0-2	1	435
	PC/DC	ECMI6054	Mini Project	0-0-2	1	
Internship		BTIP13	Internship Seminar	0-0-0	3	
Total Credits					24	
SEMESTER VI						
Theory	PC /DC	ECCS0089	Control System	3-0-0	3	385
	PC/DC	ECNT0090	Computer Networks	3-0-0	3	386
	PC/DC	ECEW0091	Electromagnetic Waves	3-0-0	3	387
	PE/IC	ECCD0092	CMOS Design	3-0-0	3	388
		ECNE0093	Nanoelectronics			389
		ECIC0094	Information Theory and Coding			390
	OE/IC	ECRB0095	Robotics	3-0-0	3	391
	OE/IC	ECES0128	Embedded Systems			422
	HS /IC	MTPO0106	Production and Operations Management	3-0-0	3	515
Lab	PC/DC	ECEW6057	Electromagnetic Waves Lab	0-0-2	1	436
	PC/DC	ECNT6058	Computer Networks Lab	0-0-2	1	438
Internship		BTIP15	Industrial Training	0-0-0	0	
Total Credits					20	
SEMESTER VII						
Theory	PC /DC	ECWP0102	Antennas and Wave Propagation	3-0-0	3	398
			Wavelets	3-0-0	3	
	PE /DE	ECES0103	Embedded System	3-0-0	3	399
		ECMN0104	Mobile Communication and Networks	3-0-0	3	400
	PE/IC	ECWN105	Wireless Sensor Network	3-0-0	3	400
		ECSC0106	Satellite Communication	3-0-0	3	401
	OE/IC	ECAM0107	Introduction to Artificial Intelligence and Machine Learning	3-0-0	3	402
	HS/IC	MTFC0107	Financial Management and Accounting	2-0-0	2	516
Internship		ECPR6061	Project-I	0-0-2	1	437
		ECTS6062	Training Seminar	0-0-0	4	438
Total Credits					20	
SEMESTER VIII						
Theory	PE/IC	ECOC0108	Fiber Optic Communication	3-0-0	3	403
		ECAS0109	Adaptive Signal Processing	3-0-0	3	404
	PE /DE	ECMT0110	Microwave Theory & Technique	3-0-0	3	405
		ECDV0111	Digital Image and Video Processing	3-0-0	3	406
		ECMD0130	Mixed Signal Design	3-0-0	3	424
	OE/IC	ECIT0112	Internet of Things	3-0-0	3	407
	OE/IC	ECBI0113	Bioinformatics	3-0-0	3	408
Internship	PC /DC	ECPR6063	Project-II	0-0-9	3	438
	MC/IC	PYTK0103	Essence of Indian Traditional Knowledge		NC	519
Total Credits					**15**	
Total Programme Credits					**163**	

Note: BTIP12 - Credits Recognized & Forwarded from Diploma/BSc- 3 Credits for CSE, EE, CVE and ECE BTECH Programmes

LIST OF OPEN ELECTIVES

SEMESTER V						
Type	**Type of Course/ Category**	**Course Code**	**Course Name**	L-T-P	**Credits**	**Page**
Theory	OE/SE	ECNT0088	Nanotechnology	3-0-0	3	
SEMESTER VI						
Theory	OE/IC	ECRB0095	Robotics	3-0-0	3	
	OE/IC	ECES0128	Embedded Systems			422
SEMESTER VII						
Theory	OE/IC	ECAM0107	Introduction to Artificial Intelligence and Machine Learning	3-0-0	3	
SEMESTER VIII						
Theory	OE/IC	ECIT0112	Internet of Things	3-0-0	3	
	OE/IC	ECBI0113	Bioinformatics	3-0-0	3	

LIST OF VALUE ADDED COURSES

SPRING						
Type	**Type of Course/ Category**	**Course Code**	**Course Name**	L-T-P	**Credits**	**Page**
Theory	Value Added Course/DE	ECES6064	Electronic Display System	2-0-0	2	440
AUTUMN						
Theory	Value Added Course/DE	ECNA6065	Nanotechnology and Applications	2-0-0	2	440

PROGRAMME: BTECH (HONOURS) –ELECTRONICS AND COMMUNICATION ENGINEERING

For B.Tech (Honors) in Electronics and Communication Engineering, students will have to earn extra 18 Credits in addition to the regular BTECH courses.

There are two domains for BTECH (Honors) in ECE for a student to opt for.

LIST OF HONORS COURSES (IOT AND SENSOR TECHNOLOGY)

SEMESTER IV						
Type	**Type of Course/ Category**	**Course Code**	**Course Name**	**L-T-P**	**Credits**	**Page**
Theory	PC/IC	ECST0114	Sensor Technology	3-1-0	4	408
SEMESTER V						
Theory	PC/IC	ECBA0115	IoT Basics & Architecture	3-1-0	4	409
SEMESTER VI						
Theory	PC/IC	ECWT0116	Web Technology	3-1-0	4	410
SEMESTER VII						
Theory	PC/IC	ECML0117	Machine Learning	3-1-0	4	411
SEMESTER VIII						
Theory	PC/IC	ECET0118	Embedded Systems and IOT	3-1-0	4	412

LIST OF HONORS COURSES (SIGNAL PROCESSING AND VLSI)

SEMESTER IV						
Type	**Type of Course/ Category**	**Course Code**	**Course Name**	**L-T-P**	**Credits**	**Page**
Theory	PC/IC	ECVD0096	VLSI Design Technology	3-1-0	4	393

SEMESTER V						
Theory	PC/IC	ECSV0119	Signal Processing for VLSI	3-1-0	4	413
SEMESTER VI						
Theory	PC/IC	EDDS0120	Advance DSP	3-1-0	4	
SEMESTER VII						
Theory	PC/IC	ECML0117	Machine Learning	3-1-0	4	
SEMESTER VIII						
Theory	PC/IC	ECCV0121	Fundamentals of Computer Vision	3-1-0	4	415

PROGRAMME: BTECH (MINOR) –ELECTRONICS AND COMMUNICATION ENGINEERING

For BTECH Minor in ECE, a student must earn a **minimum of 18 credits** in addition to the regular BTECH courses, by choosing a combination of courses from the list below:

Type	**Type of Course/ Category**	**Course Code**	**Course Name**	**L-T-P**	**Credits**	**Page**
SEMESTER IV						
Theory	PE/SE	ECDC0122	Digital Circuits	3-1-0	4	416
SEMESTER V						
Theory	PE/SE	ECSC0123	Semiconductor Devices and Circuits	3-1-0	4	417
SEMESTER VI						
Theory	PE/SE	ECFC0124	Fundamentals of Analog Electronic Circuit	3-1-0	4	418
			Principles of Communication			
SEMESTER VII						
Theory	PE/SE	ECIM0125	Introduction to Microprocessor and Microcontroller	3-1-0	4	419
SEMESTER VIII						
Theory	PE/SE	ECIC0126	Semiconductor IC Technology	3-1-0	4	421
		ECMC0127	Microelectronics: Devices to Circuits			421

PROGRAMME: MASTER OF TECHNOLOGY (MTECH) –ELECTRONICS AND COMMUNICATION ENGINEERING

Type	**Course Type/Category**	**Course Code**	**Course Name**	L-T-P	**Credits**	**Page**
SEMESTER I						
	Specialization: Power Systems					
Theory	Core 1	ECAP0053	Advanced Digital Signal Processing	3-0-0	3	351
	Core 2	ECDV0054	Digital Image and Video Processing	3-0-0	3	352
	Core	ECRM0042	Research Methodology and IPR	2-0-0	2	341
	Prog. Specific Elective I	ECAU0055	Audio Processing	3-0-0	3	353
		ECCV0056	Computer Vision			354
		ECAA0057	Advanced Computer Architecture			355
	Prog. Specific Elective II	ECSI0058	Statistical Information Processing	3-0-0	3	356
		ECVD0059	Voice and Data Networks			357
		ECVC0060	Audio Video Coding & Compression			358
Lab	Lab1	ECAP6041	Advanced Digital Signal Processing Lab	0-0-4	2	430
	Lab2	ECDV6042	Digital Image and Video Processing Lab	0-0-4	2	430
	Specialization: Communications					
Theory	Core 1	ECAP0053	Advanced Digital Signal Processing	3-0-0	3	351
	Core 2	ECWM0061	Wireless and Mobile Communication	3-0-0	3	359
	Core	ECRM0042	Research Methodology and IPR	2-0-0	2	341
	Prog. Specific Elective I	ECSC0062	Satellite Communication	3-0-0	3	360
		ECWN0063	Wireless Sensor Networks			361

		ECON0064	Optical Networks			362
	Prog. Specific Elective II	ECCR0065	Cognitive Radio	3-0-0	3	363
		ECSI0058	Statistical Information Processing			356
		ECRC0066	RF and Microwave Circuit Design			364
Lab	Lab1	ECAP6041	Advanced Digital Signal Processing Lab	0-0-4	2	430
	Lab 2	ECWM6043	Wireless and Mobile Communication Lab			431
	Specialization: Embedded System					
Theory	Core 1	ECAP0053	Advanced Digital Signal Processing	3-0-0	3	351
	Core 2	ECMA0067	Microcontroller and Applications	3-0-0	3	365
	Core	ECRM0042	Research Methodology and IPR	2-0-0	2	341
	Prog. Specific Elective I	ECPP0068	Parallel Processing	3-0-0	3	366
		ECAA0057	Advanced Computer Architecture			355
	Prog. Specific Elective II	ECWM0061	Wireless and Mobile Communication	3-0-0	3	359
		ECDV0054	Digital Image and Video Processing			352
Lab	Lab1	ECAP6041	Advanced Digital Signal Processing Lab	0-0-4	2	430
	Lab2	ECMA6044	Microcontroller and Applications Lab	0-0-4	2	431
Audit	Audit 1	EGRW0015	English for Research Paper Writing	2-0-0	2	508
			Total Credits	**16-0-8**	18	
			SEMESTER II			
	Specialization: Signal Processing					
Theory	Core 3	ECPM0069	Pattern Recognition and Machine Learning	3-0-0	3	367
	Core 4	ECDE0070	Detection and Estimation Theory	3-0-0	3	368
	Prog. Specific Elective III	ECIA0071	IOT and Applications	3-0-0	3	369
		ECDD0072	Digital Design and Verification			370
	Prog. Specific Elective IV	ECBS0073	Biomedical Signal Processing	3-0-0	3	371
		ECDS0074	DSP Architecture			372
Lab	Lab3	ECPM6045	Pattern Recognition and Machine Learning Lab	0-0-4	2	432
	Lab4	ECDE6046	Detection and Estimation Theory Lab	0-0-4	2	432
		Specialization: Communications				
Theory	Core 3	ECRS0075	Antennas and Radiating Systems	3-0-0	3	373
	Core 4	ECCN0076	Advanced Communication Networks	3-0-0	3	374
	Prog. Specific Elective III	ECDS0074	DSP Architecture	3-0-0	3	
		ECIA0071	IOT and Applications			
	Prog. Specific Elective IV	ECPM0069	Pattern Recognition and Machine Learning	3-0-0	3	
		ECMS0077	MIMO System			375
Lab	Lab3	ECRS6047	Antennas and Radiating Systems lab	0-0-4	2	432
	Lab4	ECCN6048	Advanced Communication Networks Lab	0-0-4	2	433
		Specialization: Embedded System				
Theory	Core 3	ECDS0074	DSP Architecture	3-0-0	3	
	Core 4	ECSA0078	Embedded System and Applications	3-0-0	3	376
	Prog. Specific Elective III	ECDD0072	Digital Design and Verification	3-0-0	3	
		ECIA0071	IOT and Applications			369
	Prog. Specific Elective IV	ECMT0079	Memory Technologies	3-0-0	3	377
		ECBS0080	Communication Buses and Interfaces			378
Lab	Lab3	ECDS6049	DSP Architecture lab	0-0-4	2	433
	Lab4	ECSA6050	Embedded System and Applications Lab	0-0-4	2	434
Project		ECMI6051	Mini Project	0-0-4	2	434
Audit	Audit 2 (MOOCs)	EDCI0100	Constitution of India	2-0-0	0	
		CBUI104T	Understanding India	0-0-1		520
			Total Credits	**14-0-12**	18	
			SEMESTER III			
	Specialization: Signal Processing					
Theory	Prog. Specific Elective V	ECAI0096	Artificial Intelligence	3-0-0	3	392
		ECOT0097	Optimization Techniques			394
		ECRS0098	Remote Sensing			395

	Specialization: Communications					
	Prog. Specific Elective V	ECAI0096	Artificial Intelligence	3-0-0	3	392
		ECOT0097	Optimization Techniques			394
		ECRS0098	Remote Sensing			395
	Specialization: Embedded System					
	Prog. Specific Elective V	ECAI0096	Artificial Intelligence	3-0-0	**3**	392
		ECNN0099	Nanotechnology and Nanoelectronics			396
		ECSD0100	SoC Design			397
	Open Elective	ECBI0129	Bioinformatics	3-0-0	3	
Project	Dissertation	ECDI6059	Dissertation Phase – I	0-0-20	10	437
Total Credits				**6-0-20**	**26**	
SEMESTER IV						
Theory	**Specialization: Signal Processing**					
	Dissertation	ECDI6060	Dissertation Phase – II	0-0-32	16	437
	Specialization: Control Systems					
	Dissertation	ECDI6060	Dissertation Phase – II	0-0-32	16	437
	Specialization: Embedded System					
	Dissertation	ECDI6060	Dissertation Phase – II	0-0-32	16	437
Total Credits				0-0-32	16	

LIST OF OPEN ELECTIVES

SEMESTER III						
Type	**Type of Course/ Category**	**Course Code**	**Course Name**	L-T-P	**Credits**	**Page**
Theory	Open Elective	ECBI0129	Bioinformatics	3-0-0	3	

Note: Mandatory Course EDPC0201: Indian Polity and Constitution

DEPARTMENT OF MECHANICAL ENGINEERING

PROGRAMME: BACHELOR OF TECHNOLOGY (BTECH)-MECHANICAL ENGINEERING

SEMESTER I						
Type	**Type of Course/ Category**	**Course Code**	**Course Name**	**L-T-P**	**Credits**	**Page**
Theory	BS/IC	CHCE0027	Engineering Chemistry	3-1-0	4	493
	BS/IC	MACL0012	Mathematics I - Calculus and Linear Algebra	3-1-0	4	494
	ES/IC	EEBE0038	Basic Electrical Engineering	3-1-0	4	256
Lab	BS/IC	CHCE6007	Engineering Chemistry Lab	0-0-2	2	493
	ES/IC	EEBL6027	Basic Electrical Engineering Laboratory	0-0-2	1	316
	ES/IC	MNWM6023	Workshop/Manufacturing Practice	1-0-4	3	480
	MC/IC	BTUH0001	Student Induction Program- Universal Human Values I	0-0-0	NC	517
Total Credits					**18**	
SEMESTER II						
Theory	BS/IC	PSET0040	Engineering Physics: Electromagnetic Theory	3-1-0	4	504
	BS/IC	MAIN0013	Mathematics II-Multiple Integrals, Numerical Methods and Differential Equations	3-1-0	4	495
	ES/IC	CSPS0079	Programming for Problem Solving	3-0-0	3	84
	HS/IC	EGEH0111	English	2-0-0	2	508
Lab	BS/IC	PSEG6017	Physics Lab for Engineers	0-0-2	1	506
	ES/IC	CVED6024	Engineering Graphics and Design	1-0-4	3	238
	HS/IC	EGOC6005	Oral Communication Practice Lab	0-0-2	1	509
	ES/IC	CSPL6069	Programming for Problem Solving Lab	0-0-4	2	167
	MC/IC	EDCI0100	Constitution of India	0-0-0	NC	
		CBUI104T	Understanding India	0-0-1		520
Total Credits					**20**	
SEMESTER III						
Theory	BS/IC	PSWO0052	Engineering Physics: Waves and Optics	3-0-1	4	505
	BS/IC	MACP0029	Engineering Mathematics III-Complex Variables, PDE and Probability and statistics	3-1-0	4	500
	BS/IC	BOBE0002	Biology for Engineering	3-0-0	3	489
	ES/IC	ECEE0052	Basic Electronics Engineering	3-1-0	4	350
	ES/IC	MNEM0034	Engineering Mechanics	3-1-0	4	444
	PC/IC	MNBT0035	Basic Thermodynamics	3-1-0	4	445
	Audit Course	MNMD6024	Machine Drawing Lab	0-0-2	NC	480
	Internship	BTIP16	Internship Programme		2	
	MC/IC	BTUH0002	Universal Human Values II: Understanding Harmony	3-0-0	3	517
Total Credits					**28**	
SEMESTER IV						
Theory	PC/IC	MNAP0036	Applied Thermodynamics	3-1-0	4	446
	PC/IC	MNFM0037	Fluid Mechanics	3-1-0	4	447
	PC/IC	MNSM0038	Strength of Materials	3-1-0	4	448
	ES/IC	MNSE0039	Materials Science and Engineering	3-0-0	3	449
	PC/IC	MNIC0040	Instrumentation and Control	3-0-0	3	450
	MC/IC	CHES0029	Environmental Science	0-0-0	NC	491
Lab	PC/IC	MNMF6025	Mechanical Engineering Lab1: Materials and Manufacturing Lab	0-0-4	2	481
	MC/IC	EDCI0100	Constitution of India	0-0-0	NC	
		CBUI104T	Understanding India	0-0-1		520
Total Credits					**20**	

SEMESTER V						
Theory	PC/IC	MNHT0041	Heat Transfer	3-1-0	4	454
	PC/IC	MNDM0042	Design of Machine Elements	3-1-0	4	455
	PC/IC	MNMP0043	Manufacturing Processes	3-1-0	4	456
	PC/IC	MNKT0044	Kinematics & Theory of Machine	3-1-0	4	457
	(HS/IC)	MTEE0104	Economics for Engineers	3-0-0	3	512
Lab	PC/IC	MNFT6026	Mechanical Engineering Lab2: Fluid and Thermal	0-0-4	2	482
		MNMI6027	Mini Project	0-0-2	1	482
	Internship	BTIP16	Internship Seminar		3	
	MC/IC	MNSL0200	Service Learning		NC	
Total Credits					**25**	
SEMESTER VI						
Theory	PC/IC	MNMT0045	Manufacturing Technology	4-0-0	4	458
	PC/IC	MNDD0046	Machine Design and Dynamics	3-1-0	4	459
	PE I/DE	MNHM0047	a) Hydraulic Machines	3-0-0	3	460
		MNMP0048	b) Advanced Manufacturing Processes	3-0-0	3	461
	PE II/DE	MNCM0049	a) Composite Materials	3-0-0	3	462
		MNIC0050	b) Internal Combustion Engines	3-0-0	3	462
	Open Elective (HS/IC)	MTPO0106	Production and Operation Management	3-0-0	3	515
Lab	PC/IC	MNDS6028	Mechanical Engineering Lab3: Design	0-0-4	2	483
Value Added Course		MNRF6031	Royal Enfield Fresher's Course		NC	
Total Credits					19	
SEMESTER VII						
Theory	PC/IC	MNAM0051	Automation in Manufacturing	3-0-0	3	463
	PE III/DE	MNRC0052	a) Refrigeration and Air Conditioning	3-0-0	3	464
		MNSE0053	b) Non-conventional Sources of energy	3-0-0	3	465
		MNSN0054	c) Solid Mechanics	3-0-0	3	466
	PE IV/DE	MNER0055	a) Energy Conservation and Waste Heat Recovery	3-0-0	3	467
		MNAE0056	b) Automobile Engineering	3-0-0	3	468
	OE/IC	MNPE0057	a) Power Plant Engineering	3-0-0	3	469
		MNQM0058	b) Total Quality Management	3-0-0	3	470
Project	PC/IC	MNMP6029	Major Project Phase I	0-0-2	2	483
	Internship	MNIT6030	Industrial Training		3	
Total Credits					17	
SEMESTER VIII						
	PE V /DE	MNCA0059	a) CAD/CAM (COMPUTER AIDED DESIGN AND MANUFACTURING)	3-0-0	3	471
		MNSG0060	b) Surface Engineering	3-0-0	3	472
	PE VI /DE	MNWT0061	a) Welding Technology	3-0-0	3	473
		MNGT0062	b) Gas Turbines and Jet Propulsion	3-0-0	3	474
		MNNU0066	c) Numerical Methods in Mechanical Engineering	3-0-0	3	478
	OE/IE	MNOR0065	Operations Research	3-0-0	3	477
	OE/IE	MNRA0064	Robotics and Automation	3-0-0	3	475
Project	PC/IC	MNMP6031	Major Project Phase II	0-0-8	4	484
	MC/IC	PYTK0103	Essence of Indian Traditional Knowledge		NC	519
Total Credits					**16**	
Total Programme Credits					**163**	

Note: BTIP17- 2- credits MNE lateral Students

LIST OF OPEN ELECTIVES

SEMESTER VII						
Type	**Type of Course/ Category**	**Course Code**	**Course Name**	L-T-P	**Credits**	**Page**
Theory	OE/SE	MNPE0057	Power Plant Engineering	3-0-0	3	
	OE/SE	MNQM0058	Total Quality Management	3-0-0	3	
SEMESTER VIII						
Theory	OE/IC	MNOR0065	Operations Research	3-0-0	3	
	OE/IC	MNRA0064	Robotics and Automation	3-0-0	3	476

LIST OF VALUE ADDED COURSES

VALUE ADDED COURSES						
Type	**Type of Course/ Category**	**Course Code**	**Course Name**	L-T-P	**Credits**	**Page**
SEMESTER IV						
Theory	Value Added Course/DE	MNIA6034	Introduction to AUTOCAD	2-0-0	2	486
SEMESTER VI						
Theory	Value Added Course/DE	MNRF6032	Royal Enfield Freshers Course	2-0-0	2	486
SEMESTER VII						
Theory	Value Added Course/DE	MNQC6033	Quantitative Aptitude for Competitive Examination	2-0-0	2	486

DEPARTMENT OF COMPUTER APPLICATIONS

PROGRAMME: MASTER OF COMPUTER APPLICATIONS (MCA)

Type	Course Code	Course Name	Credits	Category	Page
Semester I					
Theory	CAMF0043	Mathematical Foundation for Computer Science	4	DC	501
	CATC0048	Theory of Computation	4	DC	539
	CAOS0016	Operating Systems	4	DC	525
	CADA0044	Data Structures and Algorithms	4	DC	534
	CAPJ0018	Programming Through Java	4	DE	526
Lab	CAOS6012	Operating Systems Lab	2	DC	549
	CADA6033	Data Structures and Algorithms Lab	2	DC	551
	CAPJ6014	Programming Through Java Lab	2	DE	549
Total Credits			**26**		
Semester II					
Theory	CASE0019	Software Engineering	4	DC	527
	CACC0045	Data Communication and Computer Networks	4	DC	535
	CADM0046	Advanced Database Management Systems	4	DC	536
	CAIT0022	Internet Technology and Applications	4	DC	529
	CASI0047	Sensor Networks and Internet of Things	3	DE	538
Lab	CACC6034	Data Communication and Computer Networks Lab	2	DC	551
	CAIT6017	Internet Technology and Applications Lab	2	DE	550
	CADM6035	Advanced Database Management Systems Lab	2	DC	552
Mandatory	CASL0200	Service Learning/Community Engagement	NC	IE	557
Total Credits			**25**		
Semester III					
Theory	CACL0033	Cyber Law and IT Security	4	DC	532
	CAML0049	Machine Learning	4	DC	540
	CAEP0024	Enterprise Resource Planning	4	DC	530
	ECRM0042	Research Methodology and IPR	2	DE	341
		ELECTIVE-I Specialization I: Artificial Intelligence OR Specialization II: Data Science	4	DE	
		ELECTIVE-II Specialization I: Artificial Intelligence OR Specialization II: Data Science	4	DE	
Lab	CAML6036	Machine Learning Lab	2	DC	553
Project	CAMI6038	Minor Project - MCA	5	DC	554
Audit Courses	EGCS0110	Communication Skills	NC	IE	559
	CMES0023	Entrepreneurship	NC	IE	559
Total Credits			**29**		
Semester IV					
Project	CAMP6039	Major Project - MCA	18	DC	
		Elective-III Specialization III (Artificial Intelligence/Data Science)	2		
Total Credits			**20**		
Total Programme Credits			**100**		

Course Code	**Specialization I (Artificial Intelligence)**		
CAPA0030	Principles of Artificial Intelligence		531
CAHC0050	Human Computer Interaction		540
CABI0051	Bioinformatics		541
CADL0052	Deep Learning		542
CASC0053	Soft Computing		543
Course Code	**Specialization II (Data Science)**		
CADS0054	Data Science		544
CAVS0055	Data Visualization for Data Science		545
CABD0056	Big Data Management		546
CAWA0057	Web Analytics and Development		547
Course Code	**Specialization III (Artificial Intelligence/Data Science)**		
	NPTEL Course of 8 - 12 Weeks. List of Courses to be provided by the department.		

LIST OF VALUE-ADDED COURSES OFFERED BY THE DEPARTMENT

VALUE ADDED COURSES		
Course Code	**Course Name**	**Page**
CAAW6053	Advanced Web Application Development Techniques	557
CABC6052	Blockchain	556
CARP6051	Robotic Process Automation	556

Note: Mandatory Course EDPC0201: Indian Polity and Constitution

SCHOOL OF TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

VISION

Creating a centre of excellence in teaching, training and research in the field of Computer Science and Engineering, to mould individuals into competent professionals to address local, national and global scientific, technological and social challenges.

MISSION

1. To create professionals sound in the theory and practice of Computer Science and Engineering by providing a learning ambience that promotes innovation and research-based activities.
2. To explore the frontiers of cutting-edge technologies through academia-industry collaboration and continuous learning to solve real-world challenges
3. To inculcate the spirit of self-sustainability through research, consultancy, and development activities.
4. To infuse ethical values, team spirit and a sense of social commitment in individuals for the betterment of the society through technology.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. To prepare the students to have a strong foundation in computer science engineering with impetus to higher studies, consultancy, research and development.
2. To prepare the students to be self-sustainable and proficient to meet the real world challenges ethically and responsibly, in service to socio-economic development of the society.
3. To inculcate the spirit of life-long learning, understanding, and applying new ideas and technologies to provide novel engineering solutions in the rapidly changing environment.

PROGRAM OUTCOMES (BTECH CSE)

PO 1: **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO 3: **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

PO 4: **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO 5: **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

PO 6: **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

PO 7: **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

PO 8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

PO 10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

PO 11: **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projectsand in multidisciplinary

PO 12: **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PROGRAM SPECIFIC OUTCOME (BTECH CSE)

PSO 1: Ability to apply knowledge of data structure, algorithm, programming skill & hardware to analyse and solve complex programming in interdisciplinary fields

PSO 2: Ability to use software, theoretical knowledge of computer science, communication technology & intelligent algorithms to build optimize solution pertaining to real world problem

PSO 3: Ability to work in multidisciplinary team in small- and large-scale projects by utilizing modern software engineering tools and emerging technology.

PROGRAM OUTCOMES (MTECH CSE)

PO 1: An understanding of the theoretical foundations and the limits of computing

PO 2: An ability to adapt existing models, techniques, algorithms, data structures, etc. for efficiently solving problems

PO 3: An ability to design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society

PO 4: Understanding and ability to use advanced computing techniques and tools

PO 5: An ability to undertake original research at the cutting edge of computer science & its related areas

PO 6: An ability to function effectively individually or as a part of a team to accomplish a stated goal

PO 7: An understanding of professional and ethical responsibility

PO 8: An ability to communicate effectively with a wide range of audience

PO 9: An ability to learn independently and engage in life¬long learning

PO 10: An understanding of the impact of IT related solutions in an economic, social and environment context.

PROGRAM SPECIFIC OUTCOME (PSO)

Specialisation: Data science

PSO 1: Apply the concept of theoretical knowledge of computer science, data structures, algorithms, mathematical computation and statistical formulae with respect to research methodology.

PSO 2: Develop programs that use data mining techniques on bigdata for clustering, classification and ranking using cloud infrastructure for research.

Specialisation: Internet of Things

PSO 1: Apply the concept of theoretical knowledge of computer science, data structures, algorithms, mathematical computation and statistical formulae with respect to research methodology.

PSO 2: Design and develop code for various sensor-based applications for different sectors that use data collected through IoT deployment.

Specialisation: Information Security

PSO 1: Apply the concept of theoretical knowledge of computer science, data structures, algorithms, mathematical computation and statistical formulae with respect to research methodology.

PSO 2: Design operational and strategic cyber-security strategies, policies, and solutions that use cyber security techniques, information assurance, digital forensics software/tools, encryption, machine learning, and secure coding for securing data.

MAPPING of COURSES TO PO/PSOs (BTECH CSE)

PO-PSO Mapping Table (B.Tech CSE)

1.1 Programming For Problem Solving
1.2 Programming For Problem Solving Lab
1.3 Physics for Technologist
1.4 Mathematics I - Calculus And Linear Algebra
1.5 Physics for technologists-Lab
1.6 Engineering Graphics And Design
1.7 Induction Programme
2.1 Engineering Chemistry
2.2 Mathematics II- Multiple Integrals, Numerical Methods and Differential Equations
2.3 Basic Electrical Engineering
2.4 English
2.5 Basic ChemistryLab1
2.6 Basic Electrical Engineering Laboratory
2.7 Workshop/ManufactuRing Practice
3.1 Object Oriented Programming
3.2 Object Oriented Programming LAB

7.14 Major Project- Phase I
7.15 Value Added Course
8.1 Quantum Computing
8.2 Ad-Hoc and Sensor Networks
8.3 Neural Networks and Deep Learning
8.4 Blockchain Fundamentals
8.5 Cloud Computing
8.6 Cyner law and ethics
8.7 Course from Swayam
8.8 Business Analytics
8.9 Computer Networks
8.10 Essence of Indian Traditional Knowledge
8.11 Major Project- Phase II

	Courses	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
Semester I	1.1			M									L	H		
	1.2			M									L	M		
	1.3	L														L
	1.4	M											L			L
	1.5	L														L
	1.6															L
	1.7						L	M		M	L					L
Semester II	2.1	L														
	2.2	M			L											L
	2.3	M											L			L
	2.4										H					L
	2.5	L														L
	2.6	M														L
	2.7	M		L									L			M
Semester III	3.1		M			L							M	H	M	L
	3.2		M			L							M	H	M	L
	3.3	M												M		
	3.4	M												M		
	3.5	H	M										M	H	M	
	3.5	M	M										M	H	M	
Semester IV	4.1	M	M										M	M		
	4.2	M	M										M	M		
	4.3		M			M							M	L	H	
	4.4		M			M							M	L	H	
	4.5	H											M		M	
	4.6		H		M								M	H	M	
	4.7								M							M
	4.8	M	H		M								M	H	M	
	4.9						L	H								L
Semester V	5.1				M	M							M		H	L
	5.2	H											M		M	
	5.3		M										M	H		
	5.4		M										M	M		
	5.5				M	H							M		M	
	5.6 Advanced	L	H	M	M								H	M		

	Algorithms															
	5.7 Software Engineering	M	M	H	M	L						H	L	M	M	
	5.8 Artificial Intelligence		M	M	M	H							H	M		
	5.9															L
	5.10					M				H	M	H	M	M	M	H
	5.11															
	5.12 Internship Course															
Semester VI	6.1	L	M										M	H		
	6.2		M		M								M		H	L
	6.3		M		M	H							M		M	L
	6.4		M										M	M		
	6.5						L									L
	6.6 Soft Skill							M	M	M	L	M				L
	6.7		M	H	M									M	H	
	6.8	M		L	M	L								M	L	
	6.9	L	M	M	H	M								H	M	
	6.10		L	M	M	H								M	M	L
	6.11	L	M	M	M	M								H	M	
	6.12	L	L	M		M								M		L
	6.13		H			M									M	
	6.14	M		L	M	L								M	L	
	6.15					M								M	M	
	6.16				M	H									M	
	6.17			M		M								M		L
	6.18		H			M									M	
	6.19	M			M									M	L	
	6.20		H			M			L	M	M	H	M	M	M	H
Semester VII	7.1		M	H										H	M	
	7.2	L			M									L	M	
	7.3			M		M									L	M
	7.4		M		M									M	M	
	7.5			M										M		L
	7.6		L			M	M							M	L	L
	7.7					M	H						M		L	M
	7.8					M	L									L
	7.9															
	7.10	L			M										M	
	7.11			M		M									L	M
	7.12		M		M									M	M	
	7.13							M								M
	7.14		H	L	H	M				H	M	M	M	M	M	H
	7.15															
Semester VIII	8.1		M	M	M									H		
	8.2			L	M	L	L							M	M	L
	8.3			L	L	M									M	
	8.4			L		L										M
	8.5	L				M	L								M	L
	8.6						L		M							M
	8.7															
	8.8			H	M	M								M		
	8.9	M				L							L		L	
	8.10						H									M

	8.11		H	L	H	M				H	M	M	M	M	M	H

PROGRAM OUTCOMES (MTECH CSE)

PO 1: An understanding of the theoretical foundations and the limits of computing
PO 2: An ability to adapt existing models, techniques, algorithms, data structures, etc. for efficientlysolving problems
PO 3: An ability to design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society
PO 4: Understanding and ability to use advanced computing techniques and tools
PO 5: An ability to undertake original research at the cutting edge of computer science & its related areas
PO 6: An ability to function effectively individually or as a part of a team to accomplish a stated goal
PO 7: An understanding of professional and ethical responsibility
PO 8: An ability to communicate effectively with a wide range of audience
PO 9: An ability to learn independently and engage in life long learning
PO 10: An understanding of the impact of IT related solutions in an economic, social and environment context.

PROGRAM SPECIFIC OUTCOME (PSO)

Specialisation: Data science

PSO 1: Apply the concept of theoretical knowledge of computer science, data structures, algorithms, mathematical computation and statistical formulae with respect to research methodology.
PSO 2: Develop programs that use data mining techniques on bigdata for clustering, classification and ranking using cloud infrastructure for research.

Specialisation: Internet of Things

PSO 1: Apply the concept of theoretical knowledge of computer science, data structures, algorithms, mathematical computation and statistical formulae with respect to research methodology.
PSO 2: Design and develop code for various sensor-based applications for different sectors that use data collected through IoT deployment.

Specialisation: Information Security

PSO 1: Apply the concept of theoretical knowledge of computer science, data structures, algorithms, mathematical computation and statistical formulae with respect to research methodology.
PSO 2: Design operational and strategic cyber-security strategies, policies, and solutions that use cyber security techniques, information assurance, digital forensics software/tools, encryption, machine learning, and secure coding for securing data.

Semester I												
Courses	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
Advanced Data structure	M	H									H	M
Advanced Data structure Lab	M	M									H	M
Mathematical foundations of Computer Science	H										M	L
Research Methodology and IPR					M				L		H	
Specialisation: Data Science												
Machine Learning			M	H							M	H
Machine Learning Lab				H							M	H
Recommender System										M		
Data Storage Technologies and Networks					M						M	
Data Science		M		H								M
Distributed Systems			M									
Data Preparation and Analysis	M	M		M							H	M
Specialisation: Internet of Things												
Wireless Access	M										M	H

Technology(CSMS0095)												
Mobile application and services			H									H
Smart sensor and Internet of Things			M								H	H
Logical and functional programming				H								
English for Research Paper Writing								H			M	

Semester II												
Courses	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
Advance Algorithms	M	H									M	H
Advance Algorithms Lab	M	M									M	
Soft Computing	M										M	
Mini Project	M	M	M	M	M	H	L	L	L		M	M
Constitution of India						M		M				L
Specialisation: Data Science												
Data Visualization			M								M	M
Data Visualisation Lab			M								M	M
Big Data Analytics				H						M		H
Data Warehouse and Data Mining	M			M								H
Data Security and Access Control				M			L			L	M	M
Web Analytics and Development				H							M	H
Knowledge Discovery	M	M									M	M
Natural Language Processing		M								L	M	L
Specialisation: Internet of Things												
Advanced machine learning			H	M							M	L
Network Security(CSNY0114)	M	H									M	M
Big Data Analytics				H						M	M	H
Sensor Network and Internet of Things	M	M	M									H
Data Visualization			M									M
Data Visualisation Lab			M									M
IoT Application and Communication Protocol					M						M	H
Specialisation: Information Security												
Data Encryption & Compression	M	H									H	M
Data Encryption & Compression Lab	M	H									M	
Steganography & Digital Watermarking	M		H								M	M
Information Theory & Coding	H	M									H	
Security Assessment and Risk Analysis					H					M	M	M
Secure Coding				M							M	

Biometrics				M							M	

Semester III												
Specialisation: Data Science												
Courses	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
GPU Computing	M										M	M
Cloud Computing	M		H									M
Distributed Databases	M										M	H
Business Analytics				H								H
Dissertation Phase – I		M	M	M		H					M	M
Specialisation: Internet of Things												
IoT and Smart City			H	M							H	M
Emulation and simulation methodology			M	M							M	M
Cloud Computing	M		H									
Business Analytics				H							M	H
Dissertation Phase – I		M	M	M		H					M	M
Specialisation: Information Security												
Data Warehousing & Mining	H										H	L
Web Search & Information Retrieval				M							M	M
Database Security and Access Control	M			H								L
Business Analytics				H							H	M
Dissertation Phase – I		M	M	M		H					M	

Semester IV												
Specialisation: Data Science												
Courses	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	PO9	PO10	PSO1	PSO2
Project Phase II		M	M	M		H					M	H
Specialisation: Internet of Things												
Project Phase II		M	M	M		H					M	H

DETAILED SYLLABUS
THEORY COURSES

CSPS0079: PROGRAMMING FOR PROBLEM SOLVING

(3 credits-45 Hours)

Course Outcomes

1. Define and describe various terms and concepts of C programming language (Remembering)
2. Compare and interpret information based on their understanding of the concepts of C language syntax, data types, control statements, functions, pointers, arrays, structures, files, graphics and hardware programming using C. (Understanding)
3. Solve problems using standard algorithms and translate pseudo-codes into C programs and implement them. (Applying)
4. Analyze their skills for choosing the right data structure, function, data types and develop logic to solve various instances of problems. (Analyze)
5. Combine the various concepts and ideas learnt in C to plan, propose and develop a product. (Creating)
6. Evaluate various algorithms used for searching, sorting etc., in terms of correctness and computation cost. (Evaluate)

Module I (8 Hours)

Introduction to Programming, Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.), and Idea of Algorithm: steps to solve logical and numerical problems.

Types of Algorithm: Sequentially executed, Conditional Based, repetitive structure, Representation of Algorithm: Flowchart/Pseudo code with examples, from algorithms to programs; source code, variables (with data types) variables and memory, locations, Syntax and Logical Errors in compilation, object and executable code.

Module II (12 Hours)
Operators, precedence of operators, Arithmetic expressions, Conditional Branching and Loops, Writing and evaluation of conditionals and consequent branching, Iteration and loops.

Module III (5 Hours)
Arrays, Arrays (1-D, 2-D), Character arrays and Strings

Module IV (5 Hours)
Basic Algorithm Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

Module V (8 Hours)
Functions (including built in libraries), Parameter passing in functions, call by value, passing arrays to functions: idea of call by reference, Recursion.

Module VI (7 Hours)
Structures, Defining structures and Array of Structures, Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation), File handling.

Suggested Readings

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
2. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
3. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India

Mapping of COs to Syllabus

Course Outcomes	M1	M2	M3	M4	M5	M6
CO1	H	M				
CO2			H			H
CO3	H	H				
CO4	L				H	H
CO5				H		
CO6	L			H		

CSOP0080: OBJECT ORIENTED PROGRAMMING
(3 credits – 45 hours)

Course Outcomes

1. Define the basic OOP syntax and semantics to write programs. (Remembering)
2. Illustrate the theoretical concepts such as data type, variables, conditional statements, iterations, etc., for various programming technologies. Students can also explain and relate the principles of interfaces, inheritance and packages in OOP. (Understanding)
3. Select the various access modifiers and apply them for granting restricted access to class, methods and variables while developing any applications. (Applying)
4. Examine user requirements for software functionality to decide whether basic Java concepts can meet user requirements. (Analyzing)
5. Choose an engineering approach to solving problems, starting from the various ways of giving an input through a program, choosing an optimal method of problem solving and getting the desired output. (Evaluating)
6. Develop solutions for real life problems by choosing between different basic Java concepts like polymorphism, inheritance, method overloading and method overriding. (Creating)

Module I (10 hours)
Abstract data types and their specification. How to implement an ADT. Concrete state space, concrete invariant, abstraction function. Implementing operations, illustrated by the Text example.

Module II (10 hours)
Features of object-oriented programming. Encapsulation, object identity, polymorphism–but not Inheritance in OO design.

Module III (15 hours)
Design patterns. Introduction and classification. The iterator pattern. Model-view-controller pattern. Commands as methods and as objects. Implementing OO language features.

Module IV (10 hours)
Memory management. Generic types and collections GUIs. Graphical programming with Scala and Swing. The software development process.

The concepts should be practiced using C++ and Java. Pearl may also be introduced wherever possible.

Suggested Readings
1. Barbara Liskov, Program Development in Java, Addison-Wesley,2001
2. Any book on Core Java
3. Any book on C++

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H	M		
CO2		M		H
CO3		M		H
CO4	H		L	
CO5		M	H	
CO6	H			M

CSDE0172: DIGITAL ELECTRONICS
(3 credits – 45 hours)

Course Outcomes
1. Explain number systems, coding methods, Boolean algebra, logic circuits, logic families, and memory types. (Understanding)
2. Convert numbers between different number and coding systems and perform the basic arithmetic operations (addition, subtraction, division, and multiplication). (Applying)
3. Minimize Boolean functions using postulates and theorems of Boolean algebra, Karnaugh maps and Quine McCluskey method. (Applying)
4. Analyze combinational and sequential logic circuits to obtain Boolean expressions, state tables and state diagrams implemented by the circuits. (Analysing)
5. Design combinational and sequential logic circuits for given problem statements. (Creating)
6. Build logic gates using TTL, ECL and CMOS technologies. (Creating)

Module I: Data representation and arithmetic operations (5 Hours)
Introduction, numbering systems, decimal to binary conversion, binary coded decimal numbers, hamming code for error correction, alphanumeric codes.

Module II: Algebra for Digital systems (8 Hours)
Binary addition, binary subtraction, complement representation of numbers, addition/ subtraction of numbers in 1's complement Notation, addition/subtraction of numbers in 2's complement Notation, binary multiplication, multiplication of signed numbers, binary division, arithmetic with binary coded decimal numbers, representation of integers, Floating point representation of numbers, Floating point arithmetic.

Module III: Logic gates and Boolean Algebra (7 Hours)
Introduction to Basic logic gates (AND, OR, NOT, NOR, NAND), Truth tables, simplification of truth tables, the K-map method, SOP and POS simplifications, Quine-McCluskey tabulation method.

Module IV: Combinational logic and Sequential logic (15 Hours)
Combinational logic: Introduction, Combinational circuits, Analysis procedure, design procedure Binary Adder-Subtractor, Decimal adder, binary multiplier, Magnitude comparator, decoders, encoders, multiplexers, HDL models and Combinational Circuits
Sequential logic: Introduction, Sequential circuits, Storage elements: Latches, Storage elements: Flip-flops, Analysis of clocked sequential circuits, State reduction and Assignment, Design procedure.

Module V: Digital integrated circuits (10 Hours)
Introduction, Special characteristics, Bipolar-Transistor characteristics, RTL and DTL circuits, Transistor-TransistorLogic,Emitter-Coupledlogic,Metal-oxidesemiconductor,complementary MOS, CMOS transmission gate circuits, Switch-level Modeling with HDL

Module VI: Memories (5 Hours)
Memory types and terminology, read only memory, Semiconductor RAMs, Non-volatile RAMs, Sequential memories, Programmable logic Devices, Magnetic memories, Optical disk memory, Charge coupled devices.

Suggested Readings

1. M.Morris Mano, Digital Logic and Computer Design, Pearson Education,2009
2. V.Rajaraman, An Introduction to Digital Computer Design, 5th ed.,PHI
3. R. P Jain,Modern Digital Electronics, 4thed.,TMH
4. William Stallings, Computer Organization,PHI

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO1	H	M	L	L	M	H
CO2	H	H				
CO3			H			
CO4			M	H		
CO5			M	H		
CO6					H	

CSDS0082: DATA STRUCTURE AND ALGORITHM
(3 credits – 45 hours)

Course Outcomes
1. Explain the concept of different data types, primitive, derived and their representation and application through coding. (Understanding)
2. Apply the concept of ADT and linear and nonlinear data types and their representation. (Applying)
3. Apply these data types in various applications like arithmetic expression evaluation and conversion. (Applying)
4. Explain the concept of Graphs and Trees and their real time application. (Understanding)
5. Develop various searching and sorting techniques. (Creating)
6. Choose and implement efficient data structures and apply them to solve problems. (Evaluating)

Module I: Pointers and Structures (6 hours)
a. Pointers: chain of pointers, pointers and arrays, array of pointers, pointer to functions - passing parameters by value and by reference, dynamic memory allocation; Recursion.
b. Structures: pointers and structures.
c. Files: Sequential file handling, Indexed Sequential files, Reading and writing in random access files.

Module II: Preliminaries (3 hours)
Introduction to Data Structures; Development and analysis of algorithms.

Module III: Linear Data Structures (8 hours)
Arrays; Stacks and stack application; Queues; Linked lists, circular and doubly linked lists.

Module IV: Non-linear Data structures (8 hours)
a. Binary trees; representation in memory, traversals and operations.
b. Introduction to graphs, sequential representation of graphs, graph traversals- BFS, DFS, Shortest path algorithms -(Dijkstra's) Minimum Spanning trees - (Kruskal's, Prim's)

Module V: Advanced Data Structures (10 hours)
Binary search trees, AVL trees, B trees.

Module V: Sorting and Searching (10 hours)
Searching and data modification: Linear search, binary search, hashing techniques and collision resolution, Sorting techniques: selection, insertion, quick, radix, merge, merge-sort and heap sort.

Suggested Readings

1. Lipschutz, S., Data structures, Indian Adapted Ed, Tata McGraw Hill Publishing Company Limited, New Delhi,2006
2. Gilberg, Richard F. Forouzan, and Behrouz A., Data Structures, 2nd Ed, Course Technology, Cengage
3. Learning, New Delhi, 2005.
4. Pai,GA,DataStructuresandAlgorithms,1stEd,TataMcgrawHillPublishingCompanyLimited,New Delhi,2008.
5. Langsam,Augenstein,andTanenbaum,DataStructuresUsingCAndC++,2ndEd,PhiPublication,
6. New Delhi, 2007.

7. Krishnamoorthy R., Kumaravel, and G .Indirani, Data Structures Using C, 1st Ed., Tata Mcgraw Hill Publishing Company Limited, New Delhi,2008.
8. Horowitz,Sahni,SusanFreed,FundamentalsofDataStructuresinC,2nd Edition,Universitypress, 1997
9. AmiyaKumarRath,AlokKumarJagdev,DataStructuresusingC,2nd Edition,ScitechPublication,New Delhi,2009

Mapping of COs to Syllabus

Course Outcomes	M1	M2	M3	M4	M5
CO1	H	M	M		
CO2	H	H	H		
CO3	H	H	M		
CO4	L	H		H	H
CO5	M	M		H	H
CO6	L			H	H

CSOA0083: COMPUTER ORGANIZATION & ARCHITECTURE

(3 credits – 45 hours)

Course Outcomes

1. Recall the architecture and organization of major components of modern computer systems. (Remembering)
2. Explain the functioning and interconnection of major components of computer systems and different design issues associated with the design of any architecture. (Understanding)
3. Apply logic in designing simple control unit, instruction sets, instruction format, buses and register set etc. (Applying)
4. Compare and Analyse different styles, strategies and formats adopted for designing the instruction set, register set, memory organization and I/O transfer.(Analysing)
5. Assess various architectures and their design considerations. (Evaluating)
6. CO6: Construct and organize a new architecture by considering various design issues in order to make it more efficient with less overhead. (Creating)

Module I Introduction (8 hours)

Number representation; fixed and floating point number representation, IEEE standard for floating point representation. Error detection and correction codes: Hamming code. Digital computer generation, computer types and classifications, functional units and their interconnections, buses, bus architecture, types of buses and bus arbitration. Register, bus and memory transfer. Introduction to x86 architecture.

Module II Central Processing Unit (8 hours)

Addition and subtraction of signed numbers, look ahead, carry adders. Multiplication: Signed operand multiplication, Booth's Multiplication Algorithm; Division Algorithm and array multiplier. Division and logic operations. Floating point arithmetic operation, Processor organization, general register organization, stack organization and addressing modes.

Module III Control Unit (10 hours)

Instruction types, formats, instruction cycles and subcycles (fetch and execute etc), micro- operations, execution of a complete instruction. Hardwired and microprogrammed control: microprogramme sequencing, wide branch addressing, and microinstruction with next address field, prefetching microinstructions, concept of horizontal and vertical microprogramming.

Module IV Memory (8 hours)

Basic concept and hierarchy, semiconductor RAM memories, 2D and 2 1/2D memory organization. ROM memories. Cache memories: concept and design issues (performance, address mapping and replacement) Auxiliary memories: magnetic disk, magnetic tape and optical disks Virtual memory: concept implementation.

Module V Input / Output (8 hours)

Peripheral devices, I/O interface, I/O ports, Interrupts: interrupt hardware, types of interrupts and exceptions. Modes of Data Transfer: Programmed I/O, interrupt initiated I/O and Direct Memory Access., I/O channels and processors. Serial Communication: Synchronous and asynchronous communication, standard communication interfaces.

Module VI Pipelining (8 hours)

Basic Concepts, performance, floating point arithmetic, operations, instruction pipelining in RISC, pipelining in computer arithmetic, Data Hazard, Instruction hazard, Influence on Instruction set, datapath and controls consideration, Superscalar Operation.

Suggested Readings

1. William Stallings, Computer Organization, PHI
2. Vrunesic,Hamacher and Zaky, Computer Organization, TMH

3. M. Morris Mano, Computer System Architecture, PHI
4. Patterson, Computer Organisation and Design, Elsevier Pub. 2009
5. John P Hayes, Computer Organization, McGraw Hill
6. K.K Tripathi, Rajesh K. Gangawar, Microprocessor and its Applications, Acme Learning, New Delhi, 2010
7. Brey, Barry B, INTEL Microprocessors, PHI

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					
CO 2	H	H	M			
CO 3		H	H		H	
CO 4		H	H	H	H	
CO 5		H	H			L
CO 6		H	H	M	M	M

CSRD0084: DATABASE MANAGEMENT SYSTEMS

(3 credits – 45 hours)

Course Outcomes

1. Define the fundamental concepts necessary for designing, using and implementing database systems and applications. (Remembering)
2. Explain the core terms, concepts, and tools of relational database management systems. (Understanding)
3. Apply the techniques, components and tools of a typical database management system to build a comprehensive database information system. (Applying)
4. Apply relational algebra, TRC, and SQL to solve queries related to database tables. (Applying)
5. Compare and contrast all the physical file storage techniques and various facilities provided by database management systems. (Analyzing)
6. Evaluate and justify the database-related design diagrams related to any database project. (Evaluating)
7. Design ER-diagrams and corresponding schema diagrams for handling database projects. (Creating)

Module I (10 hours)

a. Database System Architecture - Data Abstraction, Data Independence, Data Definitions and Data Manipulation Languages.
b. Data models - Entity Relationship(ER), Enhanced Entity Relationship (EER): specialization, Aggregation, Mapping ER Model to Relational Model, Network. Relational and Object Oriented Data Models, Integrity Constraints and Data Manipulation Operations.

Module II (18 hours)

Relation Query Languages, SQL queries for retrieval and data changing commands, Relational Algebra, Tuple and Domain Relational Calculus, SQL and QBE. Relational Database Design: Domain and Data dependency, Armstrong’s Axioms, Normal Forms, Dependency Preservation, Lossless design.

Module III (8 hours)

Query Processing and Optimization: Evaluation of Relational Algebra Expressions, Query Equivalence, Join strategies, Query Optimization Algorithms.

Module IV (10 hours)

a. Storage Strategies: Indices, B-Trees, Hashing, Transaction processing: Recovery and Concurrency Control, Locking and Timestamp based Schedulers, Multiversion and Optimistic Concurrency Control Schemes.
b. Advanced topics: Object-Oriented and Object Relational databases. Logical Databases, Web Databases, Distributed Databases, Data Warehouse and Data Mining.

Suggested Readings

1. Ramez Elmasri and Shamkant B Navathe, Fundamentals of Database Systems, 5th Edition, Pearson Education
2. Abraham Silberschatz, Henry F Korth and S Sudarshan, Database System Concepts, 5th Edition, Mc-Graw Hill.
3. C.J. Date, Introduction to Database Systems, 8th ed., Pearson Education.
4. Bipin Desai, An introduction to Database System, Galgotia Publication.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M		
CO 2	H	H	M	

CO 3		H	H	M
CO 4		H	H	M
CO 5		M	H	H
CO 6			M	H
CO 7			M	H

CSRD0084: DATABASE MANAGEMENT SYSTEMS

(3 credits – 45 hours)

Course Outcomes

1. Define the fundamental concepts necessary for designing, using and implementing database systems and applications. (Remembering)
2. Explain the core terms, concepts, and tools of relational database management systems. (Understanding)
3. Apply the techniques, components and tools of a typical database management system to build a comprehensive database information system. (Applying)
4. Apply relational algebra, TRC, and SQL to solve queries related to database tables. (Applying)
5. Compare and contrast all the physical file storage techniques and various facilities provided by database management systems. (Analyzing)
6. Evaluate and justify the database-related design diagrams related to any database project. (Evaluating)
7. Design ER-diagrams and corresponding schema diagrams for handling database projects. (Creating)

Module I (10 hours)

a. Database System Architecture - Data Abstraction, Data Independence, Data Definitions and Data Manipulation Languages.
b. Data models - Entity Relationship(ER), Enhanced Entity Relationship (EER): specialization, Aggregation, Mapping ER Model to Relational Model, Network. Relational and Object Oriented Data Models, Integrity Constraints and Data Manipulation Operations.

Module II (18 hours)

Relation Query Languages, SQL queries for retrieval and data changing commands, Relational Algebra, Tuple and Domain Relational Calculus, SQL and QBE. Relational Database Design: Domain and Data dependency, Armstrong's Axioms, Normal Forms, Dependency Preservation, Lossless design.

Module III (8 hours)

Query Processing and Optimization: Evaluation of Relational Algebra Expressions, Query Equivalence, Join strategies, Query Optimization Algorithms.

Module IV (10 hours)

a. Storage Strategies: Indices, B-Trees, Hashing, Transaction processing: Recovery and Concurrency Control, Locking and Timestamp based Schedulers, Multiversion and Optimistic Concurrency Control Schemes.
b. Advanced topics: Object-Oriented and Object Relational databases. Logical Databases, Web Databases, Distributed Databases, Data Warehouse and Data Mining.

Suggested Readings

1. Ramez Elmasri and Shamkant B Navathe, Fundamentals of Database Systems, 5th Edition, Pearson Education
2. Abraham Silberschatz, Henry F Korth and S Sudarshan, Database System Concepts, 5th Edition, Mc-Graw Hill.
3. C.J. Date, Introduction to Database Systems, 8th ed., Pearson Education.
4. Bipin Desai, An introduction to Database System, Galgotia Publication.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M		
CO 2	H	H	M	
CO 3		H	H	M
CO 4		H	H	M
CO 5		M	H	H
CO 6			M	H
CO 7			M	H

CSAD0085: DESIGN AND ANALYSIS OF ALGORITHMS

(3 credits – 45 hours)

Course Outcomes

1. Define algorithms, importance of analysis of an algorithm and their asymptotic bounds and relate the different types of problem and their solutions. (Remembering)
2. Explain different design strategies such as brute force, divide and conquer, dynamic programming, greedy and backtracking used for the design of algorithms. (Understanding)
3. Build algorithms for given problems. (Applying)
4. Compare and analyze different design strategies. (Analyzing)
5. Assess various algorithms in terms of correctness, computation cost and memory space used. (Evaluating)
6. Formulate new algorithms for given problems by using most appropriate algorithmic strategy considering the problem domain. (Creating)

Module I (9 hours)

a. Basic Concepts of Algorithms: Introduction, Notion of Algorithm, Fundamentals of Algorithmic Solving, Important Problem types, Fundamentals of the Analysis Framework – Asymptotic Notations and Basic Efficiency Classes.
b. Mathematical Aspects and Analysis of Algorithms: Mathematical Analysis of Non-recursive Algorithm, Mathematical Analysis of Recursive Algorithm – Example: Fibonacci Numbers, Empirical Analysis of Algorithms, Algorithm Visualization. (12 hours)

Module II (9 hours)

Analysis of Sorting and Searching Algorithms: Brute Force – Selection Sort and Bubble Sort – Sequential Search and Brute-force string matching – Divide and conquer – Merge sort – Quick Sort – Binary Search – Binary tree-Traversal and Related Properties – Decrease and Conquer – Insertion Sort – Depth first Search and Breadth First Search.

Module III (10 hours)

Algorithmic Techniques: Transform and conquer – Presorting – Balanced Search trees – AVL Trees – Heaps and Heap sort – Dynamic Programming – Warshall’s and Floyd’s Algorithm – Optimal Binary Search trees – Greedy Techniques – Prim’s Algorithm – Kruskal’s Algorithm – Dijkstra’s Algorithm – Huffman trees. Branch and-Bound and Backtracking methodologies for the design of algorithms; Illustrations of these techniques for Problem-Solving

Module IV (9 hours)

Tractable and Intractable Problems: Computability of Algorithms, Computability classes – P, NP, NP-complete and NP-hard. Cook’s theorem, Standard NP-complete problems and Reduction techniques.

Module V (8 hours)

Advanced Topics: Approximation algorithms, Randomized algorithms, Class of problems beyond NP – P SPACE

Suggested Readings

1. Introduction to Algorithms, 4TH Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill.
2. Fundamentals of Algorithms – E. Horowitz et al.
3. Algorithm Design, 1ST Edition, Jon Kleinberg and ÉvaTardos, Pearson.
4. Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Michael T Goodrich and Roberto Tamassia, Wiley.
5. Algorithms -- A Creative Approach, 3RD Edition, UdiManber, Addison-Wesley, Reading, MA.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO1	H	M	M	L	L
CO2	H	H	L	L	L
CO3	M	M	H	H	L
CO4	M	M	H	L	M
CO5	L	M	M	H	M
CO6	M	M	M	H	M

CSMF0086: MATHEMATICAL FOUNDATION OF COMPUTER SCIENCE

(3 credits)

Objectives

- To understand the mathematical fundamentals that are prerequisites for a variety of courses like Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.
- To develop the understanding of the mathematical and logical basis to many modern techniques in information technology like machine learning, programming language design, and concurrency.
- To study various sampling and classification problems.

Course Outcomes

1. Define and Recall the basic notions of discrete and continuous probability (Remembering)
2. Explain the methods of statistical inference, and the role that sampling distributions play in those methods (Understanding).
3. Apply discrete mathematics in formal representation of various computing constructs. (Applying)
4. Analyse the recent trends in distribution functions in various interdisciplinary fields (Analysing)
5. Evaluating the basic notions of Mathematics in the application areas of Computer Science & Engineering (Evaluating).
6. Elaborate the importance of analytical problem solving approach in engineering problems (Creating).

Module I (7 hours)

Probability mass, density, and cumulative distribution functions, parametric families of distributions, Expected value, variance, conditional expectation, Applications of the univariate and multivariate Central Limit Theorem, Probabilistic inequalities, Markov chains

Module II (7 hours)

Random samples, sampling distributions of estimators, Methods of Moments and Maximum Likelihood

Module III (8 hours)

Statistical inference, Introduction to multivariate statistical models: regression and classification problems, principal components analysis, The problem of overfitting model assessment.

Module IV (9 hours)

Graph Theory: Isomorphism, Planargraphs, graphcolorings, Hamilton circuits and Eulercycles. Permutations and Combinations with and without repetition. Specialized techniques to solve combinatorial enumeration problems.

Module V (10 hours)

Computer science and engineering applications: Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.

Module VI (4 hours)

Recent Trends in various distribution functions in the mathematical field of computer science for varying fields like bioinformatics, soft computing, and computer vision.

Suggested Readings

1. John Vince, Foundation Mathematics for Computer Science,Springer.
2. K. Trivedi. Probability and Statistics with Reliability, Queuing, and Computer Science Applications. Wiley.
3. M. Mitzenmacher and E. Upfal. Probability and Computing: Randomized Algorithms and Probabilistic Analysis.
4. Alan Tucker, Applied Combinatorics, Wiley

CSDT0087: ADVANCED DATA STRUCTURES

(3 credits)

Objectives:

The student should be able to choose appropriate data structures, understand the ADT/libraries, and use it to design algorithms for a specific problem.

- Students should be able to understand the necessary mathematical abstraction to solve problems.
- To familiarize students with advanced paradigms and data structure used to solve algorithmic problems.
- Students should be able to come up with analysis of efficiency and proof of correctness.

Course Outcomes

1. Recall the mathematical background and abstractions for analysis of algorithms. (Remembering)
2. Explain the implementation of symbol tables using hashing techniques. (Understanding)
3. Apply amortized analysis on data structures, including binary search trees, mergeable heaps, and disjoint sets. (Applying)
4. Develop and Analyse algorithms for red-black trees, B-trees and Splay trees. (Analysing)
5. Develop and evaluate algorithms for text processing applications.(Evaluating)

6. Choose suitable data structures and develop algorithms for computational geometry problems. (Creating)

Module I (7 Hours)
Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries.
Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing.

Module II (5 Hours)
Skip Lists: Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists

Module III (7 Hours)
Trees: Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees, Splay Trees

Module IV (11 Hours)
Text Processing: Sting Operations, Brute-Force Pattern Matching, The Boyer Moore Algorithm, The Knuth- Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, The Huffman Coding Algorithm, The Longest Common, Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem.

Module V (10 Hours)
Computational Geometry: One Dimensional Range Searching, Two Dimensional Range Searching, Constructing a Priority Search Tree, Searching a Priority Search Tree, Priority Range Trees, Quadtrees, k-D Trees.

Module VI (5 Hours)
Recent Trends in Hashing, Trees, and various computational geometry methods for efficiently solving the new evolving problem

Suggested Readings
1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson,2004.
2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley,2002.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	M	M				
CO 2	M	H	H			
CO 3	M	M	M	H		
CO 4				H	M	
CO 5				M	H	
CO 6					M	H

CSSC0088: DATA SCIENCE
(3 credits)

Objectives:
- Provide you with the knowledge and expertise to become a proficient data scientist.
- Demonstrate an understanding of statistics and machine learning concepts that are vital for data science
- Produce Python code to statistically analyse a dataset
- Critically evaluate data visualisations based on their design and use for communicating stories from data

Course Outcomes
1. Define the basics of the knowledge and expertise required to become a proficient data scientist. (Remembering)
2. Demonstrate an understanding of statistics and machine learning concepts that are vital for data science. (Understanding)
3. Develop Python code to statistically Analyse a dataset. (Applying)
4. Analyse data visualizations based on their design (Analysing)
5. Evaluate the use of communicating stories from data (Evaluating)
6. Design and develop analytical report (Creating)

Module I (5 Hours)
Introduction to core concepts and technologies: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications.

Module II (7 Hours)
Data collection and management: Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, Using multiple data sources

Module III (10 Hours)

Data analysis: Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Samples/CLT, Basic machine learning algorithms, Linear regression, SVM, Naïve Bayes.

Module IV (10 Hours)

Data visualisation: Introduction, Types of data visualisation, Data for visualisation: Data types, Data encodings, Retinal variables, Mapping variables to encodings, Visual encodings.

Module V (6 Hours)

Applications of Data Science, Technologies for visualisation, Bokeh (Python)

Module VI (7 Hours)

Recent trends in various data collection and analysis techniques, various visualization techniques, application development methods used in data science.

Suggested Readings

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline.O'Reilly.
2. Jure Leskovek, AnandRajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge UniversityPress.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	M	M				
CO 2	H	M	H			
CO 3			M	H		
CO 4				H	M	
CO 5				M	H	
CO 6					M	H

CSDI0089: DISTRIBUTED SYSTEMS

(3 Credits)

Objectives

To introduce the fundamental concepts and issues of managing a large volume of shared data in a parallel and distributed environment, and to provide insight into related research problems.

Course Outcomes

1. Recall the fundamental concepts and issues of managing a large volume of shared data in a parallel and distributed environment. (Remembering)
2. Explain the distributed system architecture and its application in various fields. (Understanding)
3. Apply network virtualization and analyse pros and cons.(Applying)
4. Analyse design trends in distributed systems. (Analysing)
5. Formulate and evaluate remote method invocation and objects. (Evaluating, Creating)

Module I (8 Hours)

Introduction: Distributed data processing; What is a DDBS; Advantages and disadvantages of DDBS; Problem areas; Overview of database and computer network concepts Distributed database management system architecture: Transparencies in a distributed DBMS; Distributed DBMS architecture; Global directory issues

Module II (10 Hours)

Distributed database design: Alternative design strategies; Distributed design issues; Fragmentation; Data allocation Semantics data control: View management; Data security; Semantic Integrity Control Query processing issues: Objectives of query processing; Characterization of query processors; Layers of query processing; Query decomposition; Localization of distributed data.

Module III (10 Hours)

Distributed query optimization: Factors governing query optimization; Centralized query optimization; Ordering of fragment queries; Distributed query optimization algorithms

Transaction management: The transaction concept; Goals of transaction management; Characteristics of transactions; Taxonomy of transaction models

Concurrency control: Concurrency control in centralized database systems; Concurrency control in DDBSs; Distributed concurrency control algorithms; Deadlock management

Module IV (7 Hours)

Reliability issues in DDBSs; Types of failures; Reliability techniques; Commit protocols; Recovery protocols

Module V (6 Hours)

Parallel database systems: Parallel architectures; parallel query processing and optimization; load balancing

Module VI (4 Hours)

Advanced topics: Mobile Databases, Distributed Object Management, Multi-databases

Suggested Readings

1. Principles of Distributed Database Systems, M.T. Ozsu and P. Valduriez, Prentice-Hall,1991.
2. Distributed Database Systems, D. Bell and J. Grimson, Addison-Wesley,1992.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H	M				
CO 2	H	H	M			
CO 3		M	H	M		
CO 4				H	M	M
CO 5				M	H	

CSDP0090: DATA PREPARATION AND ANALYSIS

(3 Credits)

Objective

To prepare the data for analysis and develop meaningful Data Visualizations

Course Outcomes

1. List the data gathering and preparation techniques. (Remembering)
2. Explain the techniques as per utilisation. (Understanding)
3. Apply explorative analysis techniques. (Applying)
4. Analyse results after application of explorative analysis techniques. (Analysing)
5. Evaluate the data visualisation outcomes (Evaluating)
6. Formulate efficient techniques for data preparation and analysis. (Creating)

Module I (9 Hours)

Data Gathering and Preparation: Data formats, parsing and transformation, Scalability and real- time issues

Module II (10 Hours)

Data Cleaning: Consistency checking, Heterogeneous and missing data, Data Transformation And segmentation

Module III (12 Hours)

Exploratory Analysis: Descriptive and comparative statistics, Clustering and association, Hypothesis generation

Module IV (14 Hours)

Visualization: Designing visualizations, Time series, Geo located data, Correlations and connections, Hierarchies and networks, interactivity

Suggested Readings

1. Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining, by Glenn J. Myatt

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2	H	H	M	
CO 3		M	H	
CO 4			M	H
CO 5				M
CO6				H

CSRS0091: RECOMMENDER SYSTEM

(3 Credits)

Objectives:

- To learn techniques for making recommendations, including non-personalized, content-based, and collaborative filtering
- To automate a variety of choice – making strategies with the goal of providing affordable, personal, and high- quality recommendations

Course Outcomes

1. Relate techniques for making recommendations, including non-personalized, content- based, and collaborative filtering (Remembering)
2. Illustrate automation of a variety of choice-making strategies with the goal of providing affordable, personal, and high-quality recommendations. (Understanding)
3. Apply techniques for making recommendations, including non-personalized, content- based, and collaborative filtering (Applying)
4. Analyse the choice-making strategies with the goal of providing affordable, personal, and high-quality recommendations. (Analysing)
5. Evaluate recommender systems on the basis of metrics such as accuracy, rank accuracy, diversity, product coverage, and serendipity. (Evaluating)
6. Design recommendation system for a particular application domain. (Creating)

Module I (8 Hours)

Introduction: Overview of Information Retrieval, Retrieval Models, Search and Filtering, Techniques: Relevance Feedback, User Profiles, Recommender system functions, Matrix operations, covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.

Module II (8 Hours)

Content-based Filtering: High level architecture of content-based systems, Advantages and drawbacks of content-based filtering, Item profiles, discovering features of documents, pre- processing and feature extraction, obtaining item features from tags, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.

Module III (8 Hours)

Collaborative Filtering: User-based recommendation, Item-based recommendation, Model based approaches, Matrix factorization, Attacks on collaborative recommender systems.

Module IV (8 Hours)

Hybrid approaches: Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade, Meta-level, Limitations of hybridization strategies

Module V (5 Hours)

Evaluating Recommender System: Introduction, General properties of evaluation research, Evaluation designs: Accuracy, Coverage, confidence, novelty, diversity, scalability, serendipity, Evaluation on historical datasets, Offline evaluations.

Module VI (8 Hours)

Types of Recommender Systems: Recommender systems in personalized web search, knowledge- based recommender system, social tagging recommender systems, Trust-centric recommendations, Group recommender systems.

Suggested Readings

1. Jannach D., Zanker M. and Fel Fering A., Recommender Systems: An Introduction, Cambridge University Press (2011), 1sted.
2. Charu C. Aggarwal, Recommender Systems: The Textbook, Springer (2016), 1sted.
3. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer (2011),1sted.
4. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems for Learning, Springer (2013), 1st ed.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	M	M				
CO 2	H	M	H			
CO 3			M	L		
CO 4				M	M	
CO 5				H	H	
CO 6				H		H

CSML0092: MACHINE LEARNING
(3 Credits)

Objectives:
- To learn the concept of how to learn patterns and concepts from data without being explicitly programmed in various IOT nodes.
- To design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
- Explore supervised and unsupervised learning paradigms of machine learning.
- To explore Deep learning techniques and various feature extraction strategies.

Course Outcomes
1. Relate how to learn patterns and concepts from data without being explicitly programmed in various IOT nodes.(Remembering)
2. Illustrate supervised and unsupervised learning paradigms of machine learning. (Understanding)
3. Design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances. (Applying, Analysing)
4. Examine the Deep learning techniques and various feature extraction strategies. (Analysing)
5. Evaluate the results and compare in a different environment to have best results. (Evaluating)
6. Create applications as per the requirements in a suitable environment. (Creating)

Module I (10Hours) Supervised Learning (Regression/Classification)
Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Bayes, Linear models: Linear Regression, Logistic Regression, Generalized Linear Models, Support Vector Machines, non linearity and Kernel Methods, Beyond Binary Classification: Multi-class/Structured Outputs, Ranking

Module II (7 Hours) Unsupervised Learning
Clustering: K-means/Kernel K-means, Dimensionality Reduction: PCA and kernel PCA, Matrix Factorization and Matrix Completion, Generative Models (mixture models and latent factor models)

Module III (6 Hours)
Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical, Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)

Module IV (8 Hours)
Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning

Module V (8 Hours)
Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference

Module VI (6 Hours)
Recent trends in various learning techniques of machine learning and classification methods for IOT applications. Various models for IOT applications.

Suggested Readings
1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press,2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer,2007.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H	M				
CO 2	H	H	M			
CO 3			H			
CO 4				H	M	
CO 5			M	M	H	M
CO 6						H

CSTN0093: DATA STORAGE TECHNOLOGIES AND NETWORKS
(3 Credits)

Objective
To provide learners with a basic understanding of Enterprise Data Storage and Management Technologies

Course Outcomes
1. Recall the various data storage techniques (Remembering)
2. Explain the basic understanding of Enterprise Data Storage and Management Technologies (Understanding)
3. Experiment with Storage System Architecture (Applying)
4. Analyse the Virtualization Technologies and Storage Area Network (Analysing)
5. Evaluate and deploy an efficient technique for data storage. (Evaluating & Creating)

Module I (7 Hours)
Storage Media and Technologies – Magnetic, Optical and Semiconductor Media, Techniques for read/write Operations, Issues and Limitations.

Module II (8Hours)
Usage and Access – Positioning in the Memory Hierarchy, Hardware and Software, Design for Access, Performance issues.

Module III (7 Hours)
Large Storages – Hard Disks, Networked Attached Storage, Scalability issues, networking issues.

Module IV (8 Hours)
Storage Architecture- Storage Partitioning, Storage System Design, Caching, Legacy Systems.

Module V (10 Hours)
Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS– Performance, Reliability, and Security issues.

Module VI (5 Hours)
Recent Trends related to Copy data management, Erasure coding, and Software Defined Storage appliances.

Suggested Readings
1. The Complete Guide to Data Storage Technologies for Network- centric Computing Paperback– Import, Mar 1998 by Computer Technology Research Corporation
2. Data Storage Networking: Real World Skills for the CompTIA Storage by Nigel Poulton

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H	M				
CO 2	H	H	M			
CO 3			H			
CO 4				H	M	
CO 5			M	M	H	M

CSWA0094: WIRELESS ACCESS TECHNOLOGIES
(3 credits)

Objectives:
- Overview of wireless access technologies, Fixed wireless access networks. Terminal mobility issues regarding wireless access to Internet
- Introduction to various Network topologies, hotspot networks, Communication links: point-to- point, point-to-multipoint, multipoint-to-multipoint.
- To provide an overview of Standards for most frequently used wireless access networks: WPAN, UWB, WLAN, WMAN, WWAN. Network services. Wireless access networks planning, design and installation.
- To get an insight of Wireless networking security issues, Wireless access network exploitation and management, software requirements, link quality control.

Course Outcomes
1. Recall basics of wireless access technologies, Fixed wireless access networks and terminal mobility issues regarding wireless access to the Internet (Remembering)
2. Explain the various Network topologies, hotspot networks and Communication links. (Understanding)

3. Explain the standards for most frequently used wireless access networks. (Understanding)
4. Planning, design and installation of Wireless access networks (Applying)
5. Analyse and get an insight of Wireless networking security issues, Wireless access network exploitation and management, software requirements and link quality control. (Analysing)
6. Estimate the requirements of accessories to establish a network (Evaluating)
7. Establish a network as per requirements. (Creating)

Module I (7 Hours)
Necessity for wireless terminals connectivity and networking. Wireless networking advantages and disadvantages, Overview of wireless access technologies. Narrowband and broadband networks, fixed and nomadic networks. Wireless local loop (WLL), Public Switched Telephone Network (PSTN) interfaces.

Module II (7 Hours)
Fixed wireless access (FWA) networks, frequency bands for different networks. Criterions for frequency bands allocation, Network topologies, hotspot networks. Communication links: point- to-point (PTP), point to multipoint (PMP), multipoint-to-multipoint (MTM).

Module III (9 Hours)
Standards for most frequently used wireless access networks: WPAN (802.15, Bluetooth, DECT, IrDA), UWB (Ultra-Wideband), WLAN (802.11, Wi-Fi, HIPERLAN, IrDA), WMAN (802.16, WiMAX, HIPERMAN, HIPERACCESS),
WWAN (802.20), Other technologies for broadband wireless access, Local Multipoint Distribution Service (LMDS), Multichannel Multipoint Distribution Service (MMDS). Ad Hoc networks, Network services. Services types based on carrier frequency and bandwidth.

Module IV (9 Hours)
Wireless access networks planning, design and installation. Services provision, legislative and technical aspects, Technical and economical factors for network planning: expenses, coverage, link capacity, network complexity and carrier-to-interference ratio (C/I). Base station or access point allocation. Base station and access point equipment. Terminal mobility issues regarding wireless access to the Internet. Wireless networking security issues.

Module V (8 Hours)
Example of laptop or handheld PC wireless connection in real environment. PC wireless interface equipment. Wireless access network exploitation and management, software requirements, link quality control. Business model, wireless network services market, market research and marketing, service providers, wireless data application service providers (WDASP) and their role on the public telecommunication services market, billing systems.

Module VI (8 Hours)
Recent trends in wireless networking and various access mechanisms, new standards of wireless communication.

Suggested Readings
1. M. P. Clark, Wireless Access Networks: Fixed Wireless Access and WLL networks -- Design and Operation, John Wiley & Sons, Chichester
2. D. H. Morais, Fixed Broadband Wireless Communications: Principles and Practical Applications, Prentice Hall, Upper Saddle River
3. R. Pandya, Introduction to WLLs: Application and Deployment for Fixed and Broadband Services, IEEE Press, Piscataway

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H	M				
CO 2	L	H	M			
CO 3			H	M		
CO 4				H	M	
CO 5				M	H	
CO 6					M	H

CSMS0095: MOBILE APPLICATIONS AND SERVICES
(3 Credits)

Objectives
- This course presents the three main mobile platforms and their ecosystems, namely Android, iOS, and PhoneGap/WebOS.

- It explores emerging technologies and tools used to design and implement feature-rich mobile applications for smart phones and tablets.
- It also take into account both the technical constraints relative to storage capacity, processing capacity, display screen, communication interfaces, and the user interface, context and profile

Course Outcomes

1. Relate and explain the emerging technologies and tools used to design and implement feature-rich mobile applications for smartphones and tablets. (Remembering, Understanding)
2. Building the applications for different platform. (Applying)
3. Analyze the technical constraints relative to storage capacity, processing capacity, display screen, communication interfaces, and the user interface, context and profile. (Analyzing)
4. Evaluate the results and compare in different environment to have best outcome. (Evaluating)
5. Create applications as per requirements in suitable environment. (Creating)

Module I (7 Hours)
Introduction: Introduction to Mobile Computing, Introduction to Android Development Environment, Factors in Developing Mobile Applications, Mobile Software Engineering, Frameworks and Tools, Generic UI Development Android User.

Module II (7 Hours)
More on Uis: VUIs and Mobile Apps, Text-to-Speech Techniques, Designing the Right UI, Multichannel and Multimodal Uis, . Storing and Retrieving Data, Synchronization and Replication of Mobile Data, Getting the Model Right, Android Storing and Retrieving Data, Working with a Content Provider.

Module III (9 Hours)
Communications via Network and the Web: State Machine, Correct Communications Model, Android Networking and Web, Telephony Deciding Scope of an App, Wireless Connectivity and Mobile Apps, Android Telephony, Notifications and Alarms: Performance, Performance and Memory Management, Android Notifications and Alarms, Graphics, Performance and Multithreading, Graphics and UI Performance, Android Graphics.

Module IV (9 Hours)
Putting It All Together: Packaging and Deploying, Performance Best Practices, Android Field Service App, Location Mobility and Location Based Services Android Multimedia: Mobile Agents and Peer to-Peer Architecture, Android Multimedia.

Module V (8 Hours)
Platforms and Additional Issues: Development Process, Architecture, Design, Technology Selection, Mobile App Development Hurdles, Testing, Security and Hacking, Active Transactions, More on Security, Hacking Android.

Module VI (5 Hours)
Recent trends in Communication protocols for IOT nodes, mobile computing techniques in IOT, agents based communications in IOT.

Suggested Readings

1. Wei-Meng Lee, Beginning Android™ 4 Application Development, 2012 by John Wiley & Sons

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					
CO 2		H	M			
CO 3			H	M		
CO 4				H	H	
CO 5					M	H

CSSI0096: SMART SENSORS AND INTERNET OF THINGS

(3 Credits)

Objectives

- Able to understand the application areas of IOT.
- Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks.
- Able to understand building blocks of Internet of Things and characteristics.

Course Outcomes

1. Explain the revolution of Internet in Mobile Devices, Cloud & Sensor Networks. (Understanding)

2. Identify the application areas of IOT. (Applying)
3. Examine the building blocks of Internet of Things and their characteristics. (Analyzing)
4. Evaluate the results and compare the performance in different environment. (Evaluating)
5. Construct IoT based products as per requirements for a suitable environment. (Creating)
6. List and explain the different sensors and illustrate their applications in smart devices. (Remembering)

Module I (7 Hours)
Environmental Parameters Measurement and Monitoring: Why measurement and monitoring are important, effects of adverse parameters for the living being for IOT.

Module II (7 Hours)
Sensors: Working Principles: Different types; Selection of Sensors for Practical Applications Introduction of Different Types of Sensors such as Capacitive, Resistive, Surface Acoustic Wave for Temperature, Pressure, Humidity, Toxic Gas etc.

Module III (9 Hours)
Important Characteristics of Sensors: Determination of the Characteristics Fractional order element: Constant Phase Impedance for sensing applications such as humidity, water quality, milk quality Impedance Spectroscopy: Equivalent circuit of Sensors and Modelling of Sensors Importance and Adoption of Smart Sensors.

Module IV (10 Hours)
Architecture of Smart Sensors: Important components, their features Fabrication of Sensor and Smart Sensor: Electrode fabrication: Screen printing, Photolithography, Electroplating Sensing film deposition: Physical and chemical Vapor, Anodization, Sol-gel

Module V (7 Hours)
Interface Electronic Circuit for Smart Sensors and Challenges for Interfacing the Smart Sensor, Usefulness of Silicon Technology in Smart Sensor and Future scope of research in smart sensor.

Module VI (5 Hours)
Recent trends in smart sensor for day to day life, evolving sensors and their architecture.

Suggested Readings
1. Yasuura, H., Kyung, C.-M., Liu, Y., Lin, Y.-L., Smart Sensors at the IoT Frontier, Springer International Publishing.
2. Kyung, C.-M., Yasuura, H., Liu, Y., Lin, Y.-L., Smart Sensors and Systems, Springer International Publishing

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				
CO 2		H	M			
CO 3			H	M		
CO 4				H	M	
CO 5					H	M
CO 6						H

CSLF0097: LOGIC AND FUNCTIONAL PROGRAMMING
(3 credits)

Objectives:
- To further the state of the art on the theoretical and practical aspects of developing declarative programming tools in logic programming for IOT data analysis.
- To introduce basics of functional programming and constraint logic programming for nodes in IOT.
- Introduction into formal concepts used as a theoretical basis for both paradigms, basic knowledge and practical experience.

Course Outcomes
1. Define sensors and relate their data collection technique with various criteria set by the users. (Remembering)
2. Explain the state of the art on the theoretical and practical aspects of developing declarative programming tools in logic programming for IOT data analysis. (Understanding)
3. Experiment with the basics of functional programming and constraint logic programming for nodes in IOT. (Applying)
4. Examine the formal concepts used as a theoretical basis for both paradigms, basic knowledge and practical experience. (Analysing)
5. Evaluate the results and compare in different environments to have best results. (Evaluating)

6. Create IoT based products as per requirements in a suitable environment. (Creating)

Module I (5 Hours)
Proposition Logic: Introduction of logic and Functional Paradigm, Propositional Concepts, Semantic Table , Problem Solving with Semantic Table.

Module II (7 Hours)
Natural Deduction and Axiomatic Propositional Logic: Rules of Natural Deduction, Sequent Calculus, Axiomatic Systems, Meta theorems, Important Properties of AL, Resolution, Resolving Arguments

Module III (7 Hours)
Introduction to Predicate Logic Objects, Predicates and Quantifiers, Functions, First Order Language, Quantifiers, Scope and Binding, Substitution, An Axiomatic System for First Order Predicate Logic, Soundness and Completeness, Axiomatic Semantic and Programming

Module IV (12 Hours)
Semantic Tableaux & Resolution in Predicate Logic: Semantic Tableaux, Instantiation Rules, Problem- solving in Predicate Logic, Normal forms, Herbrand Universes and H-interpretation, Resolution, Unification, Resolution as a computing Tool, Nondeterministic Programming, Incomplete Data Structure, Second Order Programming in Prolog, Logic Grammars: Definite Clause Grammar, A Grammar Interpreter.

Module V (9 Hours)
Lazy and Eager Evaluation strategies: Evaluation Strategies, Lazy Evaluation: Evaluation Order and strictness of function, Programming with lazy evaluation, Interactive functional program, Delay of unnecessary Computation, Infinite Data Structure, Eager Evaluation and Reasoning

Module VI (5 Hours)

Recent trends in logical and functional programming, predicate logics and various evaluation strategies.

Suggested Readings
1. John Kelly, “The Essence of Logic”, Prentice-Hall India.
2. Saroj Kaushik, “Logic and Prolog Programming”, New Age International Ltd

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H	M				
CO 2	M	H				
CO 3			H	M		
CO 4				H	M	
CO 5				M	H	M
CO 6					M	H

CSDF0098: DIGITAL FORENSICS
(3 Credits)

Course Outcomes
1. Recall the computer forensics related features of relevant legislations. (Remembering)
2. Explain the digital forensics related processes and procedures. (Understanding)
3. Utilize e-discovery tools to gather evidence from computers, mobiles, network, emails and the web. (Applying)
4. Analyse gathered forensics data to conduct an investigation. (Analysing)
5. Criticize digital forensics related case. (Evaluating)
6. Formulate plans for investigating real-world cyber-crimes. (Creating)

Module 1 (8 Hours)
Digital Forensics Science: Forensics science, computer forensics, and digital forensics.
Computer Crime: Criminalistics as it relates to the investigative process, analysis of cyber- criminalistics area, holistic approach to cyber-forensics

Module 2 (7 Hours)
Cyber Crime Scene Analysis: Discuss the various court orders etc., methods to search and seizure electronic evidence, retrieved and un-retrieved communications, Discuss the importance of understanding what court documents would be required for a criminal investigation.

Module 3 (8 Hours)
Evidence Management & Presentation: Create and manage shared folders using operating system, importance of the forensic mindset, define the workload of law enforcement, Explain what the normal case would look like, Define who should be notified of a crime, parts of gathering evidence, Define and apply probable cause.

Module 4 (10 Hours)
Computer Forensics: Prepare a case, Begin an investigation, Understand computer forensics workstations and software, Conduct an investigation, Complete a case, Critique a case, Network Forensics: open-source security tools for network forensic analysis, requirements for preservation of network data.

Module 5 (8 Hours)
Mobile Forensics: mobile forensics techniques, mobile forensics tools. Legal Aspects of Digital Forensics: IT Act 2000, amendment of IT Act 2008

Module 6 (4 Hours)
Recent trends in mobile forensic technique and methods to search and seizure electronic evidence

Suggested Readings
1. John Sammons, The Basics of Digital Forensics, Elsevier
2. John Vacca, Computer Forensics: Computer Crime Scene Investigation, Laxmi Publications

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO1	H			M		
CO2		H				
CO3		M	H			
CO4				H		
CO5			M		H	
CO6				M		H

CSEH0099: ETHICAL HACKING
(3 Credits)

Course Outcomes
1. Recall the features of various cyber laws related to ethical hacking and the code of ethics for ethical hacking. (Remembering)
2. Explain the terms penetration testing, vulnerability analysis, and malware analysis. (Understanding)
3. Utilize various tools to gather data for penetration testing, vulnerability analysis, and malware analysis. (Applying)
4. Analyse gathered data to discover vulnerabilities. (Analysing)
5. Assess the exploitability of vulnerabilities present in a software or hardware. (Evaluating)
6. Maximize a detected vulnerability to hack a computer, mobile or network. (Creating)

Module 1 (9 Hours)
Introduction to Ethical Disclosure: Ethics of Ethical Hacking, Ethical Hacking and the legal system, Proper and Ethical Disclosure

Module 2 (8 Hours)
Penetration Testing and Tools: Using Metasploit, Using Back Track Live CD Linux Distribution

Module 3 (9 Hours)
Vulnerability Analysis: Passive Analysis, Advanced Static Analysis with IDA Pro, Advanced Reverse Engineering

Module 4 (10 Hours)
Client-side browser exploits, Exploiting Windows Access Control Model for Local Elevation Privilege, Intelligent Fuzzing with Sulley, From Vulnerability to Exploit

Module 5 (5 Hours)
Malware Analysis: Collecting Malware and Initial Analysis, Hacking Malware

Module 6 (4 Hours)
Case study of vulnerability of cloud platforms and mobile platforms & devices.

Suggested Readings
1. Shon Harris, Allen Harper, Chris Eagle and Jonathan Ness, Gray Hat Hacking: The Ethical Hackers' Handbook, TMH Edition
2. Jon Erickson, Hacking: The Art of Exploitation, SPD

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO1	H			M		
CO2		H				
CO3		M		H		
CO4			H	M		
CO5			M		H	
CO6				M		H

CSID0100: INTRUSION DETECTION

(3 Credits)

Course Outcomes

1. Recall the fundamentals and history of Intrusion Detection in order to avoid common pitfalls in the creation and evaluation of new Intrusion Detection Systems. (Remembering)
2. Explain the different classes of attacks and anomaly detection systems and algorithms. (Understanding)
3. Identify and describe the parts of all intrusion detection systems and characterize new and emerging IDS technologies according to the basic capabilities all intrusion detection systems share. (Applying)
4. Compare alternative tools and approaches for Intrusion Detection through quantitative analysis to determine the best tool or approach to reduce risk from intrusion. (Analysing)
5. Evaluate the security posture of an enterprise. (Evaluating)
6. Formulate a plan to secure an enterprise network using an appropriate intrusion detection system. (Creating)

Module 1 (9 Hours)

The state of threats against computers, and networked systems-Overview of computer security solutions and why they fail-Vulnerability assessment, firewalls, VPN's -Overview of Intrusion Detection and Intrusion Prevention Network and Host-based IDS

Module 2 (8 Hours)

Classes of attacks - Network layer: scans, denial of service, penetration Application layer: software exploits, code injection-Human layer: identity theft, root access-Classes of attackers-Kids/hackers/ sop Hesitated groups-Automated: Drones, Worms, Viruses

Module 3 (8 Hours)

A General IDS model and taxonomy, Signature-based Solutions, Snort, Snort rules, Evaluation of IDS, Cost sensitive IDS

Module 4 (8 Hours)

Anomaly Detection Systems and Algorithms-Network Behavior Based Anomaly Detectors (rate based)-Host- based Anomaly Detectors-Software Vulnerabilities State transition, Immunology, Payload Anomaly Detection

Module 5 (8 Hours)

Attack trees and Correlation of alerts-Autopsy of Worms and Botnets-Malware Detection- Obfuscation, polymorphism-Document vectors

Module 6 (4 Hours)

Email/IM security issues-Viruses/Spam-From signatures to thumbprints to zero day detection- Insider Threat issues-Taxonomy-Masquerade and Impersonation Traitors, Decoys and Deception- Future: Collaborative Security

Suggested Readings

1. The Art of Computer Virus Research and Defense, Peter Szor, Symantec Press ISBN 0-32130545-3
2. Crimeware, Understanding New Attacks and Defenses, Markus Jakobsson and Zulfikar Ramzan, Symantec Press, ISBN: 978-0-321-50195-0 2008

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO1	H			M		
CO2		H				
CO3		M	H	M		M
CO4			M	H		
CO5			M		M	H

CO6				M	H	M

CSMR0101: MALWARE ANALYSIS & REVERSE ENGINEERING
(3 Credits)

Course Outcomes

1. Recall an insight of fundamentals of malware analysis (Remembering)
2. Explain the concept of malware and reverse engineering. (Understanding)
3. Utilize tools and techniques of malware analysis (Applying)
4. Analyse data with respect to Malware and Kernel Debugging (Analysing)
5. Evaluate results from analysed data. (Evaluating)
6. Create an environment to protect malware. (Creating)

Module 1 (11 Hours)

Fundamentals of Malware Analysis (MA), Reverse Engineering Malware (REM)Methodology, Brief Overview of Malware analysis lab setup and configuration, Introduction to key MA tools and techniques, Behavioral Analysis vs. Code Analysis, Resources for Reverse-Engineering Malware (REM) Understanding Malware Threats, Malware indicators, Malware Classification, Examining Clam AV Signatures, Creating Custom Clam AV Databases, Using YARA to Detect Malware Capabilities, Creating a Controlled and Isolated Laboratory, Introduction to MA Sandboxes, Ubuntu, Zeltser’s REMnux, SANS SIFT, Sandbox Setup and Configuration New Course Form, Routing TCP/IP Connections, Capturing and Analysing Network Traffic, Internet simulation using INet Sim, Using Deep Freeze to Preserve Physical Systems, Using FOG for Cloning and Imaging Disks, Using MySQL Database to Automate FOG Tasks, Introduction toPython ,Introduction to x86 Intel assembly language, Scanners: Virus Total, Jotti, and No Virus Thanks, Analysers: Threat Expert, CW Sandbox, Anubis, Joebox, Dynamic Analysis Tools: Process Monitor, Regshot, Handle Diff, Analysis Automation Tools: Virtual Box, VM Ware, Python , Other Analysis Tools

Module 2 (6 Hours)

Using TSK for Network and Host Discoveries, Using Microsoft Offline API to Registry Discoveries , Identifying Packers using PEiD, Registry Forensics with Reg Ripper Plugins:, Bypassing Poison Ivy’s Locked Files, Bypassing Conficker’s File System ACL Restrictions, Detecting Rogue PKI Certificates.

Module 3 (8 Hours)

Opening and Attaching to Processes, Configuration of JIT Debugger for Shell code Analysis, Controlling Program Execution, Setting and Catching Breakpoints, Debugging with Python Scripts and Py Commands, DLL Export Enumeration, Execution, and Debugging, debugging a VMware Workstation Guest (on Windows), Debugging a Parallels Guest (on Mac OS X). Introduction to Win Dbg Commands and Controls, Detecting Rootkits with Win Dbg Scripts, Kernel Debugging with IDA Pro.

Module 4 (8 Hours)

Memory Dumping with Moon Sols Windows Memory Toolkit, Accessing VM Memory Files Overview of Volatility, Investigating Processes in Memory Dumps, Code Injection and Extraction, Detecting and Capturing Suspicious Loaded DLLs, Finding Artifacts in Process Memory, Identifying Injected Code with Malfind and YARA.

Module 5 (7 Hours)

Using WHOIS to Research Domains, DNS Hostname Resolution, Querying Passive DNS, Checking DNS Records, Reverse IP Search New Course Form, Creating Static Maps, Creating Interactive Maps.

Module 6 (5 Hours)

Case study of Finding Artifacts in Process Memory, Identifying Injected Code with Malfind and YARA

Suggested Readings

1. Michael Sikorski, Andrew Honig “Practical Malware Analysis: The Hands-On Guide to DissectingMalicious Software” publisher William Pollock

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO1	H					
CO2		H				
CO3		M	H			M
CO4				H		
CO5			M		H	
CO6				M		H

CSSC0102: SECURE SOFTWARE DESIGN AND ENTERPRISE COMPUTING

(3 Credits)

Course Outcomes

1. Recall the various software vulnerabilities. (Remembering)
2. Explain the software process vulnerabilities for an organization. (Understanding)
3. Apply techniques for successfully implementing and supporting network services on an enterprise scale and heterogeneous systems environment (Applying)
4. Analyse and monitor resources consumption in a software. (Analysing)
5. Evaluate results by interrelating security and software development process. (Evaluating)
6. Create methodologies and tools to design and develop secure software containing minimum vulnerabilities and flaws. (Creating)

Module 1 (8 Hours)

Secure Software Design Identify software vulnerabilities and perform software security analysis, Master security programming practices, Master fundamental software security design concepts, Perform security testing and quality assurance

Module 2 (9 Hours)

Enterprise Application Development Describe the nature and scope of enterprise software applications, Design distributed N-tier software application, Research technologies available for the presentation, business and data tiers of an enterprise software application, Design and build a database using an enterprise database system, Develop components at the different tiers in an enterprise system, Design and develop a multi-tier solution to a problem using technologies used in enterprise system, Present software solution.

Module 3 (8 Hours)

Enterprise Systems Administration Design, implement and maintain a directory-based server infrastructure in a heterogeneous systems environment, Monitor server resource utilization for system reliability and availability, Install and administer network services (DNS/DHCP/Terminal Services/Clustering/Web/Email).

Module 4 (8 Hours)

Obtain the ability to manage and troubleshoot a network running multiple services, Understand the requirements of an enterprise network and how to go about managing them.

Module 5 (8 Hours)

Handle insecure exceptions and command/SQL injection, Defend web and mobile applications against attackers, software containing minimum vulnerabilities and flaws.

Module 6 (4 Hours)

Case study of DNS server, DHCP configuration and SQL injection attack.

Suggested Readings

1. Theodor Richardson, Charles N Thies, Secure Software Design, Jones & Bartlett
2. Kenneth R. van Wyk, Mark G. Graff, Dan S. Peters, Diana L. Burley, Enterprise Software Security, Addison Wesley

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO1	H					
CO2		H				
CO3		M		H		M
CO4			H	M		
CO5			M		H	
CO6				M		H

CSAA0103: ADVANCED ALGORITHMS

(3 credits)

Course Outcomes

1. Recall different algorithms (Remembering)
2. Explain the applications of various algorithms (Understanding)
3. Apply computer algorithms for different purposes. (Applying)

4. Analyse the complexity/ performance of different algorithms. Categorize the different problems in various classes according to their complexity. (Analysing)
5. Evaluate the different problems in various classes according to their complexity. (Evaluation)
6. Elaborate the recent activities in the field of the advanced data structure. (Creating)

Module 1 (6 Hours)
Sorting: Review of various sorting algorithms, topological sorting
Graph: Definitions and Elementary Algorithms: Shortest path by BFS, shortest path in edge weighted case (Dijkstra's), depth-first search and computation of strongly connected, components, emphasis on correctness proof of the algorithm and time/space analysis, example of amortized analysis.

Module 2 (7 Hours)
Matroids: Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST.
Graph Matching: Algorithm to compute maximum matching. Characterization of maximum matching by augmenting paths, Edmond's Blossom algorithm to compute augmenting paths.

Module 3 (8 Hours)
Flow-Networks: Maxflow-mincut theorem, Ford-Fulkerson Method to compute, maximum flow, Edmond-Karp maximum-flow algorithm.
Matrix Computations: Strassen's algorithm and introduction to divide and conquer paradigm, inverse of a triangular matrix, relation between the time complexities of basic matrix operations, LUP-decomposition.

Module 4 (9 Hours)
Shortest Path in Graphs: Floyd-Warshall algorithm and introduction to dynamic programming paradigm. More examples of dynamic programming.
Modulo Representation of integers/polynomials: Chinese Remainder Theorem, Conversion between base-representation and modulo-representation. Extension to polynomials. Application: Interpolation problem.
Discrete Fourier Transform (DFT): In complex field, DFT in modulo ring. Fast Fourier Transform algorithm.Schonhage-Strassen Integer Multiplication algorithm

Module 5 (10 Hours)
Linear Programming: Geometry of the feasibility region and Simplex algorithm NP-completeness: Examples, proof of NP-hardness and NP-completeness.
One or more of the following topics based on time and interest Approximation algorithms, Randomized Algorithms, Interior Point Method,Advanced Number Theoretic Algorithm

Module 6 (5 Hours)
Recent Trends in problem solving paradigms using recent searching and sorting techniques by applying recently proposed data structures.

Suggested Readings
1. "Introduction to Algorithms" by Cormen, Leiserson, Rivest, Stein.
2. "The Design and Analysis of Computer Algorithms" by Aho, Hopcroft, Ullman.
3. "Algorithm Design" by Kleinberg and Tardos.

Mapping of COs to Syllabus:

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				
CO 2	M	H	M			
CO 3		M	H	M		
CO 4			M	H	M	
CO 5					H	M
CO 6						H

CSSP0104: SOFT COMPUTING
(3 Credits)

Objectives:
- To introduce soft computing concepts and techniques and foster their abilities in designing appropriate techniques for a

given scenario.
- To implement soft computing-based solutions for real-world problems.
- To give students knowledge of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, genetic algorithms.
- To provide student hand-on experience on MATLAB to implement various strategies.

Course Outcomes
1. Identify and describe soft computing techniques and their roles in building intelligent machines. (Remembering & understanding)
2. Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems. (Applying)
3. Analyse genetic algorithms to combinatorial optimization problems. (Analysing)
4. Evaluate and discuss solutions by various soft computing approaches for a given problem. (Evaluating and creating).

Module I (7 Hours)
Introduction to soft computing and neural networks: Evolution of Computing: Soft Computing Constituents, From Conventional AI to Computational Intelligence: Machine Learning Basics

Module II (8 Hours)
Fuzzy logic: Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making.

Module III (8 Hours)
Neural networks: Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks: Reinforcement Learning, Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks

Module IV (5 Hours)
Genetic algorithms: Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning: Machine Learning Approach to Knowledge Acquisition.

Module V (12 Hours)
Matlab/Python Lib: Introduction to Matlab/Python, Arrays and array operations, Functions and Files, Study of neural network toolbox and fuzzy logic toolbox, Simple implementation of Artificial Neural Network and Fuzzy Logic

Module VI (5 Hours)
Recent Trends in deep learning, various classifiers, neural networks and genetic algorithms. Implementation of recently proposed soft computing techniques.

Suggested Readings
1. Jyh Shing Roger Jang, Chuen Tsai Sun, Eiji Mizutani, Neuro Fuzzy and Soft Computing, Prentice: Hall of India,2003.
2. George J. Klirand Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall,1995.
3. MATLAB Toolkit Manual.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H					L
CO 2	H	H			M	
CO 3		M		H		
CO 4			M		M	M

CSDV0105: DATA VISUALISATION
(3 Credits)

Objectives:
- familiarize students with the basic and advanced techniques of information visualization and scientific visualization,
- to learn key techniques of the visualization process
- a detailed view of visual perception, the visualized data and the actual visualization interaction and distorting techniques

Course Outcomes
1. Recall the basic and advanced techniques of information and scientific visualization. (Remembering)
2. Explain the key techniques of the visualization process. (Understanding)
3. Apply detailed view of visual perception, the visualized data and the actual visualization, interaction and distorting techniques. (Applying)

4. Analyse different visualization techniques and their applicability to different types of data. (Analysing)
5. Compare techniques for visual mapping, geographic data and collaborative visualization. (Evaluating)
6. Create a process to have an understanding of large-scale abstract data. (Creating)

Module I (8 Hours)
Introduction of visual perception, visual representation of data, Gestalt principles, information overloads.

Module II (8 Hours)
Creating visual representations, visualization reference model, visual mapping, visual analytics, Design of visualization applications.

Module III (8 Hours)
Classification of visualization systems, Interaction and visualization techniques misleading, Visualization of one, two and multi-dimensional data, text and text documents.

Module IV (10 Hours)
Visualization of groups, trees, graphs, clusters, networks, software, Metaphorical visualization

Module V (7 Hours)
Visualization of volumetric data, vector fields, processes and simulations, Visualization of maps, geographic information, GIS systems, collaborative visualizations, Evaluating visualizations

Module VI (4 Hours)
Recent trends in various perception techniques, various visualization techniques, data structures used in data visualization.

Suggested Readings
1. WARD, GRINSTEIN, KEIM, Interactive Data Visualization: Foundations, Techniques, and Applications. Natick: A K Peters, Ltd.
2. E. Tufte, The Visual Display of Quantitative Information, Graphics Press

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					
CO 2	L	H	H			
CO 3						
CO 4			M	H	H	
CO 5					H	
CO 6			H	H	H	M

CSBD0106: BIG DATA ANALYTICS
(3 Credits)

Objectives:
- Understand big data for business intelligence. Learn business case studies for big data analytics.
- Understand no sql big data management. Perform map-reduce analytics using Hadoop and related tools

Course Outcomes
1. Describe big data and use cases from selected business domains. (Remembering & Understanding)
2. Applying NoSQL big data management. (Applying)
3. Install, configure, and run Hadoop and HDFS and analyse the data. (Analysing)
4. Perform map-reduce analytics using Hadoop (Evaluating)
5. Use Hadoop related tools such as HBase, Cassandra, Pig, and Hive for creating big data analytics. (Creating)

Module I (8 Hours)
What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and bigdata, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open source technologies, cloud and bigdata, mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics.

Module II (8 Hours)
Introduction to NoSQL, aggregate data models, aggregates, key-value and document data models, relationships, graph databases, schema less databases, materialized views, distribution models, sharding, master-slave replication, peer peer replication, sharding and replication, consistency, relaxing consistency, version stamps, map-reduce, partitioning and

combining, composing map- reduce calculations.

Module III (8 Hours)
Data format, Analysing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, design of Hadoop distributed file system (HDFS), HDFS concepts, Java Interface, data flow, Hadoop I/O, data integrity, compression, serialization, Avro, file-based data structures

Module IV (8 Hours)
Map Reduce workflows, unit tests with MR Unit, test data and local tests, anatomy of Map Reduce jobrun, classic Map-reduce, YARN, failures in classic Map-reduce and YARN, job scheduling, shuffle and sort, task execution, MapReduce types, input formats, output formats

Module V (7 Hours)
Hbase, data model and implementations, Hbase clients, Hbase examples, praxis. Cassandra, Cassandra data model, Cassandra examples, Cassandra clients, Hadoop integration.

Module VI (6 Hours)
Pig, Grunt, pig data model, Pig Latin, developing and testing Pig Latin scripts. Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation, HiveQL queries.

Suggested Readings

1. Michael Minelli, Michelle Chambers, and AmbigaDhiraj, “Big Data, Big Analytics:Emerging
2. Business Intelligence and Analytic Trends for Today’s Businesses”, Wiley, 2013.
3. P.J. Sadalage and M. Fowler, “NoSQL Distilled: A Brief Guide to the Emerging Worldof
4. Polyglot Persistence”, Addison-Wesley Professional,2012.
5. Tom White, “Hadoop: The Definitive Guide”, Third Edition, O’Reilly,2012.
6. Eric Sammer, “Hadoop Operations”, O’Reilly,2012.
7. E. Capriolo, D. Wampler, and J. Rutherglen, “Programming Hive”, O’Reilly,2012.
8. Lars George, “HBase: The Definitive Guide”, O’Reilly,2011.
9. Eben Hewitt, “Cassandra: The Definitive Guide”, O’Reilly,2010.
10. Alan Gates, “Programming Pig”, O’Reilly, 2011.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					
CO 2	L	H	M			
CO 3			H			
CO 4			M	H	H	
CO 5					H	M

CSDD0107: DATA WAREHOUSING AND DATA MINING
(3 Credits)

Objectives:
- The objective of this course is to introduce data warehousing and mining techniques.
- Application of data mining in web mining, pattern matching and cluster analysis is included to aware students of broad data mining areas.

Course Outcomes
1. List the various data warehousing and data mining techniques. (Remembering)
2. Explain the principles, concepts, functions and various applications of data warehouse. (Understanding)
3. Apply data mining techniques for classification and prediction. (Applying)
4. Perform cluster, periodicity and social network analysis. (Analysing)
5. Evaluate and compare various data mining solutions for a given problem. (Evaluating)
6. Choose appropriate data warehousing and data mining techniques to build real-world systems. (Creating)

Module I (7 Hours)
Introduction to Data Warehousing; Data Mining: Mining frequent patterns, association and correlations; Sequential Pattern Mining concepts, primitives, scalable methods;

Module II (7 Hours)
Classification and prediction; Cluster Analysis – Types of Data in Cluster Analysis, Partitioning methods, Hierarchical Methods;

Transactional Patterns and other temporal based frequent patterns,

Module III (8 Hours)
Mining Time series Data, Periodicity Analysis for time related sequence data, Trend analysis, Similarity search in Time-series analysis;

Module IV (9 Hours)
Mining Data Streams, Methodologies for stream data processing and stream data systems, Frequent pattern mining in stream data, Sequential Pattern Mining in Data Streams, Classification of dynamic data streams, Class Imbalance Problem; Graph Mining; Social Network Analysis;

Module V (9 Hours)
Web Mining, Mining the webpage layout structure, mining weblink structure, mining multimedia data on the web, Automatic classification of web documents and web usage mining; Distributed Data Mining.

Module VI (5 Hours)
Recent trends in Distributed Warehousing and Data Mining, Class Imbalance Problem; Graph Mining; Social Network Analysis

Suggested Readings
1. Jiawei Han and M Kamber, Data Mining Concepts and Techniques, Second Edition, Elsevier Publication,2011.
2. Vipin Kumar, Introduction to Data Mining - Pang-Ning Tan, Michael Steinbach, Addison Wesley,2006.
3. G Dong and J Pei, Sequence Data Mining, Springer,2007.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					
CO 2	M	H				
CO 3		H	M			
CO 4		M	H	M		
CO 5				H	M	M
CO 6						H

CSDS0108: DATA SECURITY AND ACCESS CONTROL
(3 Credits)

Objective
The objective of the course is to provide fundamentals of database security. Various access control techniques mechanisms were introduced along with application areas of access control techniques.

Course Outcomes
1. Define access control in the database. (Remembering)
2. Explain the purpose and fundamentals of access control. (Understanding)
3. Identify the capabilities and limitations of various access control mechanisms. (Applying)
4. Analyse the data, identify the problems, and choose the relevant models and algorithms to apply. (Analysing)
5. Assess the strengths and weaknesses of various access control models and to Analyse their behaviour. (Evaluating)
6. Design and develop access control mechanisms for enterprise IT infrastructures. (Creating)

Module I (7 Hours)
Introduction to Access Control, Purpose and fundamentals of access control, brief history, Policies of Access Control, Models of Access Control, and Mechanisms, Discretionary Access Control (DAC), Non- Discretionary Access Control, Mandatory Access Control (MAC). Capabilities and Limitations of Access Control Mechanisms: Access Control List (ACL) and Limitations, Capability List and Limitations.

Module II (8 Hours)
Role-Based Access Control (RBAC) and Limitations, Core RBAC, Hierarchical RBAC, Statically Constrained RBAC, Dynamically Constrained RBAC, Limitations of RBAC. Comparing RBAC to DAC and MAC Access control policy.

Module III (9 Hours)
Biba Integrity model, Clark-Wilson model, Domain type enforcement model, mapping the enterprise view to the system view, Role hierarchies- inheritance schemes, hierarchy structures and inheritance forms, using SoD in real system Temporal Constraints in RBAC, MAC AND DAC. Integrating RBAC with enterprise IT infrastructures: RBAC for WFMSs, RBAC for UNIX and JAVA environments Case study: Multi-line Insurance Company

Module IV (10 Hours)

Smart Card based Information Security, Smart card operating system fundamentals, design and implantation principles, memory organization, smart card files, file management, atomic operation, smart card data transmission ATR, PPS Security techniques- user identification, smart card security, quality assurance and testing, smart card life cycle-5 phases, smart card terminals.

Module V (7 Hours)

Recent trends in Database security and access control mechanisms. Case study of Role-Based Access Control (RBAC) systems.

Module VI (4 Hours)

Recent Trends related to data security management, vulnerabilities in different DBMS.

Suggested Readings

1. Role Based Access Control: David F. Ferraiolo, D. Richard Kuhn, Ramaswamy Chandramouli.
2. http://www.smartcard.co.uk/tutorials/sct-itsc.pdf : Smart Card Tutorial.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					
CO 2	M	H				
CO 3		M	M			
CO 4		M	H	H		
CO 5				M	M	L
CO 6					H	M

CSWD0109: WEB ANALYTICS AND DEVELOPMENT

(3 Credits)

Objective

The course explores use of social network analysis to understand growing connectivity and complexity in the world ranging from small groups to WWW.

Course Outcomes

1. Relate with core research communities, publications, focused on web and social media analytics and research questions engaged. (Remembering)
2. Discuss clickstream data collection techniques, their impact on metrics, and their inherent limitations. (Understanding)
3. Identify and interpret commonly used web metrics (Applying)
4. Analyse and evaluate tasks and techniques used in web analytics. (Analysis/Evaluation)
5. Elaborate the resulting insights to support website design decisions, campaign optimisation, search analytics, etc. (Creating)

Module I (8 Hours)

Introduction – Social network and Web data and methods, Graph and Matrices, Basic measures for individuals and networks, Information Visualization

Module II (8 Hours)

Web Analytics tools: Click Stream Analysis, A/B testing, Online Surveys

Module III (8 Hours)

Web Search and Retrieval: Search Engine Optimization, Web Crawling and indexing, Ranking Algorithms, Web traffic models

Module IV (12 Hours)

Making Connection: Link Analysis, Random Graphs and Network evolution, Social Connects: Affiliation and identity

Module V (9 Hours)

Connection: Connection Search, Collapse, Robustness Social involvements and diffusion of innovation

Suggested Readings

1. Hansen, Derek, Ben Sheiderman, Marc Smith. 2011. Analysing Social Media Networks with NodeXL: Insights from a Connected World. Morgan Kaufmann,304.
2. Avinash Kaushik. 2009. Web Analytics 2.0: The Art of Online Accountability.
3. Easley, D. & Kleinberg, J. (2010). Networks, Crowds, and Markets: Reasoning About a Highly Connected World. New York: Cambridge University Press. http://www.cs.cornell.edu/home/kleinber/networks- book/

4. Wasserman, S. &Faust, K. (1994). Social network analysis: Methods and applications. NewYork: Cambridge University Press.
5. Monge, P.R. &Contractor, N.S. (2003). Theories of communication networks. NewYork: Oxford University Press.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H				
CO 2	M	H			
CO 3		M	H		
CO 4		M	M	H	
CO 5				M	H

CSKD0110: KNOWLEDGE DISCOVERY
(3 Credits)

Objective
To conduct case studies on real data mining examples

Course Outcomes
1. Recall the basic terminologies like learning goals, concept representation, decision tree, computational learning, artificial neural network, classification. (Remembering)
2. Explain different categories of machine learning and machine learning methodologies and illustrate the theory behind designing a learning model. (Understanding)
3. Compare efficiency of different learning algorithms, classify supervised and unsupervised learning goals. (Understanding)
4. Apply different learning algorithms for real life classification problem, sketch the structure of different learning model such as neural network, support vector machine, naive bayes etc. (Applying)
5. Analyse decision tree learning, computational learning, artificial neural network and instance-based learning and how one learning overcomes the drawback in the other. (Analysing)
6. Judge in terms of different complexity which algorithms betters in what situation. (Evaluating).
7. Create and design ensemble-based learning, propose new learning for optimizing real life problems. (Creating)

Module I (7 Hours)
Introduction KDD and Data Mining - Data Mining and Machine Learning, Machine Learning and Statistics, Generalization as Search, Data Mining and Ethics

Module II (8 Hours)
Knowledge Representation - Decision Tables, Decision Trees, Classification Rules, Association Rules, Rules involving Relations, Trees for Numeric Predictions, Neural Networks, Clusters

Module III (9 Hours)
Decision Trees - Divide and Conquer, Calculating Information, Entropy, Pruning, Estimating Error Rates, The C4.5 Algorithm Evaluation of Learned Results- Training and Testing, Predicting Performance, Cross-Validation

Module IV (8 Hours)
Classification Rules - Inferring Rudimentary Rules, Covering Algorithms for Rule Construction, Probability Measure for Rule Evaluation, Association Rules, Item Sets, Rule Efficiency

Module V (6 Hours)
Numeric Predictions - Linear Models for Classification and Numeric Predictions, Numeric Predictions with Regression Trees, Evaluating Numeric Predictions

Module VI (7 Hours)
Artificial Neural Networks – Perceptrons, Multilayer Networks, The Backpropagation Algorithm Clustering - Iterative Distance-based Clustering, Incremental Clustering, The EM Algorithm

Suggested Readings
1. Data mining and knowledge discovery handbook by Maimon, Oded(etal.)
2. Data Cleansing: A Prelude to knowledge Discovery

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				
CO 2	M	H	H	M		

CO 3		M	M	H		
CO 4		M	H	H		
CO 5				M	M	L
CO 6					H	M
CO 7				H	L	L

CSNL0111: NATURAL LANGUAGE PROCESSING

(3 Credits)

Objectives

The goals for this course are to study:

- algorithms and methods for building computational models of natural language understanding, including syntactic analysis, semantic representations, discourse analysis, and statistical and corpus- based methods for text processing and knowledge acquisition
- issues involved in natural language understanding
- applications that can benefit from natural language processing, such as information extraction, question answering, machine translation, and spoken language understanding. By the end of the course, students will have a good understanding of and appreciation for natural language processing, and have the necessary skills to build natural language processing tools.

Course Outcomes

1. Recall algorithms and methods for building computational models of natural language processing (Remembering)
2. Explain syntactic analysis, semantic representations, discourse analysis, and statistical and corpus-based methods for text processing and knowledge acquisition. (Understanding)
3. Apply the methods of natural language processing. (Applying)
4. Analyse Issues involved in natural language processing. (Analysing)
5. Evaluate and generate applications that can benefit from natural language processing, such asinformation extraction, question answering, machine translation, and spoken language understanding. (Evaluating &creating)

Module I (10 hours)

Introduction to NLP, Knowledge in language processing, Representation and Understanding, Organization of NLP systems, Models and algorithms, Linguistic Essentials

Module II (15 hours)

Grammars and Parsing - Syntactic Processing: Collocations; Regular Expression and Automata; Morphology and Finite-State Transducers; N-grams; Word Classes and Part-of-Speech Tagging; Context-Free Grammars for English; Parsing with Context-Free Grammars: Top-down parsing, Bottom-up parsing; Features and Unification; Lexicalized and Probabilistic Parsing

Module III (10 hours)

Semantic processing: Representing Meaning; Semantic Analysis: Integrating semantic analysis to parsers, Semantic Grammars; Lexical Semantics; Word Sense Disambiguation and Information Retrieval: Selection- Restriction based disambiguation, Machine learning approaches; Dictionary based approaches, Information retrieval

Module IV (7 hours)

Pragmatics: Discourse, Dialogue and Conversational Agents: Dialogue acts, Automatic Interpretation of Dialogue acts; Natural Language Generation: Discourse Planning; Machine Translation: Direct Translations, Translation using Statistical techniques
Module V (3 hours)
NLP Applications and Tools: Sentiment Analysis, Text Summarization, Text Entailment, Machine Translation, Question Answering, Cross Lingual Information Retrieval (CLIR), NLTK, WordNet

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H				
CO 2	M	H	M		
CO 3		M	H	L	
CO 4		M	M	H	M
CO 5				M	H

CSNI0112: SENSOR NETWORKS AND INTERNET OF THINGS

(3 credits)

Objectives

- The course gives an overview of various topics related to wireless sensor networks, which are expected to be the basis for the emerging internet-of-things.
- The course covers topics with relation to various sub disciplines of computer science such as hardware, operating systems, distributed systems, networking, security and databases.
- Able to understand wireless sensor network (WSN) specific issues such as localization, time synchronization, and topology control are addressed as well.

Course Outcomes

1. Define the function of sensors. (Remembering)
2. Explain how to connect sensors to the environment. (Understanding)
3. Organize and connect sensors together to have generated output. (Applying)
4. Examine hardware and software level consideration for IoT sensors. (Analyzing)
5. Evaluate results from data. (Evaluating)
6. Creating a real time application. (Creating)

Module I (7 Hours)

Introduction and Applications: smart transportation, smart cities, smart living, smart energy, smart health, and smart learning. Examples of research areas include for instance: Self-Adaptive Systems, Cyber Physical Systems, Systems of Systems, Software Architectures and Connectors, Software Interoperability, Big Data and Big Data Mining, Privacy and Security.

Module II (8 Hours)

IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints hardware, Data representation and visualization, Interaction and remote control.

Module III (8 Hours)

Industrial Automation- Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, Commercial Building Automation- Introduction, Case study: phase one-commercial building automation today, Case study: phase two- commercial building automation in the future.

Module IV (10 Hours)

Hardware Platforms and Energy Consumption, Operating Systems, Time Synchronization, Positioning and Localization, Medium Access Control, Topology and Coverage Control, Routing: Transport Protocols, Network Security, Middleware, Databases.

Module V (7 Hours)

IOT Physical Devices & Endpoints: What is an IOT Device, Exemplary Device Board, Linux on Raspberry, Interface and Programming & IOT Device

Module VI (5 Hours)

Recent trends in sensor network and IOT architecture, Automation in Industrial aspect of IOT.

Suggested Readings

1. Mandler, B., Barja, J., MitreCampista, M.E., Cagá_ová, D., Chaouchi, H., Zeadally, S., Badra, M., Giordano, S., Fazio, M., Somov, A., Vieriu, R.-L., Internet of Things. IoT Infrastructures, Springer International Publishing.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				
CO 2		H				
CO 3			H	H		
CO 4				H	M	
CO 5					H	
CO 6						H

CSAC0113: IOT APPLICATIONS AND COMMUNICATION PROTOCOLS

(3 credits)

Objectives

- Basic introduction of all the elements of IoT-Mechanical, Electronics/sensor platform, Wireless and wireline protocols, Mobile to Electronics integration, Mobile to enterprise integration.

- Open source/commercial electronics platform for IoT-Raspberry Pi, Arduino, Arm Mbed LPC.
- Open source /commercial enterprise cloud platform for IoT-Ayla, iO Bridge, Libellium, Axeda, Cisco fog cloud.

Course Outcomes

1. Define IoT and respective protocols. (Remembering)
2. Explain the functions of different layers of communication protocol. (Understanding)
3. Identify the different functions with respect to different layers. (Applying)
4. Distinguish protocol and functionalities. (Analyzing)
5. Evaluate the sensor collected data in connection to communication layer. (Evaluating)
6. Create applications using different communication protocol. (Creating)

Module I (7 Hours)

Basic function and architecture of a sensor — sensor body, sensor mechanism, sensor calibration, sensor maintenance, cost and pricing structure, legacy and modern sensor network. Development of sensor electronics — IoTvs legacy, and open-source vs traditional PCB design style Development of sensor communication protocols, Protocols: Modbus, relay, Zigbee, Zwave, X10, Bluetooth, ANT, etc. Business driver for sensor deployment — FDA/EPA regulation, fraud/ tempering detection, supervision, quality control and process management Different kind of calibration Techniques: manual, automation, infield, primary and secondary calibration — and their implication in IoT Powering options for sensors: battery, solar, Witricity, Mobile and PoE.

Module II (9 Hours)

Zigbee and Zwave — advantage of low power mesh networking. Long distance Zigbee. Introduction to different Zigbee chips. Bluetooth/BLE: Low power vs high power, speed of detection, class of BLE. Introduction of Bluetooth vendors & their review. Wireless protocols such as Piconet and packet structure for BLE and Zigbee Other long distance RF communication link. LOS vs NLOS links, Capacity and throughput calculation Application issues in wireless protocols: power consumption, reliability, PER, QoS, LOS.

Module III (9 Hours)

PCB vs FPGA vs ASIC design Prototyping electronics vs Production electronics, QA certificate for IoT CE/CSA/UL/IEC/RoHS/IP65 Basic introduction of multi-layer PCB design and its workflow Electronics reliability-basic concept of FIT and early mortality rate Environmental and reliability testing-basic concepts Basic Open source platforms: Arduino, Raspberry Pi, Beaglebone.

Module IV (7 Hours)

Introduction to Mobile app platform for IoT: Protocol stack of Mobile app for IoT, Mobile to server integration, iBeacon in IoS, Window Azure, Linkafy Mobile platform for IoT, Axeda, Xively.

Module V (8 Hours)

Database implementation for IoT : Cloud based IoT platforms, SQL vsNoSQL, Open sourced vs. Licensed Database, Available M2M cloud platform, AxedaXively, Omega NovoTech, Ayla Libellium, CISCO M2M platform, AT &T M2M platform, Google M2M platform.

Module VI (5 Hours)

Recent trends in home automation, IOT-locks, Energy optimization in home

Suggested Readings

1. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, Wiley-Blackwell.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				
CO 2		H	M			
CO 3			H	M		
CO 4			M	H	M	
CO 5					H	
CO 6						H

CSNY0114: NETWORK SECURITY

(3 credits)

Objectives:

- To learn the basics of security and various types of security issues.
- To study different cryptography techniques available and various security attacks.

- Explore network security and how they are implemented in real world.
- To get an insight of various issues of Web security and biometric authentication.

Course Outcomes

1. Recall the basics of security and various types of security issues. (Remembering)
2. Explain the different cryptography techniques available and various security attacks. (Understanding)
3. Apply network security and how they are implemented in the real world. (Applying)
4. Analyse available biometric techniques and how they are used in today's world. (Analysing)
5. Evaluate the security issues on the web and how to tackle them. (Evaluating)
6. Elaborate the various issues of web security and biometric authentication. (Creating)

Module I (6 Hours)
Data security: Review of cryptography. Examples RSA, DES, ECC.

Module II (7 Hours)
Authentication, non-repudiation and message integrity. Digital signatures and certificates. Protocols using cryptography (example Kerberos). Attacks on protocols

Module III (9 Hours)
Network security: Firewalls, Proxy-Servers, Network intrusion detection. Transport security: Mechanisms of TLS, SSL, IPSec.

Module IV (10 Hours)
Web security – SQL injection, XSS, etc. Software security and buffer overflow. Malware types and case studies. Access Control, firewalls and host/network intrusion detection.

Module V (8 Hours)
Other topics: Biometric authentication, Secure E-Commerce (ex. SET), Smart Cards, Security in Wireless Communication.

Module VI (5 Hours)
Recent trends in IOT security, IDS and Biometric.

Suggested Readings

1. W. R. Cheswick and S. M. Bellovin. Firewalls and Internet Security. Addison Wesley, 1994.
2. W. Stallings. Cryptography and Network Security. Prentice Hall, 1999.
3. Schneier. Applied Cryptography. Wiley, 1999

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					
CO 2	M	H				
CO 3		M	H			
CO 4			M	H		
CO 5				M	H	
CO 6					H	M

CSAM0115: ADVANCED MACHINE LEARNING

(3 credits)

Objectives:

- To introduce key concepts in pattern recognition and machine learning; including specific algorithms for classification, regression, clustering and probabilistic modeling.
- To give a broad view of the general issues arising in the application of algorithms to analysing data, common terms used, and common errors made if applied incorrectly.
- To demonstrate a toolbox of techniques that can be immediately applied to real world problems, or used as a basis for future research into the topic

Course Outcomes

1. Recall and explain the key concepts in pattern recognition and machine learning; including specific algorithms for classification, regression, clustering and probabilistic modeling. (Remembering, Understanding)
2. Explain the general issues arising in the application of algorithms, commonly used terms, and the common errors made if applied incorrectly. (Understanding)
3. Demonstrate a toolbox of techniques that can be immediately applied to real world problems, or used as a basis for future research into the topic. (Applying)

4. Analyse the Kernel methods for handling high dimensional and non-linear patterns. (Analysing)
5. Evaluate the State-of-the-art algorithms such as Support Vector Machines and Bayesian networks.
6. (Evaluating)
7. Solve real-world machine learning tasks: from data to inference. (Creating)

Module I (7 Hours)
Key concepts, Supervised/Unsupervised Learning, Loss functions and generalization, Probability Theory, Parametric vs Non-parametric methods, Elements of Computational Learning Theory Ensemble Learning, Bagging, Boosting, Random Forest

Module II (7 Hours)
Kernel Methods for non-linear data, Support Vector Machines, Kernel Ridge Regression, Structure Kernels, K ernel PCA, Latent Semantic Analysis

Module III (8 Hours)
Bayesian methods for using prior knowledge and data, Bayesian inference, Bayesian Belief Networks and Graphical models, Probabilistic Latent Semantic Analysis, The Expectation-Maximisation (EM) algorithm, Gaussian Processes

Module IV (9 Hours)
Dimensionality Reduction - CCA, LDA, ICA, NMF – Canonical Variates - Feature Selection vs Feature Extraction

Module V (9 Hours)
Filter Methods - Sub-space approaches - Embedded methods, Low-Rank approaches - Recommender Systems Application areas - Security - Business - Scientific

Module VI (5 Hours)
Recent trends in supervised and unsupervised learning algorithm, dimensional reducibility, feature selection and extraction

Suggested Readings
1. Christopher M. Bishop, Pattern Recognition and Machine Learning.
2. John Shawe -Taylor and Nello Cristianini, Kernel Methods for Pattern Analysis

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					
CO 2	M	H				
CO 3		M	H	M		
CO 4			M	H		
CO 5				M	H	
CO 6					M	H

CSEC0116: DATA ENCRYPTION AND COMPRESSION
(3 Credits)

Course Outcomes
1. List the different encryption techniques adopted in both traditional and modern cryptographic mechanisms. (Remembering)
2. Infer the logic adopted in different cryptographic algorithms, and their countermeasures.
3. (Understanding)
4. Apply the concepts gathered from the fundamentals of cryptographic approaches in solving related problems. (Applying)
5. Analyse the working of the different encryption and compression algorithms. (Analysing)
6. Compare and contrast the working of different data encryption and compression mechanisms.
7. (Evaluating)
8. Choose appropriate encryption and compression algorithms to build real-world systems. (Creating)

Module 1 (8 Hours)
Introduction to Security: Need for security, Security approaches, Principles of security, Types of attacks.
Encryption Techniques: Plaintext, Cipher text, Substitution Vs Transposition techniques, Encryption & Decryption, Types of attacks, Key range & Size.

Module 2 (10 Hours)
Symmetric & Asymmetric Key Cryptography: Algorithm types & Modes, DES, IDEA, Differential & Linear Cryptanalysis, RSA, Symmetric &Asymmetric key together, Digital signature, Knapsack algorithm. User Authentication Mechanism: Authentication basics, Passwords, Authentication tokens, Certificate based & Biometric authentication, Firewall.

Module 3 (9 Hours)
Case Studies of Cryptography: Denial of service attacks, IP spoofing attacks, Secure inter branch payment transactions, Conventional Encryption and Message Confidentiality, Conventional Encryption Principles, Conventional Encryption Algorithms, Location of Encryption Devices, Key Distribution. Public Key Cryptography and Message Authentication: Approaches to Message Authentication, SHA-1, MD5, Public-Key Cryptography Principles, RSA, Digital, Signatures, Key Management.

Module 4 (7 Hours)
Introduction: Need for data compression, Fundamental concept of data compression coding, Communication model, Compression ratio, Requirements of data compression, Classification. Methods of Data Compression: Data compression-- Loss less and Lossy.

Module 5 (10 Hours)
Entropy encoding-- Repetitive character encoding, run length encoding, Zero/Blank encoding; Statistical encoding-- Huffman, Arithmetic & Lempel-Zivcoding; Source encoding-- Vector quantization (Simple vector quantization & with error term); Differential encoding—Predictive coding, Differential pulse code modulation, Delta modulation, Adaptive differential pulse code modulation; Transform based coding: Discrete cosine transform JPEG standards; Fractal compression

Module 6 (4 Hours)
Recent trends in encryption and data compression techniques.

Suggested Readings
1. Cryptography and Network Security by B. Forouzan, McGraw-Hill.
2. The Data Compression Book by Nelson, BPB.
3. Cryptography & Network Security by Atul Kahate, TMH.

Mapping of COs to Syllabus:

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					
CO 2	M	H	M	L		
CO 3		M	H	M		
CO 4		L	M	H	M	
CO 5				M	H	M
CO 6				L	M	H

CSSW0117: STEGANOGRAPHY AND DIGITAL WATERMARKING
(3 Credits)

Course Outcomes
1. Define the terms Steganography, Steganalysis and Digital Watermarking. (Remembering)
2. Explain the various techniques for Steganography, Steganalysis and Digital Watermarking.
3. (Understanding)
4. Utilize various tools available to perform Steganography. (Applying)
5. Analyse data to detect and extract hidden information. (Analysing)
6. Defend against steganography and digital watermarking attacks. (Evaluating)
7. Develop frameworks for secure communication. (Creating)

Module 1 (8 Hours)
Steganography: Overview, History, Methods for hiding (text, images, audio, video, speech etc.), Issues: Security, Capacity and Imperceptibility, Steganalysis: Active and Malicious Attackers, Active and passive steganalysis.

Module 2 (10 Hours)
Frameworks for secret communication (pure Steganography, secret key, public key steganography), Steganography algorithms (adaptive and non-adaptive),

Module 3 (7 Hours)
Steganography techniques: Substitution systems, Spatial Domain, transform domain techniques, spread spectrum, Statistical steganography, Cover Generation and cover selection, Tools: EzStego, FFEn code, hide 4PGP, Hide and Seek, S Tools etc.)

Module 4 (5 Hours)
Detection, Distortion, Techniques: LSB Embedding, LSB Steganalysis using primary sets, Texture based

Module 5 (10 Hours)

Digital Watermarking: Introduction, Difference between Watermarking and steganography, History,
Classification (Characteristics and Applications), Types and techniques (Spatial-domain, Frequency- domain, and Vector quantization-based watermarking), Attacks and Tools (Attacks by Filtering, Re-modulation, Distortion, Geometric Compression, Linear Compression etc.), Watermark security & authentication.

Module 6 (5 Hours)
Recent trends in Steganography and digital watermarking techniques. Case study of LSB Embedding, LSBSteganalysis using primary sets.

Suggested Readings

1. Peter Wayner, "Disappearing Cryptography–Information Hiding: Steganography & Watermarking", Morgan Kaufmann Publishers, New York, 2002.
2. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Jessica Fridrich, Ton Kalker, "Digital Watermarking and Steganography", Morgan Kaufmann Publishers, New York, 2008.
3. Information Hiding: Steganography and Watermarking-Attacks and Countermeasures by Neil F. Johnson, Zoran Duric, Sushil Jajodia.

Mapping of COs to Syllabus:

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M	L			
CO 2	M	H	M	L		
CO 3		M	H	M		
CO 4		L	M	H	M	
CO 5					H	M
CO 6				L	M	H

CSIT0118: INFORMATION THEORY AND CODING

(3 Credits)

Course Outcomes

1. List the various coding and compression techniques. (Remembering)
2. Explain the working of lossless and lossy compression techniques. (Understanding)
3. Apply encoding techniques to encode data and perform error detection and correction.
4. (Applying)
5. Compare the various coding and compression techniques for text, video and image. (Analysing)
6. Measure information in terms of probability and entropy. (Evaluating)
7. Combine compression and coding techniques to build end-to-end systems. (Creating)

Module 1 (8 Hours)
Information and entropy information measures, Shannon's concept of Information. Channel coding, channel mutual information capacity (BW)

Module 2 (10 Hours)
Theorem for discrete memory less channel, information capacity theorem, Error Detecting and error correcting codes

Module 3 (8 Hours)
Types of codes: block codes, Hamming and Lee metrics, description of linear block codes, parity check Codes, cyclic code, Masking techniques

Module 4 (5 Hours)
Compression: loss less and lossy, Huffman codes, LZW algorithm, Binary Image compression schemes, run length encoding, CCITT group 3 1-DCompression, CCITT group 3 2D compression, CCITT group 42DCompression.

Module 5 (10 Hours)
Convolutional codes, sequential decoding. Video image Compression: CITT H261 Video coding algorithm, audio (speech) Compression. Cryptography and cipher.

Module 6 (4 Hours)
Case study of CCITT group 3 1-DCompression, CCITT group 3 2Dcompression.

Suggested Readings

1. Fundamentals in information theory and coding, Monica Borda, Springer.
2. Communication Systems: Analog and digital, Singh and Sapre, Tata McGraw Hill. Multimedia Communications Fred Halsall.
3. Information Theory, Coding and Cryptography R Bose.
4. Multimedia system Design Prabhat K Andleigh and Kiran Thakrar.

Mapping of COs to Syllabus:

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				
CO 2	M	H	M	L		
CO 3	L	M	H	M		
CO 4		L	M	H	M	
CO 5				L	H	M
CO 6					M	H

CSRA0119: SECURITY ASSESSMENT AND RISK ANALYSIS

(3 Credits)

Course Outcomes

1. List and define the various Contingency Planning components. (Remembering)
2. Explain the escalation process from incident to disaster in case of security disaster. (Understanding)
3. Plan countermeasures to threats. (Applying)
4. Analyse risks. (Analysing)
5. Recommend contingency strategies including data backup and recovery and alternate site selection for business resumption planning. (Evaluating)
6. Design Incident Response Plan, Disaster Recovery Plan and Business Continuity Plan for sustained organizational operations. (Creating)

Module 1 (8 Hours)

SECURITY BASICS: Information Security (INFOSEC) Overview: critical information characteristics – availability information states – processing security counter measures education, training and awareness, critical information characteristics – confidentiality critical information characteristics–integrity, information states – storage, information states – transmission, security countermeasures -policy, procedures and practices, threats, vulnerabilities.

Module 2 (11 Hours)

Threats to and Vulnerabilities of Systems: definition of terms (e.g., threats, vulnerabilities, risk), major categories of threats (e.g., fraud, Hostile Intelligence Service (HOIS), malicious logic, hackers, environmental and technological hazards, disgruntled employees, careless employees, HUMINT, and monitoring), threat impact areas, Countermeasures: assessments (e.g., surveys, inspections), Concepts of Risk Management: consequences (e.g., corrective action, risk assessment),cost/ benefit analysis of controls, implementation of cost effective controls, monitoring the efficiency and effectiveness of controls (e.g., unauthorized or inadvertent disclosure of information), threat and vulnerability assessment

Module 3 (8 Hours)

Security Planning: directives and procedures for policy mechanism, Risk Management: acceptance of risk(accreditation), corrective actions information identification, risk analysis and/or vulnerability assessment components, risk analysis results evaluation, roles and responsibilities of all the players in the risk analysis process, Contingency Planning/Disaster Recovery: agency response procedures and continuity of operations, contingency plan components, determination of backup requirements, development of plans for recovery actions after a disruptive event, development of procedures for off-site processing, emergency destruction procedures, guidelines for determining critical and essential workload, team member responsibilities in responding to an emergency situation

Module 4 (7 Hours)

Policies and Procedures Physical Security Measures: alarms, building construction, cabling, communications centre, environmental controls (humidity and air conditioning), filtered power, physical access control systems (key cards, locks and alarms) Personnel Security Practices and Procedures: access authorization/ verification(need-to-know), contractors, employee clearances, position sensitivity, security training and awareness, systems maintenance personnel, Administrative
Security Procedural Controls: attribution, copyright protection and licensing, Auditing and Monitoring: conducting security reviews, effectiveness of security programs, investigation of security breaches, privacy review of accountability controls, review of audit trails and logs

Module 5 (8 Hours)
Operations Security (OPSEC): OPSEC surveys/OPSEC planning INFOSEC: computer security – audit, Cryptography-encryption (e.g., point-to-point network, link), cryptography-key management (to include electronic key), cryptography-strength (e.g., complexity, secrecy, characteristics of the key)

Module 6 (3 Hours)
Case study of threat and vulnerability assessment

Suggested Readings
1. Principles of Incident Response and Disaster Recovery, Whitman &Mattord, Course Technology ISBN:141883663X
2. (Web link) http://www.cnss.gov/Assets/pdf/nstissi_4011.pdf

Mapping of COs to Syllabus:

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M	L			
CO 2	M	H	M	M		
CO 3		M	H	M	L	
CO 4			M	H	M	
CO 5			L	M	H	M
CO 6				L	M	H

CSCD0120: SECURE CODING
(3 Credits)

Course Outcomes
1. Recall the basics of secure programming. (Remembering)
2. Explain the most frequent programming errors leading to software vulnerabilities. (Understanding)
3. Identify security problems in software. (Applying)
4. Compare the solutions for handling security problems in software. (Analysing)
5. Assess the vulnerabilities present in software. (Evaluating)
6. Design and develop secure programs. (Creating)

Module 1 (10 Hours)
Introduction to software security, managing software security risk, selecting software development Technologies, An open source and closed source, Guiding Principles for software security, Auditing software, Buffet overflows, Access control, Race conditions, Input validation, Password authentication

Module 2 (6Hours)
Anti-tampering, protecting against denial-of-service attack, copy protection schemes, Client-side security, Database security, applied cryptography, Randomness and determinism

Module 3 (8 Hours)
Buffer Overrun, Format String Problems, Integer Overflow, and Software Security Fundamentals SQL Injection, Command Injection, Failure to Handle Errors, and Security Touch points

Module 4 (8 Hours)
Cross Site Scripting, Magic URLs, Weak Passwords, Failing to Protect Data, Weak random numbers, improper use of cryptography

Module 5 (8 Hours)
Information Leakage, Race Conditions, Poor usability, failing to protect network traffic, improper use of PKI, trusting network name resolution

Module 6 (5 Hours)
Case study of Cross Site Scripting, Magic URLs, Weak Passwords Buffer Overflows, Access control, Race conditions

Suggested Readings
1. J. Viega, M. Messier. Secure Programming Cookbook, O'Reilly.
2. M. Howard, D. LeBlanc. Writing Secure Code, Microsoft
3. J. Viega, G. McGraw. Building Secure Software, Addison Wesley

Mapping of COs to Syllabus:

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6

CO 1	H	M				
CO 2	M	H	M			
CO 3	L	M	H	M		
CO 4	L		M	H	M	
CO 5			L	M	H	M
CO 6				L	M	H

CSBI0121: BIOMETRICS
(3 Credits)

Course Outcomes
1. Define biometrics. (Remembering)
2. Explain the various modules constituting a biometric system. (Understanding)
3. Identify Biometric System Vulnerabilities. (Applying)
4. Compare the various Biometric technologies. (Analysing)
5. Evaluate the challenges and limitations associated with biometrics. (Evaluating)
6. Design security systems incorporating biometrics. (Creating)

Module 1 (7 Hours)
Introduction and Definitions of biometrics, Traditional authenticated methods and technologies.

Module 2 (10 Hours)
Biometric technologies: Fingerprint, Face, Iris, Hand Geometry, Gait Recognition, Ear, Voice, Palm print, On-Line Signature Verification, 3D Face Recognition, Dental Identification and DNA.

Module 3 (6 Hours)
The Law and the use of multi biometrics systems.

Module 4 (11 Hours)
Statistical measurement of Biometric.Biometrics in Government Sector andCommercial Sector.

Module 5 (9 Hours)
Case Studies of biometric system, Biometric Transaction. Biometric System Vulnerabilities.

Module 6 (5 Hours)
Recent trends in Biometric technologies and applications in various domains.Casestudy of 3D face recognition and DNA matching.

Suggested Readings
1. Biometrics for network security, Paul Reid, Hand book of Pearson
2. D. Maltoni, D. Maio, A. K. Jain, and S. Prabhakar, Handbook of Fingerprint Recognition,Springer Verlag,2003.
3. A. K. Jain, R. Bolle, S. Pankanti (Eds.), BIOMETRICS: Personal Identification in NetworkedSociety, Kluwer Academic Publishers, 1999.
4. J. Wayman, A.K. Jain, D. Maltoni, and D. Maio (Eds.), Biometric Systems: Technology,Design and Performance Evaluation, Springer, 2004.
5. Anil Jain, Arun A. Ross, Karthik Nanda Kumar, Introduction to biometric, Springer, 2011.
6. Biometric Systems: Technology, Design and Performance Evaluation, J. Wayman, A.K. Jain, D. Maltoni, and D. Maio.

Mapping of COs to Syllabus:

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				
CO 2	M	H	M			
CO 3		M	H	M	L	
CO 4		L	M	H	M	
CO 5					H	M
CO 6					M	H

CSFA0122: FORMAL LANGUAGE AND AUTOMATA THEORY

(3 Credits-45 Hour)

Course Outcomes

1. Define basic terminology like Deterministic and Non deterministic automata, Pushdown Automata, Parse Tree, Regular Languages, Turing Machines etc. (Remembering)
2. Explain the concepts, core terms and tools used in automata theory.(Understanding)
3. Choose the techniques, components and tools of a typical automated machine and apply it in designing new machines. (Applying)
4. Identify which input pattern would be accepted by a Turing Machine, Pushdown Automata, Finite Automata etc. (Applying)
5. Compare and contrast various types of machines in Automata theory and relate it to everyday appliances like washing machines, fans, etc. (Analyzing)
6. Evaluate the correctness, computation cost and complexity for an automation. (Evaluating)
7. Design new automata and Turing machines for given problems by using most appropriate algorithmic strategy considering the problem domain. (Creating)

Module I: Theory of Automata (7 Hours)

Definition of an Automaton, Description of a Finite Automaton, Transition Systems, Properties of Transition Functions, Acceptability of a String by a Finite Automaton, Nondeterministic Finite State Machines, The Equivalence of DFA and NDFA, Mealy and Moore Models, Minimization of Finite Automata.

Module II: Formal Languages, Regular Sets and Regular Grammars (12 Hours)

Definition of formal languages, Chomsky Classification of Languages, Languages and Their Relation, Recursive and Recursively Enumerable Sets, Operations on Languages, Languages and Automata; Regular Expressions, Finite Automata and Regular Expressions, Pumping Lemma for Regular Sets, Application of Pumping Lemma, Regular Sets and Regular Grammars Exercises.

Module III: Context-free Languages (13 Hours)

Context-free Languages and Derivation tree, Ambiguity in Context-free Grammars, Simplification of Context-free Grammars, Normal Forms for Context-free Grammars, Pumping Lemma for Context-free Languages, Decision Algorithms for Context-free Languages Exercises

Module IV: Pushdown Automata Turing Machines and Linear Bounded Automata (13 Hours)

Basic Definitions, Acceptance by pda, Pushdown Automata and Context-free Languages, Parsing and Pushdown Automata; Turing machine Model, Representation of Turing Machine, Language Acceptability by Turing Machines, Design of Turing Machines, Universal Turing Machine and Other Modification, The Model of Linear Bounded Automaton, Turing Machines and Type 0 Grammars, Linear Bounded Automata and Languages, Halting Problem of Turing Machines, NP-Completeness.

Suggested Readings

1. K.L.P. Mishra, N. Chandrasekaran, Theory of Computer Science, BPB Publication, Prentice-Hall of India, Second Edition.
2. H.R. Lewis and C.H.Papadimitriou, Elements of the Theory of Computation, Second Edition, Prentice Hall of India.
3. H.E. Hopcraft and J.D. Ullamn, Introduction to Automata Theory, Languages and Computation, Narosa Publications.
4. J.C. Martin, Introduction to Languages and the Theory of Automata, Tata McGraw-Hill International, 2003..
5. C.H. Papadimitriou, Computation Complexity, Addison-Wesley.
6. Linz Peter, An Introduction to Formal Languages and Automata,Narosa.
7. Kain, Theory of Automata and Formal Language, McGraw Hill.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H			H
CO2	H	M		H
CO3		M		H
CO4	H		L	
CO5		M	H	
CO6	H			M
CO7		L		H

CSOS0123: OPERATING SYSTEMS

(3 Credits-45 Hours)

Course Outcomes

1. Elaborate what operating systems are, what they do and how they are designed and constructed. (Creating)
2. Define process concept like process scheduling, inter-process communication, process synchronization and concurrency. (Remembering)
3. Explain different memory management schemes, relate various approaches to memory management and effectiveness of a particular algorithm. (Understanding)
4. Identify different page replacement algorithms to solve problems. (Applying)
5. Explain how the file system, mass storage and I/O are handled in a modern computer system. (Remembering, Understanding)
6. Analyze the mechanisms necessary for the protection and security of computer systems. (Analysing)

Module I: Introduction (5 hours)

Concept of Operating Systems, Generations of Operating systems, Types of Operating Systems, OS Services, System Calls, Structure of an OS - Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine. Case study on UNIX and WINDOWS Operating System.

Module II: Processes (7 hours)

Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching, Thread: Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads, Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non pre-emptive, FCFS, SJF, RR; Multiprocessor scheduling: Real Time scheduling: RM and EDF.

Module 3: Inter-process Communication (7 hours)

Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, Strict Alternation, Peterson's Solution, The Producer\ Consumer Problem, Semaphores, Event counters, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem etc.

Module 4: Deadlocks (5 hours)

Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery.

Module 5: Memory Management (10 hours)

Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation – Fixed and variable partition–Internal and External fragmentation and Compaction; Paging: Principle of operation – Page allocation, Hardware support for paging, Protection and sharing, Disadvantages of paging. Virtual Memory: Basics of Virtual Memory, Hardware and control structures – Locality of reference, Page fault, Working Set, Dirty page/Dirty bit – Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU).

Module 6: (11 hours)

I/O Hardware: I/O devices, Device controllers, Direct memory access Principles of I/O Software: Goals of Interrupt handlers, Device drivers, Device independent I/O software, Secondary-Storage Structure: Disk structure, Disk scheduling algorithms

File Management: Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency and performance.

Disk Management: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, Disk reliability, Disk formatting, Boot-block, Bad blocks.

Suggested Readings:

1. Operating System Concepts Essentials, 9th Edition by AviSilberschatz, Peter Galvin, Greg Gagne, Wiley Asia Student Edition.
2. Operating Systems: Internals and Design Principles, 5th Edition, William Stallings, Prentice Hall of India.
3. Operating System: A Design-oriented Approach, 1st Edition by Charles Crowley, Irwin Publishing
4. Operating Systems: A Modern Perspective, 2nd Edition by Gary J. Nutt, Addison-Wesley
5. Design of the Unix Operating Systems, 8th Edition by Maurice Bach, Prentice-Hall of India
6. Understanding the Linux Kernel, 3rd Edition, Daniel P. Bovet, Marco Cesati, O'Reilly and Associates

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					
CO 2		H	M			
CO 3		H	H	H		
CO 4			H	M		
CO 5				M	H	
CO 6				M	M	H

CSDC0124: DATA COMMUNICATIONS

(3 Credits-45 Hours)

Course Outcomes

1. Recall the fundamentals of data communication and various techniques of communications. Students will also be able to recall the layered structure of computer network. (REMEMBERING)
2. Explain about different network topology and the type of protocol required for different communication technique. (UNDERSTANDING)
3. Develop different network topology using various networking devices. (APPLYING)
4. Compare different networking devices. Students will also be able to analyse different network behaviour depending on performance parameters. (ANALYSING)
5. Evaluation of network performance based on implementation policy, protocol, topology etc. (Evaluating)
6. Construct networks required for organization, depending on availability of hardwares and softwares (CREATING)

Module I (12hours)

Introduction to data communications: A communications model, Data communications, Networking, Protocols and Protocol architecture, Characteristics of data transmission: Concepts and Terminology, Analog and digital data transmission, Transmission impairments. Transmission media: Guided transmission media, Wireless transmission data encoding, Digital data-Digital signals, Digital data- Analog signals, Analog data-Digital signals, and Analog data-Analog signals.

Module II (10 hours)

Data communication interface: Asynchronous and Synchronous transmission, Line configurations, Interfacing. Data link control, Flow control, Error detection, Error control, High-level data link control (HDLC), Other data link control protocols.

Module III (12 hours)

Data communications hardware: Terminals- Introduction, Basic terminal components, Enhanced terminal components, General-purpose terminals, Remote job entry terminals, Transaction terminals, Clustering of terminal devices. Communications processing hardware introduction, Switching processors, Multidrop lines, Multiplexers, Concentrators, Front-end processors.

Module IV (11 hours)

Modems: Network attachment and regulations, Line conditioning and leased lines, Modems and modem circuits. Multiplexing: Frequency-division multiplexing, Synchronous time- division multiplexing: Characteristics, TDM Link control, Digital carrier systems statistical time-division multiplexing: Characteristics.

Suggested Readings

1. William Stallings, Data and Computer Communications, Sixth Edition, Pearson Education Asia.
2. Prakash C. Gupta, Data Communications and Computer Networks, PHI
3. B.A. Forouzan, Data Communications and Networking, TMH.
4. William L. Scweber, Data Communication, McGraw Hill.
5. Tenenbaum, A. S., Computer Networks (Fourth Edition), New Delhi: Prentice-Hall India
6. Larry L. Peterson and Bruce S. Davie, Computer Networks: A systems approach, 3rd Edition, Morgan Kaufmann Publishers.
7. Mary E.S. Loomis, Data Communications, PHI.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2	M	H		
CO 3		M	H	
CO 4			H	M
CO 5			M	M
CO 6				H

CSSE0127: SOFTWARE ENGINEERING

(3 Credits-45 Hour)

Course Outcome

1. Relate and recall the life cycle models of a software. (Remembering)
2. Classify and differentiate various software complexities. (Understanding)
3. Utilize different software architectures and identify the best feasible one. (Applying)
4. Examine and design any software product. (Analysing)
5. Formulate various design diagrams and find solutions to problems. (Creating)
6. Justify a practical solution towards a software applying development and also deploy a product of their own. (Evaluating).

Module I (7 Hours):

a. The Product and The Process: The Product - Evolving Role of Software, Software (Characteristics, Components and Applications;
b. The Process – Software Engineering A Layered Technology, The Software Process, Software Process Models, The Linear Sequential Model, The Prototyping Model, The RAD Model, Evolutionary Process Models (The Incremental Model, The Spiral Model, The Component Assembly Model, The Concurrent Development Model), The Formal Methods Model, Fourth Generation Techniques;
c. Project Management Concepts – The Management Spectrum (People, The Problem, The Process and The Project);
d. Software Process and Project Metrics – Measures, Metrics and Indicators, Metrics in the Process and Project Domains, Software Measurement, Reconciling Different Metrics Approaches, Metrics for Software Quality;
e. Software Project Planning – Observation on Estimating, Project Planning Objectives, Software Scope, Resources, Project Estimation Technique – Empirical estimation techniques (Expert Judgement Technique, Delphi Cost Estimation), Heuristic estimation techniques (COCOMO Model), Halstead Software Science (An Analytical Technique), The Make-Buy Decision;

Module II (7 Hours)

a. Project Scheduling and Tracking - Basic Concepts, The Relationship between People and Effort, Defining a Task set for the Software Project, Selecting Software Engineering Tasks, Defining a Task Network, Scheduling, The Project Plan;
b. Software Projects Risks, Quality Assurance and Configuration Management: Risk Management- Reactive Vs. Proactive Risk Strategies, Software Risk, Risk Identification, Risk Projection, Risk (Mitigation, Monitoring and Management), Safety Risks and Hazards, The RMMM Plan;
c. Software Quality Assurance - Quality Concepts, The Quality Movement, Software Quality Assurance, Software Reviews, Formal Technical Reviews, Statistical Quality Assurance, Software Reliability, The SQA Plan, The ISO 9000 Quality Standards;
d. Software Configuration Management - Software Configuration Management, The SCM Process, Identification of Objects in the Software Configuration, Version Control, Change Control, Configuration Audit, Status Reporting;
e. System Engineering - Computer Based Systems, Product Engineering

Module III (15 Hours)

a. Analysis and Design: Analysis Concepts and Principles - Requirements Analysis, Communication Techniques, Analysis Principles, Software Prototyping, Specification, Specification Review;
b. Analysis Modeling- The Elements of the Analysis Model, Data Modeling, Functional Modeling and Information Flow, Behavioral Modeling, The Mechanics of Structured Analysis, The Data Dictionary;
c. Design Concepts and Principles - Software Design and Software Engineering, The Design Process, Design Principles, Design Concepts, Effective Modular Design, Design Heuristic for Effective Modularity, The Design Model, Design Documentation;
d. Design Methods - Data Design, Architectural Design, The Architectural Design Process, Architectural Design Optimization, Interface Design, Human-Computer Interface Design, Interface Design Guidelines, Procedural Design;
e. Design For Real Time systems - Real Time Systems;
f. Case studies on diagram - Use case, Class, Activity, Sequence

Module IV (8Hours)

a. Software Testing: Software Testing Methods - Software Testing Fundamentals, Test Case Design, White Box Testing, Basis Path Testing, Control Structure Testing, Black Box Testing, Testing for Specialized Environments;
b. Software Testing Strategies - A Strategic Approach to Software Testing, Strategic Issues, Unit Testing, Integration Testing, Validation Testing, System Testing, The Art of Debugging;
c. Technical Metrics for Software - Software Quality, A Framework for Technical Software Metrics, Metrics for the Analysis Model, Metrics for the Design Model, Metrics for Source Code, Metrics for Testing, Metrics for Maintenance

Module V (7 Hours)

a. Object Oriented Software Engineering: Object Oriented Concepts and Principles - The Object-Oriented Paradigm, Object Oriented Concepts, Identifying the Elements of an Object Model, Management of Object-Oriented Software Projects

b. Object Oriented Analysis - Object Oriented Analysis, Domain Analysis, Generic Components of the Object-Oriented Analysis Model, The OOA Process, The Object Relationship Model, The Object Behavior Model
c. Object Oriented Design - Design for Object Oriented Systems, The Generic Components of the OO Design Model, The Systems Design Process, The Object Design Process, Design Patterns, Object Oriented Programming
d. Advanced Topics In Software Engineering: Cleanroom Software Engineering- The Cleanroom Approach, Functional Specification, Design Refinement and Verification, Cleanroom Testing
e. Software Reuse - Management Issues, The Reuse Process, Domain Engineering, Building Reusable Components, Classifying and Retrieving Components, Economics of Software Reuse
f. Reengineering - Software Reengineering, Reverse Engineering, Restructuring, Forward Engineering, Economics of Reengineering.
g. Computer Aided Software Engineering - Case Definition, Building Blocks of Case, Taxonomy of Case Tools, Integrated Case Environments, The Integration Architecture, The Case Repository

Suggested Readings

1. Roger S. Pressman, Software Engineering A Practitioner’s Approach, Fourth Edition, Tata McGraw Hill.
2. Rajib Mall, Fundamentals of Software Engineering, Second Edition, Prentice Hall of India Private Limited.
3. Ian Sommerville, Software Engineering, Sixth Edition, Addison Wesley, Pearson Education.
4. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, Fundamentals Of Software Engineering, Second Edition, Prentice Hall of India Private Limited, New Delhi, 2002.
5. Jeffrey A. Hoffer, Joey F. George, Joseph S. Valacich, Modern Systems Analysis and Design, Second Edition, Pearson Education.
6. Richard E Fairley, Software Engineering Concepts, Tata McGraw Hill Publishing Company Limited, New Delhi, 1997.
7. Hans Van Vilet, Software Engineering Principles and Practice, Second Edition, John Wiley and Sons, Ltd

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					
CO 2		H	M			
CO 3		H	H	H		
CO 4			H	M		
CO 5			M	M	H	
CO 6				H	M	H

CSCD0128: COMPILER DESIGN

(3 credits- 45 hours)

Course Outcomes

1. Recall the application of compiler in program execution (Remembering)
2. Demonstrate the various types of parser and their merits and demerits. It also explains about error handling technique in compiler construction. (UNDERSTANDING)
3. Applying different parsing technique to input string. (APPLYING)
4. Compare and analysis different techniques of parsing. (ANALYSING)
5. Decide which parsing technique will be most suitable for any input given to them. Students will also be able to know how to convert the given grammar to its respective non-left recursive grammar if it requires for certain type of parsing technique. (EVALUATING).
6. Construct intermediate code generation, code optimization, run time environment etc. during compilation.(CREATING)

Module I (9 hours)

Introduction to compiling: Compilers – Analysis of the source program – Phases of a compiler – Cousins of the Compiler – Grouping of Phases – Compiler construction tools – Lexical Analysis. Role of Lexical Analyser –Input Buffering – Specification of Tokens.

Module II (9 hours)

Syntax Analysis: Role of the parser –Writing Grammars –Context-Free Grammars – Top Down parsing – Recursive Descent Parsing – Predictive Parsing – Bottom-up parsing – Shift Reduce Parsing – Operator Precedent Parsing – LR Parsers – SLR Parser – Canonical LR Parser – LALR Parser. Syntax Directed translation: Syntax Directed definition, Construction of syntax trees, Bottom Up Evaluation of S-Attributed Definitions.

Module III (15 hours)

a. Intermediate Code Generation: Intermediate languages – Declarations – Assignment Statements –Boolean Expressions – Case Statements – Back patching – Procedure calls.

b. Code Generation: Issues in the design of code generator – The target machine – Runtime Storage management – Basic Blocks and Flow Graphs – Next-use Information – A simple Code generator – DAG representation of Basic Blocks – Peephole Optimization.

Module IV (12 hours)
Code Optimization and Run time Environments: Introduction – Principal Sources of Optimization – Optimization of basic Blocks – Introduction to Global Data Flow Analysis – Runtime Environments – Source Language issues – Storage Organization – Storage Allocation strategies – Access to non-local names – Parameter Passing.

Suggested Readings
1. Compilers Principles, Techniques and Tools- Alfred Aho, Ravi Sethi, Jeffrey D Ullman, Pearson Education.
2. Introduction to Compiler Techniques- J.P. Bennet, Tata McGraw-Hill.
3. Compiler Construction: Principles and Practice Learning. - Kenneth C. Louden, Thompson.
4. Practice and Principles of Compiler Building with C- HenkAlblas and Albert Nymeyer, PHI.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	M			
CO 2	M	M		
CO 3		H	M	
CO 4		M		
CO 5		M	M	
CO 6			M	H

CSNT0129: COMPUTER NETWORKS
(3 credits- 45 hours)

Course Outcomes
1. Define topology implementing different routing protocols that best suits a real time demand application, network and transport layer. (Remembering)
2. Explain the different network topologies, network, transport and application design issues and the importance of QoS in a network. (Understanding)
3. Solve different problems related to sub-netting, configuring working routing protocols in some model network topology and implement presentation layer security. (Applying)
4. Distinguish TCP from OSI and Analyze different layer protocols, sub-netting application layer security. (Analyzing)
5. Judge which protocol operate in which layer and why. (Evaluating)
6. Formulate the pros, cons and implementation of different IEEE based protocols. (Creating)

Module I (7 hours)
Review of OSI, TCP/IP models, Switching Techniques: Circuit Switching, Switching Techniques: Packet Switching, Multiple Accesses –RANDOM ACCESS-ALOHA, CSMA, CSMA/CD, CSMA/CA, Controlled Access, Channelization.

Module II (9 hours)
X.25, ATM, LAN - Ethernet IEEE 802.3 - IEEE 802.4 - IEEE 802.5 - IEEE 802.11 – FDDI - SONET –Bridges.

Module III (12 hours)
Network Layer: IP addressing methods, Subnetting, ARP, RARP, BOOTP, DHCP – Routing – Distance Vector Routing – Link State Routing – Routers.

Module IV (9 hours)
Transport layer: Duties of transport layer – Multiplexing – Demultiplexing – Sockets – User Datagram Protocol (UDP) – Transmission Control Protocol (TCP) – Congestion Control – Quality of services (QOS) – Integrated Services.

Module V (8 hours)
Application Layer: Domain Name Space (DNS), EMAIL, Network Security-PLAYFAIR CIPHER, AES, DES, Public key cryptosystem and RSA, Message authentication code using Hash Function, Introduction to Kerberos.

Suggested Readings
1. Andrew S. Tanenbaum , Computer Networks, PHI
2. Larry L. Peterson and Bruce S. Davie, Computer Networks –A system approach.
3. Behrouz A. Forouzan, Data communication and Networking, Tata McGraw-Hill.

4. William Stallings, Data and Computer Communication, Pearson Education.
5. James F. Kurose and Keith W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, Pearson Education.

Mapping of COs to Syllabus

Course Outcomes	M1	M2	M3	M4	M5
CO 1			H	M	M
CO 2			M	H	M
CO 3			M		H
CO 4	H			L	
CO 5	L		H	L	
CO 6	M	H			

CSCG0134: GPU COMPUTING

(3 Credits)

Objectives

The objective of the course is to learn concepts of parallel programming, learn parallel programming with Graphics Processing Units (GPUs), implement programs on GPUs, and learn debugging and profiling of programs written for GPUs.

Course Outcomes

1. Describe the basic concepts of GPUs and parallel programming (Remembering)
2. Explain the hardware and software aspects of GPU (Understanding)
3. Use GPU for applications such as Image Processing, Graph algorithms, Simulations and Deep Learning. (Applying)
4. Analyze GPU programs to detect errors (Analyzing)
5. Evaluate the efficiency of GPU programs (Evaluating)
6. Develop GPU programs including programs for concurrent data structures and programs employing different synchronization techniques (Creating)

Module I (12 Hours)

Introduction: History, Graphics Processors, Graphics Processing Units, GPGPUs. Clock speeds, CPU/GPU comparisons, Heterogeneity, Accelerators, Parallel programming, CUDA Open CL/Open ACC, Hello World Computation Kernels, Launch parameters, Thread hierarchy, Warps/Wave fronts, Thread blocks/Workgroups, Streaming multiprocessors, 1D/2D/3D thread mapping, Device properties, Simple Programs

Module II (7 Hours)

Memory:Memoryhierarchy,DRAM/global,local/shared,private/local,textures,ConstantMemory,Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different memories

Module III (9 Hours)

Synchronization: Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Worklists, Linked-lists. Synchronization across CPU and GPU
Functions: Device functions, Host functions, Kernels functions, Using libraries (such as Thrust), and developing libraries.

Module IV (7 Hours)

Support: Debugging GPU Programs. Profiling, Profile tools, Performance aspects
Streams: Asynchronous processing, tasks, Task-dependence, Overlapped data transfers, Default Stream, Synchronization with streams. Events, Event-based-Synchronization - Overlapping data transfer and kernel execution, pitfalls.

Module V (5 Hours)

Case Studies: Image Processing, Graph algorithms, Simulations, Deep Learning

Module VI (5 Hours)

Advanced topics: Dynamic parallelism, Unified Virtual Memory, Multi-GPU processing, Peer access, Heterogeneous processing.

Suggested Readings

1. Programming Massively Parallel Processors: A Hands-on Approach; David Kirk, Wen-meiHwu; Morgan Kaufman; 2010 (ISBN:978-0123814722)
2. CUDA Programming: A Developer’s Guide to Parallel Computing with GPUs; Shane Cook; Morgan Kaufman; 2012

(ISBN:978-0124159334)

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					M
CO 2	M	H	M			
CO 3		M	H	L		
CO 4		M	M	H	M	
CO 5				M	H	
CO 6			H	H		L

CSCL0135: CLOUD COMPUTING

(3 Credits)

Objectives:

- The student will also learn how to apply trust – based security model to real – world security problems.
- An overview of the concepts, processes, and best practices needed to success fully secure information within Cloud infrastructures.
- Students will learn the basic Cloud types and delivery models and develop an understanding of the risk and compliance responsibilities and Challenges for each Cloud type and service delivery model.

Course Outcomes

1. Basics of cloud computing(Remembering)
2. Understanding cloud computing architecture and cloud computing model(Understanding)
3. Identify security aspects of each cloud model (Applying)
4. Develop a risk management strategy for moving to the cloud (Analysing)
5. Implement a public cloud instance using a public cloud service provider (Evaluating)
6. Apply trust based security model to different layer (Creating)

Module I (8 Hours)

IntroductiontoCloudComputing

Online Social Networks and Applications, Cloud introduction and overview, Different clouds, Risks, Novel applications of cloudcomputing.

Module II (8 Hours)

Cloud Computing Architecture Requirements, Introduction Cloud computing architecture, On Demand Computing Virtualization at the infrastructure level, Security in Cloud computing environments, CPU Virtualization, A discussion on Hypervisors Storage Virtualization Cloud Computing Defined, The SPI Framework for Cloud Computing, The Traditional Software Model, The Cloud Services Delivery Model

Cloud Deployment Models Key Drivers to Adopting the Cloud, The Impact of Cloud Computing on Users, Governance in the Cloud, Barriers to Cloud Computing Adoption in the Enterprise

Module III (8 hours)

Security Issues in Cloud Computing, Infrastructure Security, Infrastructure Security: The Network Level, The Host Level, The Application Level, Data Security and Storage, Aspects of Data Security, Data Security Mitigation Provider Data and Its Security Identity and Access Management, Trust Boundaries and IAM, IAM Challenges, Relevant IAM Standards and Protocols for Cloud Services, IAM Practices in the Cloud, Cloud Authorization Management

Module IV (8 hours)

Security Management in the Cloud: Security Management Standards, Security Management in the Cloud, Availability Management: SaaS, PaaS, IaaS

Privacy Issues: Privacy Issues, Data Life Cycle, Key Privacy Concerns in the Cloud, Protecting Privacy, Changes to Privacy Risk Management and Compliance in Relation to Cloud Computing, Legal and Regulatory Implications,

U.S. Laws and Regulations, International Laws and Regulations.

Module V (8 hours)

Audit and Compliance: Internal Policy Compliance, Governance, Risk, and Compliance (GRC), Regulatory/ External Compliance, Cloud Security Alliance, Auditing the Cloud for Compliance, Security-as-a-Cloud

Module VI (5 hours)
ADVANCED TOPICS: Recent developments in hybrid cloud and cloud security

Suggested Readings
1. Cloud Computing Explained: Implementation Handbook for Enterprises, John Rhoton, Publication Date: November 2,2009
2. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance (Theory in Practice),Tim Mather, ISBN-10: 0596802765, O' Reilly Media, September2009

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				
CO 2	M	H				
CO 3		M	H	L		
CO 4		M	M	H	M	
CO 5			M	H	M	M
CO 6			H	H		L

CSDD0136: DISTRIBUTED DATABASES
(3 Credits)

Objectives
The objective of course is to provide insight to distributed database, normalization techniques and integrity rules, and to learn about parallel database systems along with object oriented models.

Course Outcomes
1. Describe the concepts related to distributed database, normalization techniques and integrity rules, parallel database systems, and distributed object database management systems. (Remembering)
2. Explain concepts related to distributed DBMS architecture, query processing, transaction management, distributed concurrency control, distributed object database management systems etc. (Understanding)
3. Apply normalization to make efficient retrieval from database and query. (Applying)
4. Analyze design issues and efficiency of query statements. (Analyzing)
5. Choose appropriate distributed database design for a given application. (Evaluating)
6. Create distributed databases, parallel database systems, and object database systems for a given problem. (Creating)

Module I (10 Hours)
Introduction: Distributed Data processing, Distributed database system (DDBMS), Promises of DDBMSs, Complicating factors and Problem areas in DDBMSs, Overview Of Relational DBMS Relational Database concepts, Normalization, Integrity rules, Relational Data Languages, Relational DBMS.

Module II (7 Hours)
Distributed DBMS Architecture: DBMS Standardization, Architectural models for Distributed DBMS, Distributed DBMS Architecture. Distributed Database Design: Alternative design Strategies, Distribution design issues, Fragmentation, Allocation. Semantic Data Control: View Management, Data security, Semantic Integrity Control.

Module III (8 Hours)
Overview of Query Processing: Query processing problem, Objectives of Query Processing, Complexity of Relational Algebra operations, characterization of Query processors, Layers of Query Processing.
Introduction to Transaction Management: Definition of Transaction, Properties of transaction, types of transaction. Distributed Concurrency Control: Serializability theory, Taxonomy of concurrency control mechanisms, locking based concurrency control algorithms.

Module IV (7 Hours)
Parallel Database Systems: Database servers, Parallel architecture, Parallel DBMS techniques, Parallel execution problems, Parallel execution for hierarchical architecture.

Module V (8 Hours)
Distributed Object Database Management systems: Fundamental Object concepts and Object models, Object distribution design. Architectural issues, Object management, Distributed object storage, Object query processing. Transaction management. Database Interoperability: Database Integration, Query processing.

Module VI (5 Hours)

Recent approaches, models and current trends in improving the performance of Distributed Database.

Suggested Readings

1. Principles of Distributed Database Systems, Second Edition, M. Tamer Ozsu Patrick Valduriez
2. Distributed Databases principles and systems, Stefano Ceri, Giuseppe Pelagatti, Tata McGraw Hill.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				
CO 2	M	H				
CO 3		M	H	L		
CO 4		M	M	H	M	
CO 5			M	H	M	M
CO 6				M	H	L

CSCL0135: CLOUD COMPUTING

(3 credits)

Objectives:

- The student will also learn how to apply trust-based security model to real-world security problems.
- An overview of the concepts, processes, and best practices needed to successfully secure information within Cloud infrastructures.
- Students will learn the basic Cloud types and delivery models and develop an understanding of the risk and compliance responsibilities and Challenges for each Cloud type and service delivery model.

Course Outcomes

1. The basics of cloud computing(Remembering)
2. Illustrate cloud computing architecture and cloud computing model(Understanding)
3. Identify and apply security aspects of each cloud model (Applying)
4. Analyse a risk management strategy for moving to the cloud (Analysing)
5. Implement and evaluate a public cloud instance using a public cloud service provider (Evaluating)
6. Create a trust based security model to different layer (Creating)

Module I (10 Hours)

Introduction to Cloud Computing

Online Social Networks and Applications, Cloud introduction and overview, Different clouds, Risks, Novel applications of cloud computing.

Module II (11 Hours)

Cloud Computing Architecture Requirements, Introduction Cloud computing architecture, On Demand Computing Virtualization at the infrastructure level, Security in Cloud computing environments, CPU Virtualization, A discussion on Hypervisors Storage Virtualization Cloud Computing Defined, The SPI Framework for Cloud Computing, The Traditional Software Model, The Cloud Services Delivery Model

Cloud Deployment Models Key Drivers to Adopting the Cloud, The Impact of Cloud Computing on Users, Governance in the Cloud, Barriers to Cloud Computing Adoption in the Enterprise

Module III (10 hours)

Security Issues in Cloud Computing, Infrastructure Security, Infrastructure Security: The Network Level, The Host Level, The Application Level, Data Security and Storage, Aspects of Data Security, Data Security Mitigation Provider Data and Its Security

Identity and Access Management, Trust Boundaries and IAM, IAM Challenges, Relevant IAM Standards and Protocols for Cloud Services, IAM Practices in the Cloud, Cloud Authorization Management

Module IV (11 hours)

Security Management in the Cloud: Security Management Standards, Security Management in the Cloud, Availability Management: SaaS, PaaS, IaaS

Privacy Issues: Privacy Issues, Data Life Cycle, Key Privacy Concerns in the Cloud, Protecting Privacy, Changes to Privacy Risk Management and Compliance in Relation to Cloud Computing, Legal and Regulatory Implications,

U.S. Laws and Regulations, International Laws and Regulations.

Module V ((8 hours)

Audit and Compliance: Internal Policy Compliance, Governance, Risk, and Compliance (GRC), Regulatory/ External Compliance, Cloud Security Alliance, Auditing the Cloud for Compliance, Security-as-a-Cloud

Module VI (4 hours)
ADVANCED TOPICS: Recent developments in hybrid cloud and cloud security

Suggested Readings
1. Cloud Computing Explained: Implementation Handbook for Enterprises, John Rhoton, Publication Date: November 2, 2009
2. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance (Theory in Practice), Tim Mather, ISBN-10: 0596802765,O'Reilly Media, September 2009

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				
CO 2		H				
CO 3			H	M		
CO 4			M	H	H	
CO 5					H	
CO 6						H

CSIS0137: IOT AND SMART CITIES
(3 Credits)

Objectives
- Explain the basic methodologies and techniques of the arts and humanities, social sciences, business, and science and technology
- To describe the current practices and future trends about smart city
- Capacity of critique the current practice and provide recommendations

Course Outcomes
1. List the various applications of smart cities (Remembering)
2. Explain the IoT reference architecture, fundamental knowledge of the sustainable and smart city (Understanding)
3. Identify different technologies used for sustainable smart cities (Applying)
4. Analyze the learnt knowledge to conduct a case study in an organized way. (Analyzing)
5. Estimate the ability to present the study clearly to audiences; Demonstration of critical thinking and discovering. (Evaluating)
6. Formulate the methods to design public mobile services aimed at efficiency, cost-saving and participation with attention for e-inclusion (Creating)

Module I (8 hours)
Introduction and Applications: smart transportation, smart cities, smart living, smart energy, smart health, and smart learning.

Module II (9 hours)
IoT Reference Architecture- methods to assist local governments to develop international good e-practice

Module III (8 hours)
Methods to redesign and redefine back and front offices in order to build smarter and transparent governments

Module IV (8 hours)
Methods to design public mobile services aimed at efficiency, cost-saving and participation with attention for e-inclusion

Module V (10 hours)
Methodologies for user involvement, profiling customers and identifying needs; test methodologies to transfer these needs in appropriate services; and test techniques to fit the right channel to the specific services and customers thereby setting a framework for a higher level of e-services in the NSR

Module VI (5 hours)
Pilot new service channels, bluetooth services for public transport, online forms in mobile phones and wireless city services

Suggested Readings
1. Smart City on Future Life - Scientific Planning and Construction by XianyiLi
2. The Age of Intelligent Cities: Smart Environments and Innovation-for-all Strategies (Regions and Cities) byNicosKomninos

3. Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia by Anthony Townsend.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				
CO 2		H				
CO 3			H	M		
CO 4			M	H	H	
CO 5					H	
CO 6						H

CSEM0138: EMULATION AND SIMULATION METHODOLOGIES

(3 Credits)

Objectives

- This module teaches the fundamentals of simulation and emulation methodologies providing guidance on how to design a performance evaluation campaign
- Set up a test scenario, select the appropriate models, level of granularity
- Metrics for statistical correctness, and discuss the differences between simulation and emulation platforms and how to use them for accurate performance evaluation of communications.

Course Outcomes

1. Define and explain the fundamental concepts of Discrete Event Simulations. (Remembering)
2. Explain about the communication and networking techniques used in DES. (Understanding)
3. Identify the various Application-based Granularity Requirements. (Applying)
4. Analyze the performance evaluation of Statistical Tools (Analyzing)
5. Assess the evaluation of communications for ITS. (Evaluating)
6. Discuss the recent trends of simulation and emulation for IOT. (Creating)

Module I (8 hours)

Fundamentals of Discrete Event Simulations (DES)

Module II (8 hours)

Model-based representation for DES, from communication and networking, to mobility and data traffic.

Module III (8 hours)

Application-based Granularity Requirements: from bit-level, packet-level, to system-level evaluation, and their appropriate selection as a function of the application requirements.

Module IV (12 hours)

Fundamentals on Random Numbers, Fundamentals on Statistical Tools for Performance Evaluation, Simulation vs. Emulations

Module V (8 hours)

Case study for the evaluation of communications for ITS.

Module VI (4 hours)

Recent trends in simulation and emulation for IOT, model based and application based granularity presentation

Suggested Readings

Jack L. Burbank, An Introduction to Network Simulator 3, Wiley

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				
CO 2		H				
CO 3			H			

CO 4				H		
CO 5					H	
CO 6					M	H

CSDM0139: DATA WAREHOUSING & MINING

(3 Credits)

Course Outcomes

1. Illustrate different classification, prediction, sequential pattern algorithms (remembering and Understanding)
2. Construct cluster, periodicity and social network analysis. (Applying)
3. Analyze technique to extract patterns from time series data and it application in real world (Analysing)
4. Apprise the Graph mining algorithms to Web mining (Evaluating)
5. Design computing framework for Big Data (Creating)

Module 1 (12 hours)

Introduction to Data Warehousing; Data Mining: Mining frequent patterns, association and correlations; Sequential Pattern Mining concepts, primitives, scalable methods; Classification and prediction; Cluster Analysis – Types of Data in Cluster Analysis, Partitioning methods, Hierarchical Methods; Transactional Patterns and other temporal based frequent patterns.

Module 2 (15 hours)

Mining Time series Data, Periodicity Analysis for time related sequence data, Trend analysis, Similarity search in Time-series analysis; Mining Data Streams, Methodologies for stream data processing and stream data systems, Frequent pattern mining in stream data, Sequential Pattern Mining in Data Streams, Classification of dynamic data streams, Class Imbalance Problem; Graph Mining; Social Network Analysis;

Module 3 (12 hours)

Web Mining, Mining the web page layout structure, mining web link structure, mining multimedia data on the web, Automatic classification of web documents and web usage mining; Distributed Data Mining.

Module 4 (6 hours)

Recent trends in Distributed Warehousing and Data Mining, Class Imbalance Problem; Graph Mining; Social Network Analysis

Suggested Readings

1. Jiawei Han and M Kamber, Data Mining Concepts and Techniques,, Second Edition, Elsevier Publication, 2011.
2. Vipin Kumar, Introduction to Data Mining - Pang-Ning Tan, Michael Steinbach, Addison Wesley,2006.
3. G Dong and J Pei, Sequence Data Mining, Springer, 2007

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H			M
CO2		H		
CO3		M	H	
CO4				H
CO5			M	H

CSWI0140: WEB SEARCH& INFORMATION RETRIEVAL

Course Outcomes

1. Recall basic theories and analysis tools as they apply to information retrieval. (Remembering and Understanding)
2. Apply the understanding of problems and potentials of current IR systems. (Applying)
3. Analyze different retrieval algorithms and systems. (Analysing)
4. Evaluate various indexing, matching, organizing, and evaluating methods to IR problems. (Evaluating)
5. Formulate various theoretical IR research. (Creating)

Module 1 (15 hours)

Information retrieval model, Information retrieval evaluation, Searching the Web, Document Representation, Query languages and query operation, Meta-data search.

Module 2 (15 hours)

Indexing and searching, Scoring and ranking feature vectors, Ontology, domain specific search, parallel and distributed information retrieval.

Module 3 (10 hours)

Text and multimedia languages, Social networks.

Module 4 (5 hours)
Recent trends in Web search and Information retrieval techniques.

Suggested Readings

1. C. D. Manning, P. Raghavan and H. Schütze, Introduction to Information Retrieval, CambridgeUniversity Press, 2008 (available at http://nlp.stanford.edu/IR-book).
2. Chakrabarti, S. (2002). Mining the web: Mining the Web: Discovering knowledge from hypertext data. Morgan-kaufman.
3. B. Croft, D. Metzler, T. Strohman, Search Engines: Information Retrieval in Practice, AddisonWesley, 2009 (available at http://ciir.cs.umass.edu/irbook/).
4. R. Baeza-Yates, B. Ribeiro-Neto, Modern Information Retrieval, Addison-Wesley, 2011 (2ndEdition).

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H			
CO2		H		
CO3		M	H	
CO4			M	H
CO5				H

CSDY0141: DATABASE SECURITY AND ACCESS CONTROL
(3 Credits)

Course Outcomes
1. Summarize the access control and implement classical models and algorithms. (Remembering and Understanding)
2. Identify the capabilities and limitations of various access control mechanisms. (Applying)
3. Analyze the data, identify the problems, and choose the relevant models and algorithms to apply. (Analysing)
4. Assess the strengths and weaknesses of various access control models and to analyze their behaviour. (Evaluating)
5. Design and develop access control mechanisms for enterprise IT infrastructures.(Creating)

Module 1 (15 hours)
Introduction to Access Control, Purpose and fundamentals of access control, brief history,Policies of Access Control, Models of Access Control, and Mechanisms, Discretionary Access Control (DAC), Non- Discretionary Access Control , Mandatory Access Control (MAC). Capabilities and Limitations of Access Control Mechanisms: Access Control List (ACL) and Limitations, Capability List and Limitations,

Module 2 (15 hours)
Role-Based Access Control (RBAC) and Limitations, Core RBAC, Hierarchical RBAC, Statically Constrained RBAC, Dynamically Constrained RBAC, Limitations of RBAC. Comparing RBAC to DAC and MAC Access control policy, Biba Integrity model, Clark-Wilson model, Domain type enforcement model, mapping the enterprise view to the system view, Role hierarchies- inheritance schemes, hierarchy structures and inheritance forms, using SoD in real system, Temporal Constraints in RBAC, MAC AND DAC. Integrating RBAC with enterprise IT infrastructures: RBAC for WFMSs, RBAC for UNIX and JAVA environments Case study: Multiline Insurance Company.

Module 3 (10 hours)
Smart Card based Information Security, Smart card operating system, fundamentals, design and implantation principles, memory organization, smartcard files, file management, atomic operation, smart card data transmission, ATR,PPS Security techniques- user identification , smart card security, quality, assurance and testing , smart card life cycle-5 phases, smart card terminals.

Module 4 (5 hours)
Recent trends in Database security and access control mechanisms. Case study ofRole-Based Access Control (RBAC) systems.

Suggested Readings

1. Role Based Access Control: David F. Ferraiolo, D. Richard Kuhn, RamaswamyChandramouli.
2. http://www.smartcard.co.uk/tutorials/sct-itsc.pdf : Smart Card Tutorial.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H			
CO2		H		

CO3		M	H	
CO5			H	

CSBA0142: BUSINESS ANALYTICS
(3 Credits)

Course Outcomes
1. Recall the scope of business analytics (Remembering)
2. Interpret the modeling relationships and trends in data, simple linear regression. (Understanding)
3. Experiment with knowledge of data analytics (Applying)
4. Analyze critically in making decisions based on data and deep analytics. (Analysis)
5. Asses technical skills in predictive and prescriptive modeling to support business decision-making.(Evaluating)
6. Adapt the ability to translate data into clear, actionable insights.(Creating)

Module 1 (8 hours)
Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

Module 2 (8 hours)
Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Module 3 (8 hours)
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predictive Modeling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modeling, nonlinear Optimization.

Module 4 (9 hours)
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.
Monte Carlo Simulation and Risk Analysis: Monte Carlo Simulation Using Analytic Solver Platform, New- Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

Module 5 (8 hours)
Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, the Value of Information, Utility and Decision Making.

Module 6 (4 hours)
Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

Suggested Readings
1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO1	H					
CO2		H				
CO3		M	H			M
CO4				H		
CO5			M		H	
CO6				M		H

CSAI0143: ARTIFICIAL INTELLIGENCE
(3 credits – 45 hours)

Course Outcomes
1. Describe the key aspects of intelligent agents, evolutionary computing, handling of uncertainity, and expert systems. (Remembering)
2. Explain the AI techniques for searching, knowledge representation and inference, planning, natural language processing, and machine learning. (Understanding)
3. Apply AI techniques for searching, reasoning, and planning to solve problems. (Applying)
4. Infer knowledge from given facts and rules using Propositional and First-Order logic. (Analyzing)
5. Evaluate the performance of the different search algorithms. (Evaluating)
6. Develop algorithms and programs that use AI techniques to solve real-world problems. (Creating)

Module 1(10hours)
Overview of Artificial intelligence: Problems of AI, AI technique, Tic-Tac-Toe problem. Intelligent Agents: Agents and environment, nature of environment, structure of agents, goal based agents, utility based agents, learning agents. Problem Solving: Problems, Problem Space and search: Defining the problem as state space search, production system, problem characteristics, issues in the design of search programs. Search techniques: Solving problems by searching: Problem solving agents, searching for solutions; uniform search strategies: breadth first search, depth first search, depth limited search, bidirectional search, comparing uniform search strategies.

Module 2(15 hours)
Greedy best-first search, A* search, memory bounded heuristic search: local search algorithms and optimization problems: Hill climbing search, simulated annealing search, local beam search, genetic algorithms; constraint satisfaction problems, local search for constraint satisfaction problems. Adversarial search: Games, optimal decisions and strategies in games, the minimax search procedure, alpha-beta pruning, additional refinements, iterative deepening. Knowledge and reasoning: Knowledge representation issues, representation and mapping, approaches to knowledge representation, issues in knowledge representation. Using predicate logic: Representing simple fact in logic, representing in stant and ISA relationship, computable functions and predicates, resolution, natural deduction.

Module 3 (10hours)
Representing knowledge using rules: Procedural versus declarative knowledge, logic programming, forward versus backward reasoning, matching, control knowledge. Probabilistic reasoning: Representing knowledge in an uncertain domain, the semantics of Bayesian networks, Dempster-Shafer theory, Fuzzy sets and fuzzy logics. Planning: Overview, components of a planning system, Goal stack planning, Hierarchical planning, other planning techniques. Natural Language processing: Introduction, Syntactic processing, semantic analysis, discourse and pragmatic processing.

Module 4 (10 hours)
Learning: Forms of learning, Inductive learning, learning decision trees, explanation based learning, learning using relevance information, neural net learning and genetic learning. Expert Systems: Representing and using domain knowledge, expert system shells, knowledge acquisition. Basic knowledge of programming language like Prolog and Lisp.

Suggested Readings
1. Ritch and Knight, Artificial Intelligence, TMH.
2. S. Russel and P. Norvig, Artificial Intelligence a Modern Approach, Pearson.
3. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI.
4. S. Kaushik, Logic and Prolog Programming, New Age International.

Mapping of COs to Syllabus

Course Outcomes	M1	M2	M3	M4
CO1	M	L	L	H
CO2	M	L	M	H
CO3	H	H	M	
CO4		H	H	
CO5	H	H		
CO6	H	M	H	L

CSPD0144: PARALLEL AND DISTRIBUTED ALGORITHMS
(3 credits – 45 hours)

Course Outcomes
1. Recall the primitives of MPI, OpenMP, and POSIX Thread API. (Remembering)
2. Explain the benefits and challenges of parallel and distributed computing. (Understanding)
3. Apply design, development, and performance analysis of parallel and distributed applications. (Applying)

4. Analyze the performance of parallel/distributed algorithms. (Analysis)
5. Formulate a parallel/distributed approach to solve a given problem. (Creating)

Module I (8 lectures)
Introduction to Parallel Computing: Motivating Parallelism, Scope of Parallel Computing; Parallel Programming Platforms: Implicit Parallelism, Limitations of Memory System Performance, Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines, Routing Mechanisms for Interconnection Networks, Impact of Process-Processor Mapping and Mapping Techniques

Module II (10 lectures)
Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads; Basic Communication Operations: One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Scatter and Gather, All-to-All Personalized Communication, Circular Shift, Improving the Speed of Some Communication Operations; Analytical Modeling of Parallel Programs: Sources of Overhead in Parallel Programs, Performance Metrics for Parallel Systems, The Effect of Granularity on Performance, Scalability of Parallel Systems, Minimum Execution Time and Minimum Cost-Optimal Execution Time, Asymptotic Analysis of Parallel Programs, Other Scalability Metrics

Module III (12 lectures)
Programming Using the Message-Passing Paradigm: Principles of Message-Passing Programming, The Building Blocks - Send and Receive Operations, MPI - the Message Passing Interface, Topologies and Embedding, Overlapping Communication with Computation, Collective Communication and Computation Operations, Groups and Communicators; Programming Shared Address Space Platforms: Thread Basics, Why Threads?, The POSIX Thread API, Thread Basics - Creation and Termination, Synchronization Primitives in Pthreads, Controlling Thread and Synchronization Attributes, Thread Cancellation, Composite Synchronization Constructs, Tips for Designing Asynchronous Programs, OpenMP - a Standard for Directive Based Parallel Programming

Module IV (15 lectures)
Dense Matrix Algorithms: Matrix-Vector Multiplication, Matrix-Matrix Multiplication; Sorting: Issues in Sorting on Parallel Computers, Sorting Networks, Bubble Sort and its Variants, Quicksort, Bucket and Sample Sort; Graph Algorithms: Definitions and Representation, Minimum Spanning Tree - Prim's Algorithm, Single-Source Shortest Paths - Dijkstra's Algorithm, All-Pairs Shortest Paths; Search Algorithms for Discrete Optimization Problems: Definitions and Examples, Sequential Search Algorithms, Search Overhead Factor, Parallel Depth-First Search, Parallel Best-First Search, Speedup Anomalies in Parallel Search Algorithms

Suggested Readings
1. Ananth Grama, George Karypis, Vipin Kumar and Anshul Gupta, Introduction to Parallel Computing, Pearson Education India, 2004.
2. Michael J Quinn, Parallel Programaming in C with MPI and OpenMP, McGraw Hill, 2017.
3. Peter Pacheco, An Introduction to Parallel Programming, Morgan Kaufmann, 2011.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1			H	
CO2	H	H		
CO3		M	H	M
CO4	L	H		
CO5			M	H

CSAP0145: ADVANCED COMPUTER ARCHITECTURE
(3 credits – 45 hours)

Course Outcomes
1. Describe techniques for building instruction, arithmetic and memory access pipelines. (Remembering)
2. Discuss the basic concepts associated with parallel computing environments, pipelining, and parallel programming. (Understanding)
3. Apply program transformation techniques to remove data dependencies. (Applying)
4. Analyze code segments to identify data dependencies. (Analysing)
5. Assess collision free schedules for pipelines. (Evaluating)
6. Develop programs for different parallel processing models including shared memory programming and distributed computing. (Creating)

Module I (12 hours)

Introduction to Parallel Processing: Shared Memory Multiprocessing, Distributed Memory, Parallel Processing Architectures-Introduction-Parallelism in sequential Machines, Abstract Model of Parallel Computer, Multiprocessor Architecture, Array Processors.

Module II (10 hours)

Pipelining and Super Scalar Techniques, Linear Pipeline Processors, Non-Linear Pipeline processors, Instruction pipeline design, Arithmetic pipeline Design, Super Scalar and Super pipeline Design.

Module III (11 hours)

Programmability Issues - An Overview, Operating system support, Types of Operating Systems, Parallel Programming models, Software Tools-Data Dependency Analysis- Types of Dependencies, Program Transformations, Shared Memory Programming.

Module IV (12 hours)

Thread-based Implementation, thread Management, Attributes of Threads, Mutual Exclusion with Threads, Mutex Usage of Threads, Thread implementation, Events and Conditions variables, Deviation Computation with Threads, Java Threads, Distributed Computing: Message Passing Model, General Model, Programming Model, PVM-Algorithms for Parallel Machines, Debugging Parallel programming, Other Parallelism Paradigms.Analysis of parallel algorithm, Matrix operations.

Suggested Readings

1. Kai Hwang, Advanced Computer Architecture: Parallelism, Scalability, \ Programmability, McGraw Hill.
2. M. Sasikumar, D. Sikhare and P. Ravi Prakash, Introduction to Parallel Processing, PHI.
3. W. Stallings, Computer Organization and Architecture, PHI.
4. K. Parthasarathy, Advanced Computer Architecture, Thomson Business Information.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO1	H	H	H	H	H	H
CO2	H	H				
CO3			H			
CO4			M	H		
CO5			M	H		
CO6					H	

CSML0146: MACHINE LEARNING

(3 credits – 45 hours)

Course Outcomes

1. Draw knowledge about basic concepts of Machine Learning and describe what is involved in learning from data.
2. Discuss machine learning techniques suitable for a given problem and explain the variety of learning algorithms.
3. Solve basic image classification problems and handwritten character recognition using various machine learning techniques.
4. Research a small scale computer vision system using machine learning techniques.
5. Evaluate a Deep Learning model with small scale dataset for a real life problem.
6. Formulate and design how to perform evaluation of learning algorithms and model selection.

Module 1 (10 hours)

Foundations for ML: Definition of learning systems. Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation. ML Techniques overview.

Module 2 (13 hours)

Linear regression, Decision Trees: ID4, C4.5, CART. Pruning. Overfitting, Python Exercise. K-Nearest Neighbors, K-Nearest Neighbor algorithm; Python Exercise. Naïve Bayes, Model Assumptions, Probability estimation, Use Naive Bayes with Scikit learn in Python. Logistic Regression, Support Vector Machines, The dual formulation, Maximum margin, SVM for classification and regression problems. Implement an SVM classifier in SKLearn/Scikit-learn. Ensembles methods, Bagging & boosting, C5.0 boosting, Random forests.

Module 3 (10 hours)

Unsupervised Learning: Distance measures, Different clustering methods (Distance, Density, Hierarchical), Iterative distance-based clustering; Dealing with continuous, categorical values in K-Means, Agglomerative clustering, Constructing a hierarchical cluster, K-Medoids, k-Mode and density-based clustering, Measures of quality of clustering. Python exercise.

Module 4 (12 hours)

Neural Network basics (Perceptron and MLP, FFN, Backpropagation), Convolution Neural Networks, Image classification, Text classification, Image classification and hyper-parameter tuning, Famous architectures - AlexNet, ZFNet, VGG, C3D, GoogLeNet, ResNet, MobileNet-v1, Emerging NN architectures,Recurrent Neural Networks, Building recurrent NN, Long Short-Term Memory, Time Series Forecasting, Auto-encoders and unsupervised learning, Stacked auto-encoders and semi-supervised learning, Regularization - Dropout and Batch normalization.

Suggested Readings

1. Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995. ISBN: 9780198538646.
2. Duda, Richard, Peter Hart, and David Stork. Pattern Classification. 2nd ed. New York, NY: Wiley-Interscience, 2000. ISBN: 9780471056690.
3. Hastie, T., R. Tibshirani, and J. H. Friedman. The Elements of Statistical Learning: Data Mining, Inference and Prediction. New York, NY: Springer, 2001. ISBN: 9780387952840.
4. Mitchell, Tom. Machine Learning. New York, NY: McGraw-Hill, 1997. ISBN: 9780070428072.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H	M	M	H
CO2	H	H	H	M
CO3	M	M	H	M
CO4	M	M	H	H
CO5	L	M	L	H
CO6	M	M	M	L

CSCC0147: COMPUTATIONAL COMPLEXITY

(3 credits – 45 hours)

Course Outcomes

1. Classify decision problems into appropriate complexity classes, including P, NP, PSPACE and complexity classes based on randomised machine models and use this information effectively.(Understanding)
2. State precisely what it means to reduce one problem to another, and construct reductions for simple examples. (Remembering)
3. Classify optimisation problems into appropriate approximation complexity classes and use this information effectively. (Applying)
4. Use the concept of interactive proofs in the analysis of optimisation problems. (Applying)

Module 1 (10 lectures)

Introduction. Easy and hard problems. Algorithms and complexity. Turing machines. Models of computation. Multitape deterministic and non-deterministic Turing machines. Decision problems. The Halting Problem and Undecidable Languages. Counting and diagonalisation. Tape reduction. Universal Turing machine. Undecidability of halting. Reductions. Rice's theorem.

Module 2 (13 lectures)

Deterministic Complexity Classes. DTIME[t]. Linear Speed-up Theorem. PTime. Polynomial reducibility. Polytime algorithms: 2-satisfiability, 2-colourability. NP and NP-completeness. Non-deterministic Turing machines. NTIME[t]. NP. Polynomial time verification. NP-completeness. Cook-Levin Theorem. Polynomial transformations: 3-satisfiability, clique, colourability, Hamilton cycle, partition problems. Pseudo-polynomial time. Strong NP-completeness. Knapsack. NP-hardness.

Module 3 (10 lectures)

Space complexity and hierarchy theorems. DSPACE[s]. Linear Space Compression Theorem. PSPACE, NPSPACE. PSPACE = NPSPACE. PSPACE-completeness. Quantified Boolean Formula problem is PSPACE-complete. L, NL and NL-completeness. NL=coNL. Hierarchy theorems.

Module 4 (12 lectures)

Optimization and approximation. Combinatorial optimisation problems. Relative error. Bin-packing problem. Polynomial and fully polynomial approximation schemes. Vertex cover, travelling salesman problem, minimum partition. Randomized Complexity. The classes BPP, RP, ZPP. Interactive proof systems: IP = PSPACE.

Suggested Readings

1. Computational Complexity - A Modern Approach, Sanjeev Arora and Boaz Barak, Cambridge University Press, 2009.
2. Computational Complexity Theory, Steven Rudich and Avi Wigderson, American Mathematical Society.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	H		
CO 2	M	H	M	
CO 3		H	H	H
CO 4			H	M

CSDS0148: DISTRIBUTED SYSTEMS

(3 credits – 45 hours)

Course Outcomes

1. Define the various evolutionary steps of distributed computing (Remembering)
2. Compare and define the various distributed computing system models. (Understanding/ Remembering)
3. Compile the purpose of using message passing mechanisms and illustrate the various synchronization techniques used in distributed computing. (Applying/ Understanding)
4. Categorize distributed computing systems based on load balancing and load sharing approaches. (Analyzing)
5. Conclude the use of replication and fault tolerance to analyze the efficiency of a distributed computing system. (Evaluating/Analyzing)
6. Rewrite the necessity of having a global naming system and explain why security is such an essential component in designing a trustable distributed system. (Evaluating)

Module 1(10hours)

Fundamentals: Introduction, Models and Features, Concept of distributed operating system ,Issues in design of a distributed operating system. Message Passing: Good message passing system, IPC, Synchronization, Buffering, Multi-datagram messages, Encoding and decoding techniques, Process addressing ,Failure handling, Group communication; Remote procedure calls(RPC)-Models, Communication protocols, RPC, Light weight RPC.

Module 2 (12hours)

Distributed Shared Memory: Architecture, Thrashing, Granularity, Advantages. Synchronization: Introduction, Clock Synchronization, Event handling, Mutual Exclusion; Deadlock–Conditions, Avoidance, Prevention, Recovery.

Module 3 (11hours)

Resource and Process Management: Features of a good scheduling algorithm, Task assignment approach, Load balancing and load sharing approach, Introduction to process management, Process migration, Threads. Distributed File Systems: Introduction, Features, Models, Accessing models; sharing Semantics and caching schemes, replication, Fault Tolerance, Atomic transactions.

Module 4 (12hours)

Naming: Introduction, Features, Fundamental Terminologies and concepts, System oriented names, Human oriented names, Name caches. Security: Potential attacks to computer system,Cryptography,Authentication,digitalsignatures,AccessControl.

Suggested Readings

1. P. K. Sinha, Distributed Operating Systems: Concepts and Design, PHI.
2. A. S.Tanenbaum, Distributed Operating Systems, Pearson.
3. G. Coulouris, J. Dollimore and T. Kindberg, Distributed Systems: Concepts and Design, Pearson.
4. A. Silberschatz and P. Galvin, Operating System Concepts, John Wiley.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H			L
CO2	H			M
CO3	L	H		
CO4			H	
CO5			H	

CSDM0149: DATA MINING

(3 credits – 45 hours)

Course Outcomes

1. Describe the technological enablers, principles, concepts, functions and various applications of data warehousing.

(Remembering)
2. Explain the technical concepts in building a data warehouse, architectural and organizational issues and technological advancement in data mining. (Understanding)
3. Solve the market basket problems and Construct the association and dependency rules in various data mining algorithms. (Applying)
4. Analyze and distinguish the data mining algorithms based on utility factor and their pros and cons in application.(Analyze)
5. Evaluate the different approaches of data warehousing development and data mining algorithm with various technologies. (Evaluating)
6. Design the various concepts of web mining for practical applications .(Creating)

Module 1 (10hours)
Definitions and characteristics, Multi-dimensional data model, Warehouse schema. DataMarts: Datamarts, types of datamarts, loading a datamart, metadata, data model, maintenance, nature of data, software components; external data, reference data, performance issues, monitoring requirements and security in a data mart. Online Analytical Processing: OLTP and OLAP systems, Data Modeling, LAP tools, State of the market, Arbor Essbase web, Microstrategy DSS web, Brio Technology, star schema for multi-dimensional view, snowflake schema; OLAPtools.

Module 2 (12hours)
Building of a Data Warehouse, Architectural strategies and organizational issues, design considerations, data content, distribution of data, Tools for Data Warehousing Data Mining: Definitions; KDD(Knowledge Discovery database) versus Data Mining; DBMS versus Data Mining,DataMiningTechniques;Issuesandchallenges;ApplicationsofDataWarehousing and Data mining in Government.

Module 3 (16hours)
A priori algorithm ,Partition algorithm, Dynamic inset counting algorithm,FP–tree growth algorithm; Generalized association rule. Clustering Techniques: Clustering paradigm, Partition algorithms, CLARA, CLARANS; Hierarchical clustering, DBSCAN, BIRCH,CURE; Categorical clustering, STIRR, ROCK, CACTUS. Decision Trees: Tree construction principle, Best split, Splitting indices, Splitting criteria, Decision tree construction with pre-sorting.

Module 4 (7hours)
Web content Mining, Web structure Mining, Web usage Mining, Text Mining. Temporal and Spatial Data Mining: Basic concepts of temporal data Mining, The GSP algorithm, SPADE, SPIRIT, WUM.

Suggested Readings
1. C.S.R.Prabhu, DataWarehousing-Concepts,Techniques,Products,Application,PHI.
2. AKPujari,DataMiningTechniques,UniversitiesPress.
3. BersonandS.J.Smith, DataWarehousing,DataMiningandOLAP,TMH.
4. M.H.Dunham,DataMiningIntroductoryand AdvancedTopics, Pearson

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M		
CO 2	M	H	M	L
CO 3		M	H	
CO 4		M	H	L
CO 5			H	M
CO 6				H

CMCG0150: COMPUTATIONAL GEOMETRY
(3 Credits – 45 Hours)

Course Outcomes
1. Construct algorithms for simple geometrical problems (Applying)
2. Solve linear programs geometrically (Applying)
3. Apply geometric techniques to real-world problems in graphics. (Applying)
4. Analyze randomized algorithms for small domain problems. (Analyzing)
5. Develop efficient algorithms using line-point duality. (Creating)

Module 1 (11 Hours)
Polygon triangulation: area of a simple polygon, counting the number of triangulations in a convex polygon, Plane sweep -- the general paradigm, Line segment intersection, Doubly Connected Edge List (DCEL), Triangulation of a monotone polygon, Triangulations of Planar Point Sets, The Delaunay Triangulation, Computing the Delaunay Triangulation

Module 2(9 Hours)
Convex hull in 2D -- lower bound, Graham's scan, Jarvis march, output sensitive Chan's algorithm. Range search -- Kd tree, Range tree, Fractional Cascading, Art Gallery theorem. Convex hull in 3D--The Complexity of Convex Hulls in 3-Space, Computing Convex Hulls in 3-Space

Module 3(9 Hours)
Linear Programming: The Geometry of Casting, Half-Plane Intersection, Incremental Linear Programming, Randomized Linear Programming, Unbounded Linear Programs
Arrangements and Duality-- Computing the Discrepancy, Duality, Arrangements of Lines, Levels and Discrepancy

Module 4(10 Hours)
Voronoi Diagrams: The Post Office Problem, Definition and Basic Properties, Computing the Voronoi Diagram, Voronoi Diagrams of Line Segments, Farthest-Point Voronoi Diagrams
Point Location: Knowing Where You Are, Point Location and Trapezoidal Maps, A Randomized Incremental Algorithm, Dealing with Degenerate Cases

Module 5(6 Hours)
Robot Motion Planning: Getting Where You Want to Be, Work Space and Configuration Space, A Point Robot, Minkowski Sums, Translational Motion Planning

Suggested Readings

1. Computational Geometry: Algorithms and Applications, Mark de Berg, Otfried Cheong, Marc van Kreveld, Mark Overmars, Springer Verlag
2. Computational Geometry -- An Introduction, Franco Preparata and Michael Ian Shamos, Springer Verlag
3. Computational Geometry in C, Joseph O'Rourke, Cambridge University Press
4. Lecture Notes by David Mount - http://www.cs.umd.edu/~mount/754/Lects/754lects.pdf

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	H			
CO 2			H		
CO 3	M	M	M	H	H
CO 4				H	
CO 5			H		

CSOS0151: ADVANCED OPERATING SYSTEMS
(3 credits – 45 hours)

Course Outcomes

1. Define the concepts of concurrent processes, deadlock, process synchronization and list the various conditions for identifying these scenarios. (Remembering)
2. Explain the advanced terms like distributed deadlock, distributed mutual exclusion and distributed file system etc. (Remembering)
3. Apply various algorithms like Lamport's algorithm and Ricart- Agarwala algorithm to solve the problem of distributed mutual exclusion. (Applying)
4. Compare techniques of implementing distributed file systems, distributed shared memory, different load scheduling algorithms like- load balancing and load sharing. (Analysing)
5. Determine the requirements of security and protection for a computer system and estimate the efficiency of different security models. (Evaluating)
6. Discuss the design and implementation issues of multiprocessor operating systems. (Creating)

Module I (10 hours)
Concepts of processes, Concurrent processes, Threads, Overview of different classical synchronization problems, Monitors, Communicating Sequential processes (CSP), Process deadlocks: Introduction, causes of deadlocks, Deadlock handling strategies, Models of deadlock.

Module II (11 hours)
Distributed operating system: Architectures, Issues in Distributed operating systems, Limitations of Distributed Systems, Lamport's logical clock, Global states, Chandy-Lampert's global state recording algorithm, Basic concepts of Distributed Mutual Exclusion, Lamport's Algorithm, Ricart-Agrawala Algorithm; Basic concepts of Distributed deadlock detection, Distributed File system, Architecture, Design issues, SUN Network File system, Basic concepts of Distributed shared memory, Basic concepts of Distributed Scheduling, Load balancing, Load sharing

Module III (12 hours)
Multiprocessor System: Motivation, Classification, Multiprocessor Interconnections, Types, Multiprocessor OS functions and requirements; Design and Implementation Issue; Introduction to parallel programming; Multiprocessor Synchronization. Performance, Coprocessors, RISC and data flow: Introduction, Necessity, Measures, Techniques, Bottlenecks and Saturation, Feedback loops, Coprocessors, RISC.

Module IV (12 hours)
Analytic Modeling: Introductions, Queuing Theory, Markov Process. Security and Protection: Security-threats and goals, Penetration attempts, Security Policies and mechanisms, Authentication, Protections and access control Formal models of protection, Cryptography, worms and viruses.

Suggested Readings
Milan Milenkovic, Operating Systems Concepts and Design, TMH.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	H		
CO 2		H		
CO 3		H		
CO 4		H		
CO 5				H
CO 6			H	M

CSSN0152: SPEECH AND NATURAL LANGUAGE PROCESSING
(3 credits-45Hours)

Course Outcomes
1. Recall algorithms and methods for building computational models of speech and natural language processing (Remembering)
2. Explain syntactic analysis, semantic representations, discourse analysis, phonetics, and automatic speech recognition. (Understanding)
3. Apply statistical and corpus-based methods and algorithms for text and speech processing. (Applying)
4. Analyse syntactic structure and meaning of given text taking into account ambiguity. (Analysing)
5. Evaluate the performance of algorithms and models used for text and speech processing. (Evaluating)
6. Develop natural language and speech processing systems for applications such as information extraction, question answering, machine translation etc. (Creating)

Module I (5 Lectures)
Introduction to NLP, Knowledge in language processing, Representation and Understanding, Organization of NLP systems, Models and algorithms, Linguistic Essentials

Module II (12 Lectures)
Grammars and Parsing - Syntactic Processing: Collocations; Regular Expression and Automata; Morphology and Finite-State Transducers; N-grams; Word Classes and Part-of-Speech Tagging; Context-Free Grammars for English; Parsing with Context-Free Grammars: Top-down parsing, Bottom-up parsing; Features and Unification; Lexicalized and Probabilistic Parsing

Module III (12 Lectures)
Semantic processing: Representing Meaning; Semantic Analysis: Integrating semantic analysis to parsers, Semantic Grammars; Lexical Semantics; Word Sense Disambiguation and Information Retrieval: Selection- Restriction based disambiguation, Machine learning approaches; Dictionary based approaches, Information retrieval

Module IV (7 Lectures)
Pragmatics :Discourse, Dialogue and Conversational Agents: Dialogue acts, Automatic Interpretation of Dialogue acts; Natural Language Generation: Discourse Planning; Machine Translation: Direct Translations, Translation using Statistical techniques

Module V (7 Lectures)
Phonetics: Articulatory Phonetics, Phonetic features, Phonetic variations, Acoustic phonetics and signals; Speech Synthesis: Text normalization, Phonetic analysis, Prosodic analysis; Automatic Speech Recognition: Speech recognition architecture, Feature extraction - MFCC vectors, Search and decoding; Text-to-speech

Module VI (2 Lectures)

NLP Applications and Tools :Sentiment Analysis, Text Summarization, Text Entailment, Machine Translation, Question Answering, Cross Lingual Information Retrieval (CLIR), NLTK, WordNet

Suggested Readings

1. D. Jurafsky, J. H. Martin, Speech and Language Processing, Pearson Education
2. Christopher D. Manning, Hinrich Schütze, Foundations of Statistical Natural Language Processing, The MIT Press, Cambridge, Massachusetts
3. James Allen, Natural Language Understanding, 2/e, Pearson Education

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO1	H	H	L		L	
CO2		L	L	H	L	
CO3		L	M	M	H	
CO4		H	H			
CO5		H	H	M		
CO6		L	L	H		H

CSCY0153: COMPUTATIONAL NUMBER THEORY

(3 credits – 45 hours)

Course Outcomes

1. Define the concepts of discrete mathematics, probability, cryptography.(Remembering)
2. Extend and explain the discrete mathematical concepts to modular arithmetic. (Understanding)
3. Apply the concepts of number theory in finite field and polynomial theory(Applying)
4. Analyze the number theory using different algorithmic approach like Primality testing algorithms, Integer factoring algorithms. (Analyzing)
5. Evaluate the algorithms in real time problem solving applications. (Evaluating)
6. Integrate the mathematical concept to computational model using software tools. (Creating)

Module 1 (8 lectures)

Introduction todiscrete mathematical structures (groups, rings, fields), Probability, Algorithms for integer arithmetic, GCD, Montgomery modular arithmetic and exponentiation, congruence, Chinese remainder theorem, orders and primitive roots, quadratic residues, integer and modular square roots, prime number theorem, rational approximations, Hensel's lemma .

Module 2 (15 lectures)

Finite fields and their representation, Prime fields, extension fields, representation of extension fields, primitive elements, normal basis, optimal normal basis, irreducible polynomials, Algorithms for polynomialsRoot-finding and factorization, Lenstra-Lenstra-Lovasz algorithm, polynomials over finite fields, Elliptic curves: The elliptic curve group, elliptic curves over finite fields, Schoof's point counting algorithm.

Module 3 (15 lectures)

Integer factoring algorithms: Trial division, Pollard rho method, p-1 method, CFRAC method, quadratic sieve method, elliptic curve method, Primality testing algorithms, Fermat test, Miller-Rabin test, Solovay-Strassen test, AKS test, Computing discrete logarithms over finite fields: Baby-step-giant-step method, Pollard rho method, Pohlig-Hellman method, index calculus methods, linear sieve method, Coppersmith's algorithm.

Module 4 (7 lectures)

Applications: Algebraic coding theory, cryptography, cryptology, Basic introduction to software packages like Mathematica, Maple, PARI etc.

Suggested Readings

1. A. Das, Computational number theory, Chapman and Hall/CRC.
2. V. Shoup, A computational introduction to number theory and algebra, Cambridge University Press.
3. I. Niven, H. S. Zuckerman and H. L. Montgomery, An introduction to the theory of numbers, John Wiley.
4. J. von zurGathen and J. Gerhard, Modern computer algebra, Cambridge University Press.
5. R. Lidl and H. Niederreiter, Introduction to finite fields and their applications, Cambridge University Press.
6. A. J. Menezes, editor, Applications of finite fields, Kluwer Academic Publishers.
7. A Course in Computational Algebraic Number Theory, Cohen, Henri, springer.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4

CO 1	H			
CO 2	M	H		
CO 3		M	H	L
CO 4			H	
CO 5				H
CO6				H

CSRT0154: REAL TIME SYSTEMS

(3 credits – 45 hours)

Course Outcomes

1. Recognize the characteristics of a real-time system in context with real time scheduling. (Remembering)
2. Describe concepts of Real-Time systems and modelling(Understanding)
3. Classify various resource sharing mechanisms and their related protocols.(Analysing)
4. Interpret the basics of real time communication by the knowledge of real time models and protocols. (Evaluating)
5. Apply the basics of RTOS in interpretation of real time systems. (Applying).
6. Design a particular Real time system for solving real world problems.(Creating).

Module I: Introduction(8 Hours)

Definition, Typical Real Time Applications: Digital Control, High Level Controls, Signal Processing etc., Release Times, Dead-lines, and Timing Constraints, Hard Real Time Systems and Soft Real Time Systems, Reference Models for Real Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency.

Module II: Real Time Scheduling (12 hours)

Common Approaches to Real Time Scheduling: Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Dynamic Versus Static Systems, Optimality of Effective-Deadline-First (EDF) and Least-Slack-Time-First (LST) Algorithms, Rate Monotonic Algorithm, Offline Versus Online Scheduling, Scheduling Aperiodic and Sporadic jobs in Priority Driven and Clock Driven Systems.

Module III: Resource Sharing (12 hours)

Effect of Resource Contention and Resource Access Control (RAC), Non preemptive Critical Sections, Basic Priority-Inheritance and Priority-Ceiling Protocols, Stack Based Priority- Ceiling Protocol, Use of Priority-Ceiling Protocol in Dynamic Priority Systems, Preemption Ceiling Protocol, Access Control in Multiple-Module Resources, Controlling Concurrent Accesses to Data Objects.

Module IV: Real Time Communication (8 hours)

Basic Concepts in Real time Communication, Soft and Hard RT Communication systems, Model of Real Time Communication, Priority Based Service and Weighted Round-Robin Service Disciplines for Switched Networks, Medium Access Control Protocols for Broadcast Networks, Internet and Resource Reservation Protocols.

Module V: Real Time Operating Systems and Databases (5 hours)

Features of RTOS, Time Services, UNIX as RTOS, POSIX Issues, Characteristic of Temporal data, Temporal Consistency, Con-currency Control, Overview of Commercial Real Time databases.

Suggested Reading

1. R. Mall, Real-Time Systems, Pearson , 2007
2. P. A. Laplante, Real-Time Systems Design & Analysis, Willey , 2011
3. S. V. Iyer& P. Gupat, Embedded Real-Time System Programming, Tata McGraw Hill , 2004
4. R. Kamal, Embedded System Architecture, Programming and Design, Tata McGraw Hill , 2007

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H				
CO 2		H	H	M	
CO 3			H	M	
CO 4			M	H	
CO 5			H	M	H
CO 6			M	M	M

CSIR0155: INFORMATION RETRIEVAL

(3 credits – 45 hours)

Course Outcomes

1. Define Information Retrieval Systems and its objectives (Remembering)
2. Interpret models like vector-space, probabilistic, statistical, and other language models to identify how they can be applied to the document retrieval problem. (Understanding)
3. Anticipate clustering algorithms like hierarchical agglomerative clustering and k-means algorithm. (Analyze)
4. Identify the basic concepts related to Tolerant Retrieval, evaluation of IR systems and Latent Semantic Indexing. (Understanding)
5. Identify the concepts behind Query Expansion and Probabilistic Information Retrieval. (Understanding)
6. Discover XML Indexing Search and basic operations of image processing that support IR (Understanding)

Module 1 (10 lectures)

Introduction to Information Retrieval, Design Features of Information Retrieval Systems, Indexing, Elimination of Stop Words, Stemming, Zipf's Law, Information Retrieval Models- Classical, Non-Classical, Alternative, Boolean Model, Probabilistic Model, Vector Space Model, Term Weighting, Similarity Measures, Cluster Model, Fuzzy Model, Latent Semantic Indexing Model

Module 2 (15 lectures)

Tolerant Retrieval-Wild card queries, Permuterm index, Bigram index, spelling correction, Edit distance, Jaccard coefficient, Soundex Evaluation of IR Systems, Relevance, Effectiveness Measures, Precision and Recall, User-centered evaluation, Document, and concept clustering - hierarchical clustering, k-means, Web retrieval - Page rank, difficulties of Web retrieval, Document clustering.

Module 3 (10 lectures)

Eigen vectors, Singular value decomposition, Low-rank approximation, Problems with Lexical Semantics, Relevance feedback, Rocchio algorithm, Probabilistic relevance feedback, Query Expansion and its types, Query drift, Probabilistic relevance feedback, Probability ranking principle, Binary Independence Model, Bayesian network for text retrieval.

Module 4 (10 lectures)

Data vs. Text-centric XML, Text-Centric XML retrieval, Structural terms, Introduction to content Based Image retrieval, Challenges in Image retrieval, Image representation, Indexing and retrieving images, Relevance feedback.

Suggested Readings

1. Introduction to Information Retrieval by Christopher D. Manning
2. Natural Language Processing and Information Retrieval by Tanveer Siddiqui and U. S. Tiwary

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	L	L
CO 2	H	M	L	L
CO 3	L	H	L	L
CO 4	L	H	H	L
CO 5	L	L	H	L
CO6	L	L	L	H

CSQC0156: QUANTUM COMPUTING

(3 credits – 45 hours)

Course Outcomes

1. Explain the working of a Quantum Computing program, its architecture and program model.
2. Develop the mathematical foundation for Quantum Computing.
3. Understand the architecture of a Quantum Computing platform.
4. Program quantum algorithm on major toolkits.

Module 1 (6 hours)

Introduction to Quantum Computing - Motivation for studying Quantum Computing, Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.), Origin of Quantum Computing, Overview of major concepts in Quantum Computing - Qubits and multi-qubits states, Bra-ket notation, Bloch Sphere representation, Quantum Superposition, Quantum Entanglement

Module 2 (9 hours)

Mathematical Foundation for Quantum Computing, Matrix Algebra - basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.

Module 3 (10 hours)
Building Blocks for Quantum Program, Architecture of a Quantum Computing platform, Details of q-bit system of information representation - Block Sphere, Multi-qubits States, Quantum superposition of qubits (valid and invalid superposition), Quantum Entanglement, Useful states from quantum algorithmic perceptive e.g. Bell State, Operation on qubits: Measuring and transforming using gates, Quantum Logic gates and Circuit: Pauli, Hadamard, phase shift, controlled gates, Ising, Deutsch, swap etc. Programming model for a Quantum Computing Program - Steps performed on classical computer, Steps performed on Quantum Computer, Moving data between bits and qubits.

Module 4 (20 hours)
Quantum Algorithms, Basic techniques exploited by quantum algorithms - Amplitude amplification, Quantum Fourier Transform, Phase Kick-back, Quantum Phase estimation, Quantum Walks. Major Algorithms, Shor's Algorithm, Grover's Algorithm, Deutsch's Algorithm, Deutsch -Jozsa Algorithm. OSS Toolkits for implementing Quantum program, IBM quantum experience, Microsoft Q, Rigetti PyQuil (QPU/QVM)

Suggested Readings
1. Michael A. Nielsen, “Quantum Computation and Quantum Information”, Cambridge University Press.
2. David McMahon, “Quantum Computing Explained”, Wiley

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2		H	M	
CO 3		M	H	M
CO 4			M	H

CSAD0157: AD HOC AND SENSOR NETWORKS
(3 credits – 45 hours)

Course Outcomes
1. Recall and Understand the concept design issues in ad hoc and sensor networks (Remembering)
2. Understand the different types of MAC protocols.(Understanding)
3. Apply the concept of routing protocol in adhoc network (Applying)
4. Analyse the TCP issues in adhoc networks. (Analysing)
5. Formulate the architecture and protocols of wireless sensor networks. (Evaluating)

Module 1 (9 hours)
Fundamentals of Wireless Communication Technology – The Electromagnetic Spectrum – Radio propagation Mechanisms – Characteristics of the Wireless Channel -mobile ad hoc networks (MANETs) and wireless sensor networks (WSNs) : architectures, Applications of Ad Hoc and Sensor networks. Design Challenges in Ad hoc network

Module 2 (9 hours)
Issues in designing a MAC Protocol- Classification of MAC Protocols- Contention based protocols-Contention based protocols with Reservation Mechanisms- Contention based protocols with Scheduling Mechanisms – Multi channel MAC-IEEE 802.11

Module 3 (9 hours)
Issues in designing a routing and Transport Layer protocol for Ad hoc networks- proactive routing, reactive routing (on-demand), hybrid routing- Classification of Transport Layer solutions-TCP over Ad hoc wireless Networks.

Module 4 (9 hours)
Single node architecture: hardware and software components of a sensor node – WSN Network architecture: typical network architectures-data relaying and aggregation strategies -MAC layer protocols: self-organizing, Hybrid TDMA/FDMA and CSMA based MAC- IEEE 802.15.4.

Module 5 (9 hours)
Issues in WSN routing – OLSR- Localization – Indoor and Sensor Network Localization-absolute and relative localization, triangulation-QOS in WSN-Energy Efficient Design-Synchronization-Transport Layer issues.

Suggested Readings

1. C. Siva Ram Murthy, and B. S. Manoj, “Ad Hoc Wireless Networks: Architectures and Protocols “, Prentice Hall Professional Technical Reference, 2008.
2. Carlos De Morais Cordeiro, Dharma Prakash Agrawal “Ad Hoc & Sensor Networks: Theory and Applications”, World Scientific Publishing Company, 2006.
3. Feng Zhao and Leonides Guibas, “Wireless Sensor Networks”, Elsevier Publication – 2002.
4. Holger Karl and Andreas Willig “Protocols and Architectures for Wireless Sensor Networks”, Wiley, 2005
5. Kazem Sohraby, Daniel Minoli, & Taieb Znati, “Wireless Sensor Networks-Technology, Protocols, and Applications”, John Wiley, 2007.
6. Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H				
CO 2	M	H			
CO 3			M		
CO 4			M		
CO 5				M	H

CSNN0158: NEURAL NETWORKS AND DEEP LEARNING

(3 credits – 45 hours)

Course Outcomes

1. Summarize the role of Deep learning in Machine Learning Applications.(Understanding)
2. To design and implement Deep Learning Applications. (Creating)
3. Critically Analyse Different Deep Learning Models in Image Related Projects. (Analysing)
4. To design and implement Convolutional Neural Networks. (Applying)
5. Apply Deep Learning in NLP and Image Processing.(Applying)

Module I(12 hours)
INTRODUCTION TO ANN
Features , structure and working Computing Comparison of BNN and ANN, Backpropagation networks : (BPN)Architecture of feed forward network, single layer ANN, multilayer perceptron, back propagation learning, input - hidden and output layer computation, backpropagation algorithm, applications, selection of tuning parameters in BPN, Numbers of hidden nodes, learning. Basics of Artificial Neural Networks -History of neural network research, characteristics of neural networks terminology, models of neuron Mc Culloch – Pitts model, Perceptron, Adaline model, Basic learning laws, Topology of neural network architecture,

Module II (9 hours)
TRAINING NEURAL NETWORK
Risk minimization, loss function, backpropagation, regularization, model selection, and optimization. Conditional Random Fields: Linear chain, partition function, Markov network, Belief propagation, Training CRFs, Hidden Markov Model, Entropy.

Module III (15 hours)
INTRODUCTION TO DEEP LEARNING ARCHITECTURES
Feed Forward Neural Networks,Gradient Descent, Back Propagation Algorithm, Vanishing Gradient problem, Mitigation,RelU Heuristics for Avoiding Bad Local Minima, Heuristics for Faster Training, Nestors Accelerated Gradient Descent, Regularization ,Dropout.CNN Architectures, Convolution, Pooling Layers, Transfer Learning, Image Classification using Transfer Learning,LSTM, GRU, Encoder/Decoder Architectures ,Autoencoders, Standard- Sparse, Denoising ,Contractive, Variational Autoencoders, Adversarial Generative Networks Autoencoder and DBM

Module IV (9 hours)
APPLICATIONS OF NEURAL NETWORKS DEEP LEARNING
Image Segmentation, Object Detection, Automatic Image Captioning, Image generation with Generative Adversarial Networks,Video to Text with LSTM Models, Attention Models for Computer Vision, Case Study: Named Entity Recognition, Opinion Mining using Recurrent Neural Networks, Parsing and Sentiment Analysis using Recursive Neural Networks, Sentence Classification using Convolutional Neural Networks, Dialogue Generation with LSTMs.

Suggested Readings

1. Ian Good Fellow, YoshuaBengio, Aaron Courville, “Deep Learning”, MIT Press, 2017.
2. Francois Chollet, “Deep Learning with Python”, Manning Publications, 2018.
3. Phil Kim, “Matlab Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence”, Apress , 2017.

4. Ragav Venkatesan, Baoxin Li, “Convolutional Neural Networks in Visual Computing”, CRC Press, 2018.
5. Navin Kumar Manaswi, “Deep Learning with Applications Using Python”, Apress, 2018. 6. Joshua F. Wiley, “R Deep Learning Essentials”, Packt Publications, 2016.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2		H	M	
CO 3		M	H	M
CO 4			H	
CO 5		M		M

CSBF0159: BLOCKCHAIN FUNDAMENTALS

(3 credits – 45 hours)

Course Outcome

1. The student will be able to identify the history, technology, and applications of Blockchain (Remembering)
2. The student will be able to explain Blockchain applications (Understanding)
3. The student will be able to demonstrate Blockchain concepts clearly and persuasively (Applying)
4. The student will be able to assess crypto currency exchanges and wallets safely (Evaluate)
5. The student will be able to create Crypto token (Create)

Module I (8 hours)

Distributed systems, Byzantine Generals problem, Consensus, History of Blockchain Technology, Cryptographic Hashes, Digital Signatures, Peer to Peer Networks

Module II (12 hours)

Introduction to Blockchain, Generic elements of a Blockchain, Features of a Blockchain, Applications of Blockchain technology, Tiers of Blockchain technology, Types of Blockchain, Hash-based Ledgers, Hash Validation - Proof Of work, Proof of stake, UTXO Model, Wallets and Private Keys, Ask-the-Expert session

Module III (10 hours)

Consensus in Blockchain, , CAP theorem and Blockchain, Structure of a Block: Header, Merkle trees, Benefits and limitations of Blockchain, Smart Contracts, Types of Blockchains

Module IV (10 hours)

Platforms to implement Blockchain: Ethereum – Ether, Gas, Solidity, Multichain - permission, asset, streams, Hyperledger – Architecture, Framework (Fabric, Sawtooth Lake)

Module IV (5 hours)

Design Thinking, Business Awareness, Customer Handling, Case studies: Smart contract for crowd funding, Stock market transactions.

Reference Books and Articles

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016).
2. Wattenhofer, The Science of the Blockchain
3. Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies
4. Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System
5. DR. Gavin Wood, “ETHEREUM: A Secure Decentralized Transaction Ledger,”Yellow paper.2014.
6. Nicola Atzei, Massimo Bartoletti, and Tiziana Cimoli, A survey of attacks on Ethereum smart contracts

Mapping of COs to Syllabus

Course Outcomes	M1	M2	M3	M4
CO1	H	M		
CO2	M	M	H	
CO3	M	M	H	
CO4	L		M	H
CO5			H	M

CSCM0160: CLOUD COMPUTING

(3 credits – 45 hours)

Course Outcomes
1. Define the various evolutionary steps of computation. (Remembering)
2. Illustrate security issues associated with cloud computation. (Understanding)
3. Apply the use of a virtual private cloud in Amazon web service andExperiment with the management console for virtualization using hypervisors. (Applying)
4. Develop an application using map reduce program and create an application and deploy on real time cloud platform like IBM Bluemix. (Creating)
5. Analyze the concepts of Big data and Hadoop components. (Analyzing)
6. Develop and assess a real time application deployed on cloud platform. (Creating/Evaluating)

Module 1(10 hours)
Introduction to Cloud Computing, the Evolution of Cloud Computing, Hardware Evolution, Internet Software Evolution, Server Virtualization, Web Services Deliver from the Cloud, Communication-as-a-Service, Infrastructure-as-a-Service, Monitoring-as-a-Service, Platform-as-a-Service, Software-as-a-Service, Building Cloud Network

Module 2 (13 hours)
Datain the cloud: Relational databases, Cloud file systems: GFS and HDFS, Big Table, HBase and Dynamo. Map-Reduce and extensions: Parallel computing, The map-Reduce model, Parallel efficiency of Map-Reduce, Relational operations using Map-Reduce, Enterprise batch processing using Map-Reduce, Introduction to cloud development, Example/Application of Map-reduce.

Module 3 (14 hours)
Putting Security on the Spot with Questions: Understanding Security Risks, Reducing Cloud Security Breaches, Implementing Identity Management, Benefits of identity management, Aspects of identity management, Playing Detective: Detection and Forensics, Activity logs, HIPS and NIPS, Data audit, Encrypting Data, Creating a Cloud Security Strategy

Module 4 (8 hours)
Virtualization and the Cloud: Visualizing Virtualization, Characteristics, Using a hyper visor in virtualization, Abstracting hardware assets, Managing Virtualization, Foundational issues, Abstraction layer, Provisioning software, Virtualizing storage, Hardware provisioning, Security issues, Taking Virtualization into the Cloud.

Suggested Readings
1. Cloud Computing for Dummies by Judith Hurwitz, R. Bloor, M. Kaufman, F. Halper, (Wiley India Edition)
2. Enterprise Cloud Computing by Gautam Shroff, Cambridge.
3. Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley-India
4. Google Apps by Scott Granneman, Pearson
5. Cloud Security and Privacy by Tim Malhar, S. Kumaraswamy, S. Latif (SPD,O'REILLY)
6. Cloud Computing: A Practical Approach, Anthony T Velte, et.al McGraw Hill,
7. Cloud Computing Bible by Barrie Sosinsky, Wiley India

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2	H			
CO 3		H		
CO 4		M	H	
CO 5		H		
CO6			H	
CO7				H
CO8				H

CSBA0161: BUSINESS ANALYTICS
(3 credits – 45 hours)

Course Outcomes
1. Define data analysis in business and about decision making. (Remembering)
2. Interpret data to establish new relationships and patterns. (Understanding)
3. Experiment with data, distribution of data and statistical inferences. (Applying)
4. Investigate and examine problems in business. (Analyzing)

5. Evaluate analytics to solve business problems. (Evaluating)
6. Propose business analytic approaches into effective courses of action. (Creating)

Module 1 (11 hours)
Introduction to data analysis and decision making. Modeling and models.

Module 2 (12 hours)
Exploring data: Basic Concepts, distribution of single variables. Finding relationship among variables. Probability, Probability distribution and decision making.

Module 3 (11 hours)
Sampling and sampling distribution. Similarity, Neighbors, and Clusters. Hypothesis Testing

Module 4 (11 hours)
Regression Analysis: estimating relationships**.** Regression Analysis: statistical inference. Time series analysis and forecasting

Suggested Readings
1. Albright and Winston, Business Analytics: Data analysis and decision making (5^{th} edition).
2. Foster Provost and Tom Fawcett, Data Science for Business (1^{st} edition) O'RELLY.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2	M	H		
CO 3		H	M	
CO 4		M	H	
CO 5			H	
CO 6				H

CSNT0162: COMPUTER NETWORKS
(Theory - 3 Credits)

Course Outcomes
1. Describe various technologies used for data communication (Understanding)
2. Identify possible errors in data transfer and solutions for them (Applying)
3. Describe the various protocols used in data communication (Remembering)
4. Classify the routing protocols and analyze how to assign the IP addresses for the given network (Applying)
5. Identify security issues in networks and available protection mechanisms (Applying)

Module 1 (10 hours)
Introduction to Computer networks, Topology of networks, Protocol Stack, OSI and TCP/IP models, Switching – Circuit Switching, Packet Switching and Message Switching.

Module 2 (12 hours)
Data link layer, Types of errors, Error detection and correction, Hamming distance, Cyclic Redundancy Check(CRC), checksum, Hamming code, Multiple Access, Random Access, ALOHA, pure ALOHA and slotted ALOHA, CSMA/CD and SCMA/CA, Polling, Wired LANs, Ethernet - IEEE standards.

Module 3 (14 hours)
Network layer, Networking and Internetworking devices - Repeaters, Bridges, Routers, Gateways, Logical addressing, Network Address Translation(NAT), Internet protocols, Address Mapping, Error reporting and multicasting - Delivery, Forwarding and Routing algorithms, Distance Vector Routing, Link State Routing.

Module 4 (12 hours)
Transport layer, Process-to-process Delivery: UDP, TCP and SCTP, Congestion control and Quality of Service, Application Layer, Domain Name Systems-Remote Login-Email FTP, WWW, HTTP, Introductory concepts on Network management: SNMP.

Module 5 (12 hours)
Cryptography and Network Security: Introduction, Types of attacks, confidentiality and integrity, various terminologies in cryptography, Basics of Symmetric Key Ciphers, block cipher and stream cipher, Basics of Asymmetric Key Ciphers – RSA Cryptosystem. Message Digest: Hash Function, Digital Signature.

Suggested Readings
1. Data Communications and Networking, 4^{th} Edition, Behrouz A Forouzan, 2007, TMH.

2. Computer Networks, 4th Edition, Andrew S Tannenbaum, 2003, PHI.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H				
CO 2		H	M		
CO 3		H	H	H	
CO 4			H		
CO 5					H

CSEC0163: E-COMMERCE & CYBER SECURITY

(3 credits – 45 hours)

Course Outcomes

1. Find the scopes of e-commerce and their association with different trade cycles.
2. Summarize the concept of business to consumer mode of transaction in e-commerce.
3. Present the legal issues associated with electronic documents, jurisdiction issues, copyrights etc.
4. Explain and categorize the in-depth knowledge of EDI and its constituent elements.
5. Evaluate the symmetric and asymmetric cryptosystem implementations on e-commerce.
6. Integrate the gathered knowledge on certain case studies like internet bookshops, electronic newspapers, virtual auctions etc.

Module 1(10 hours)

Definition, Scope of E-Commerce, Hardware requirements, E-Commerce and Trade Cycle, Electronic Markets, Electronic Data Interchange and Internet Commerce. Business to Business E-Commerce: Electronic Markets, Electronic Data Interchange (EDI): Technology, Standards (UN/EDIFACT), Communications, Implementations, Agreements, Security, EDI and Business, Inter-Organizational E-commerce.

Module 2(15 hours)

Risks-Paper Document vs. Electronic document, Authentication of Electronic document, Laws, Legal issues for Internet Commerce: Trademarks and Domain names, Copyright, Jurisdiction issues, service provider liability, Enforceable on line contract. Security Issues: Security Solutions-Symmetric and Asymmetric Cryptosystems, RSA, DES,AES and Digital Signature, Protocols for secure messaging, Secure Electronic Transaction (SET)Protocol, Electronic cash over internet, Internet Security.

Module 3 (10hours)

Consumer trade transaction, Internet, Page on the Web, Elements of E-Commerce with VB, ASP, SQL.

Module 4 (10 hours)

Internet bookshops, Software supplies and support, Electronic Newspapers, Internet Banking, Virtual Auctions, Online Share Dealing, Gambling on the net, E-Diversity, Case studies through internet.

Suggested Readings

1. D. Whitley, E-Commerce-Strategy, Technologies and Applications, TMH.
2. K. K. Bajaj, E-Commerce- The Cutting Edge of Business, TMH.
3. W. Clarke, E-Commerce through ASP, BPB.
4. M. Reynolds, Beginning E-Commerce with VB, ASP, SQL Server7.0 and MTS, Wrox.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H			
CO2	L		H	
CO3		H		
CO4	H	M		L
CO5		H		
CO6			L	H

CSIC0164: ICT FOR DEVELOPMENT

(3 credits – 45 hours)

Course Outcomes

1. Define the various terms and technologies used for Information and Communication System. (Remembering)

2. Analyze the foundational and implementation issues of ICT.(Analyzing)
3. Illustrate the various impacts of ICTs on Social and Economical developments. (Understanding)
4. Classify and compare the models of e-Governance with ICTs and its impact on the Environment sustainability. (Applying)
5. Conclude and evaluate the various aspects of ICTs in future. (Evaluating)

Module 1: Information and Communication System Overview (12 lectures)
Definition of terms – Elements and Components – Basics of Information theory – Objectives of communications – components and methods of communications – Hardware subsystem (PC, Network, Enterprise, Grid and Cloud Computing) – Internet, Intranet, WEB technology in communication .

Module 2: Foundations and Implementation of ICT4D (7 lectures)
ICT4D value chain, Technological foundations of ICT4D, Human foundations, Institutional foundations, Implementing ICT4D: Strategy, Design and implementation, Adoption, monitoring and use.

Module 3: ICTs for Economic and Social development (11 lectures)
Economic growth: Development goal, ICTs and micro-economic growth, ICTs and meso-economic growth, ICTs and macro-economic growth, Poverty eradication: Development goal, ICTs and financial poverty, ICTs and livelihoods, Social development: Development goal, ICTs health, ICTs education.

Module 4: ICTs for e-Governance and Environment Sustainability (10 lectures)
Good Governance: Development goal, ICTs for e-Services, ICTs for e-Accountability, ICTs for e-Democracy, Environment Sustainability: Development goal, ICTs for e-Mitigation, e-Monitoring, e-Strategy, e-Adaptation, e-Resillience.

Module 5: Future of ICT4D (5 lectures)
Future directions, Development 2.0, Data intensive development, Open development.

Suggested Readings
1. The Language of ICT: Information and Communication Technology, Tim Shortis, 2001, Routledge.
2. Information and Communication Technology for Development (ICT4D), Richard Heeks, 2017,Taylor and Francis.
3. Information and Communications Technologies for Development: A Comparative Analysis of Impacts and Costs, Balaji, P. and Keniston, K

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H				
CO 2		H			
CO 3		M	H	M	
CO 4				H	
CO 5					H

CSCB0165: CYBER LAW AND ETHICS
(3 credits – 45 hours)

Course Outcomes
1. Identify knowledge related to the constitution and its legal issues in cyberspace. (Remembering)
2. Explain the different cybercrimes, and the related cyber laws. (Understanding)
3. Demonstrate the different perspectives of professional ethics and responsibilities of engineers. (Understand)
4. Illustrate the concepts behind Cyber Torts, Intellectual Property Rights.(Understanding)
5. Describe the concepts in connection to dispute resolution in cyberspace. (Understanding)

Module 1 (10 lectures)
Constitutional & Human Rights Issues in Cyberspace Freedom of Speech and Expression in Cyberspace, Right to Access Cyberspace – Access to Internet, Right to Privacy, Right to Data Protection, Cyber Crimes & Legal Framework Cyber Crimes against Individuals, Institution and State, Hacking, Digital Forgery, Cyber Stalking/Harassment, Cyber Pornography, Identity Theft & Fraud Cyber terrorism, Cyber Defamation.

Module2 (15 lectures)
Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship. Cybercrimes and enforcement agencies, Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the

website of Institution of Engineers (India): Profession, Professionalism, and Professional Responsibility. Clash of Ethics, Conflicts of Interest. Responsibilities in Engineering Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility. Trust and Reliability in Engineering

Module3 (10 lectures)
Cyber Torts Cyber Defamation, Different Types of Civil Wrongs under the IT Act 2000, Intellectual Property Issues in Cyber Space Interface with Copyright Law, Interface with Patent Law, Trademarks & Domain Names Related issues.

Module4 (10 lectures)
Dispute Resolution in Cyberspace, Concept of Jurisdiction, Indian Context of Jurisdiction, and IT Act, 2000. International Law and Jurisdictional Issues in Cyberspace, Dispute Resolutions.

Suggested Readings
1. Engineering Ethics M. Govindarajan, S. Natarajan, V. S. Senthilkumar Prentice –Hall, 2004
2. Constitution of India, Professional Ethics and Human Rights Shubham Singles, Charles E. Haries, and et al Cengage Learning India 2018
3. Justice Yatindra Singh, Cyber Laws, Universal Law Publishing Co, New Delhi.
4. Verma S, K, Mittal Raman, Legal Dimensions of Cyber Space, Indian Law Institute.
5. Jonthan Rosenoer, Cyber Law, Springer, New York.
6. Sudhir Naib, The Information Technology Act, 2005: A Handbook, OUP, New York.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	L	L
CO 2	M	H	L	L
CO 3	L	H	L	L
CO 4	L	L	H	L
CO 5	L	L	L	H

CSID0166: INTRODUCTION TO DATA SCIENCE
(3 Credits)

Course Outcomes
1. Recall the fundamental concepts used in data science. (Remembering)
2. Explain the key concepts in data science, including their real-world applications and the toolkit used by data scientists. (Understanding)
3. Apply various statistical techniques to find the underlying facts on various datasets. (Applying)
4. Analyze the different data using statistical and machine learning techniques. (Analyzing)
5. Evaluate the effectiveness of various data visualization techniques for real life applications. (Evaluating)
6. Design and develop various data visualization methods for a given problem. (Creating)

Module I: (8Hours)
Introduction to core concepts and technologies: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications.

Module II: (10 Hours)
Data collection and management: Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, using multiple data sources.

Module III: (10 Hours)
Data analysis: Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic.

Module IV: (10Hours)
Data visualization: Introduction, Types of data visualization, Data for visualization, Applications of Data Science Technologies for visualization.

Module V: (7 Hours)
Recent trends in various data collection and analysis techniques, various visualization techniques, application development methods used in data science.

Suggested Readings:
1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk from The Frontline. O'Reilly.

2. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press.
3. Rafael A. Erizarry. Introduction to data science: Data Analysis and Prediction Algorithms, CRC Press.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	M	M	M	
CO 2		H	M	M	
CO 3			H		
CO 4			H		
CO 5				H	
CO 6				H	H

CSII0167: INTRODUCTION TO IoT

(4 credits – 60 hours)

Course Outcomes

CO1: Recall the fundamental concepts of IoT. (Remembering)
CO2: Explain the different IoT devices and networking technologies that are used in IoT. (Understanding)
CO3: Apply IoT technologies in different applications like agriculture, smart city etc. (Application)
CO4: Compare the different IoT hardware and networking technologies. (Analyzing)
CO5: Recommend the connectivity, communication and hardware technologies for a given IoT application. (Evaluation)
CO6: Develop IoT applications to solve real world problems. (Creating)

Syllabus

Module I (8 hours)
Introduction: IoT - What is the IoT and why is it important? Elements of an IoT ecosystem, Technology drivers, Business drivers, Trends and implications, Overview of Governance, Privacy and Security Issues; Predecessors of IoT: Wireless Sensor Networks, Machine-to-Machine Communications, Cyber Physical Systems; IoT versus M2M, IoT versus CPS, IoT versus WoT; IoT Architecture.

Module II (6 hours)
IoT Devices: IoT Devices vs Computers, Embedded Systems, Components of Embedded Systems, IoT Hardware Technologies - Microcontrollers, Sensors, Actuators, RFID; Types of sensors and actuators; IoT Device Platforms - Arduino, Raspberry Pi, Beagle Board.

Module III (15 hours)
IoT Connectivity Technologies: IEEE 802.15.4, Zigbee, Thread, ISA100.11A, WirelessHART, RFID, NFC, DASH7, Z-Wave, Weightless, Sigfox, LoRa, NB-IoT, 6LoWPAN, Wi-Fi, Bluetooth; LAN/PAN vs LPWAN vs Cellular; IoT and Mobile Communication Networks: 3GPP Releases.

Module IV (10 hours)
IoT Communication Technologies: Data Protocols- MQTT, CoAP, AMQP, XMPP, SOAP, REST, WebSocket; Cloud Computing; Mobile Cloud Computing; Edge Computing; Mobile Edge Computing; Fog Computing; Cloudlet.

Module V (6 hours)
IoT Applications: Agricultural IoT, Vehicular IoT, Healthcare IoT, Smart Cities and Smart Homes, Activity Monitoring

Suggested Readings

1. Sudip Misra, Anandarup Mukherjee, and Arijit Roy, “Introduction to IoT”, Cambridge University Press.
2. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRCPress
3. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer,
4. David Easley and Jon Kleinberg, “Networks, Crowds, and Markets: Reasoning About a HighlyConnected World”, Cambridge University Press.
5. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applicationsand Protocols”, Wiley
6. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”,1st Edition, VPT.
7. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to ConnectingEverything”, 1st Edition, Apress Publications,
8. Cuno Pfister, “Getting Started with the Internet of Things”, O’Reilly Media.

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4	Module 5

CO1	H	L	L	L	
CO2	L	M	H	H	
CO3		H	H	H	
CO4		M	H	M	
CO5		M	H	H	
CO6		L	L	L	H

CSDA0168: DATA STRUCTURES AND ALGORITHMS

(4 credits – 60 hours) (L-T-P:4-0-0)

Course Outcomes

1. Explain the concept of different data types, primitive, derived and their representation and application through coding. (Understanding)
2. Apply the concept of ADT and linear and nonlinear data types and their representation. (Applying)
3. Apply these data types in various applications like arithmetic expression evaluation and conversion. (Applying)
4. Explain the concept of Graphs and Trees and their real time application. (Understanding)
5. Develop various searching and sorting techniques. (Creating)
6. Choose and implement efficient data structures and apply them to solve problems. (Evaluating)

Module I Introduction

Introduction to data structures, Data Type, Abstract Data Type, Data Structure, Fundamental and Derived Data Types; Pointers and Structures. Complexity analysis: Time and Space, asymptotic bounds.

Module II Arrays and Lists (16 Hours)

a. Array as a data structure, Representation of arrays: single and multidimensional, Address calculation using column and row major ordering; insertion and deletion in arrays; use of arrays for matrix representation and manipulation (addition, multiplication), use of arrays for large integer representation and their addition.
b. Linked List as a data structure; operations on lists; singly linked list (with one or two external pointers), doubly linked list, circular list; use of linked lists for polynomial representation and manipulation (addition and multiplication), and sparse matrix representation and manipulation (inputting, adding, and displaying in matrix form)

Module III Stacks and Queues (14 Hours)

Stacks and Queues as data structures; implementation of stacks and queues using arrays and linked lists; Circular Queue, Priority Queue; Application of stacks: Conversion of infix (containing arithmetic operators including exponential operator, and parenthesis) to postfix and prefix expressions; evaluation of postfix expression

Module IV Trees and Graphs (16 Hours)

a. Binary Trees and General Trees, Representation of trees using linked lists, Binary tree traversal methods, recursive and non-recursive algorithms for traversal methods, Binary search trees (creation, insertion and deletion of a node), threaded binary trees (construct and traverse a right in-threaded binary tree); Height balanced (AVL) binary trees (construct and traverse an AVL tree), multi-way search trees (construction and traversal); B-tree (construction and traversal of a B-tree of given order)
b. Introducing Graphs; Graph representation: Adjacency matrix, adjacency lists, incidence matrix, Traversal schemes : Depth first search, Breadth first search (Recursive and non- recursive algorithms); Shortest Path algorithms (Dijkstra's), Spanning tree, Minimal spanning tree algorithms (Kruskal's algorithm)

Module V Searching and Sorting (14 Hours)

Linear and binary search, Indexed search; Hashing, Hash Functions (division method, mid square method, folding), Analysis of ideal hash function; Conflict resolution (linear and quadratic probe, double hashing, separate chaining, coalesced chaining); Analysis of collision resolution techniques; Sorting algorithms (Insertion, Selection, Bubble, Quick, Merge, Radix, Heap). Analysis of recursive procedures: Master theorem, recursion tree.

Suggested Readings

1. Lipschutz, S., Data structures, Indian Adapted Ed, Tata McGraw Hill Publishing Company Limited, New Delhi,2006
2. Gilberg, Richard F. Forouzan, and Behrouz A., Data Structures, 2nd Ed, Course Technology, Cengage
3. Learning, New Delhi, 2005.
4. Pai, GA, Data Structures and Algorithms, 1st Ed, Tata Mcgraw Hill Publishing Company Limited, New Delhi,2008.
5. Langsam, Augenstein, and Tanenbaum, Data Structures Using C And C++,2nd Ed, Phi Publication, New Delhi, 2007.
6. Krishnamoorthy R., Kumaravel, and G .Indirani, Data Structures Using C, 1st Ed., Tata Mcgraw Hill Publishing Company Limited, New Delhi,2008.

7. Horowitz, Sahni, Susan Freed, Fundamentals of Data Structures in C,2nd Edition, University press, 1997
8. Amiya Kumar Rath, Alok Kumar Jagdev, Data Structures using C, 2nd Edition, Scitech Publication, New Delhi,2009

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO1	H	M	M		
CO2	M	H	H		
CO3	H	H	M		
CO4	L	H		H	H
CO5	M	M		H	H
CO6	L			H	H

CSOA0169: COMPUTER ORGANIZATION AND ARCHITECTURE

(4 credits – 60 hours) (L-T-P:4-0-0)

Course Outcomes

1. Relate the architecture and organization major components of modern computer systems. (Remembering)
2. Explain the functioning and interconnection of major components of computer systems. (Understanding)
3. Apply different design issues associated with the design of any architecture. Apply their logic in designing simple control unit, instruction sets, instruction format, buses and register set etc. (Applying)
4. Compare and Analyse different styles, strategies and formats adopted for designing the instruction set, register set, memory organization etc. (Analysing)
5. Assess various architectures and their design considerations. (Evaluating)
6. Construct and organize a new architecture by considering various design issues in order to make it more efficient with less overhead. (Creating)

Module I Introduction (10 hours)

Number representation; fixed and floating point number representation, IEEE standard for floating point representation. Error detection and correction codes: Hamming code. Digital computer generation, computer types and classifications, functional units and their interconnections, buses, bus architecture, types of buses and bus arbitration. Register, bus and memory transfer.

Module II Central Processing Unit (10 hours)

Addition and subtraction of signed numbers, look ahead carry adders. Multiplication: Signed operand multiplication, Booth's Multiplication Algorithm; Division Algorithm and array multiplier. Division and logic operations. Floating point arithmetic operation, Processor organization, general register organization, stack organization and addressing modes.

Module III Control Unit (12 hours)

Instruction types, formats, instruction cycles and subcycles (fetch and execute etc), micro- operations, execution of a complete instruction. Hardwire and microprogrammed control: microprogramme sequencing, wide branch addressing, and microinstruction with next address field, pre-fetching microinstructions, concept of horizontal and vertical microprogramming. Control Memory, Control Word, Microinstruction, Microprogram, Mapping of Instructions; Instruction Formats (Three- Address Instructions, Two-Address Instructions and Zero-Address Instructions); Addressing modes.

Module IV Memory (10 hours)

Basic concept and hierarchy, semiconductor RAM memories, 2D and 2 1/2D memory organization. ROM memories. Cache memories: concept and design issues (performance, address mapping and replacement) Auxiliary memories: magnetic disk, magnetic tape and optical disks Virtual memory: concept implementation.

Module V Input / Output (10 hours)

Input Output Interface, I/O Bus, Memory Bus, Isolated I/O, Memory-Mapped I/O; Asynchronous Data Transfer, Strobe Control, Handshaking; Modes of Transfer- viz. Direct Memory Access, Programmed I/O, and Interrupt-Initiated I/O; Priority Interrupt (Daisy-Chain Priority, Parallel Priority Interrupt, Priority Encoder); Input-Output Processor; Serial Communication(Character-Oriented Protocol and Bit-Oriented Protocol).

Module VI Pipelining (8 hours)

Basic Concepts, performance, floating point arithmetic, operations, instruction pipelining in RISC, pipelining in computer arithmetic, Data Hazard, Instruction hazard, Influence on Instruction set, datapath and controls consideration, Superscalar Operation.

Suggested Readings

1. M. Morris Mano, Computer System Architecture, Third Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.

2. V. Carl Hamacher, Zvonko G. Vranesic and Safwat G. Zaky, Computer Organization, Fourth Edition, McGraw Hill, 1996
3. William Stallings, Computer Organization and Architecture, Sixth Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2002

Mapping of COs to Syllabus

Course Outcome	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO1	M	H		M	M	
CO2	M	H			H	
CO3			H			
CO4		H		H		
CO5		H		M	M	
CO6						H

CSOS0170: OPERATING SYSTEMS

(4 credits – 60 hours) (L-T-P:4-0-0)

Course Outcomes

1. Elaborate what operating systems are, what they do and how they are designed and constructed. (Creating)
2. Define process concept like process scheduling, inter-process communication, process synchronization and concurrency. (Remembering)
3. Explain different memory management schemes, relate various approaches to memory management and effectiveness of a particular algorithm. (Understanding)
4. Identify different page replacement algorithms to solve problems. (Applying)
5. Explain how the file system, mass storage and I/O are handled in a modern computer system. (Remembering, Understanding)
6. Analyze the mechanisms necessary for the protection and security of computer systems. (Analysing)

Module I (15 hours)

a. Introduction to operating systems, Simple batch system, Multiprogramming and time sharing systems, Personal computer systems, Parallel systems, Distributed systems and Real time systems.
b. Operating system structures: System components, protection system, OS services, System calls.
c. Process management: Process concept, Process scheduling, Operation on processes, Cooperating processes, Interprocess communication, Threads CPU scheduling: Basic concepts, scheduling criteria, scheduling algorithms.

Module II (15 hours)

a. Deadlocks: System model, Deadlock characterization methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, recovery from Deadlock. b)Memory Management: Background, Logical versus physical address space, Swapping, Contiguous allocation, Paging, Segmentation.
b. Virtual Memory: Background, Demand paging, Performance of demand paging, Page replacement, Page replacement algorithms, Allocation of frames, Trashing.

Module III (15 hours)

File-system Interface: File concept, Access methods, Allocation methods, Directory implementation, Recovery.

Module IV (15 hours)

a. I/O Systems: Overview, I/O hardware, Application of I/O interface, Kernel I/O - subsystem, Transforming I/O requests to hardware operations.
b. Secondary storage structure: Disk structure, Disk scheduling, Disk management, Swap space management, Disk reliability, Case studies LINUX, WINDOW NT.

Suggested Readings

1. Abraham Silberschatz, Peter Bear Galvin, Operating system concepts, Addison Wesley.
2. Madnik and Donovan, Operating systems, McGraw Hill.
3. Andrew, S. Tannenbaum, Modern operating system, PHI.
4. Harvey M. Deitel, Operating Systems, Second Edition, Pearson Education Pvt. Ltd.
5. William Stallings, Operating Systems, Prentice Hall of India.
6. Pramod Chandra P. Bhatt – An Introduction to Operating Systems, Concepts and Practice, PHI.

Mapping of COs to Syllabus

Course Outcome	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2	H			

CO 3		H		
CO 4		H		
CO 5			H	M
CO 6			M	H

CSRA0173: INTRODUCTION TO RASPBERRY PI AND ARDUINO

(2 credits – 30 hours) (L-T-P:2-0-0)

Course Outcomes

At the end of this course students will demonstrate the ability to:

CO1: Recognize the characteristics of Arduino and Raspberry Pi. (Remembering)
CO2: Describe the pin configuration for Arduino and Raspberry Pi (Understanding)
CO3: Classify various sensors and actuators for Arduino and Raspberry Pi.(Analysing)
CO4: Interpret the basics of IoT by the knowledge of communication techniques and protocols. (Evaluating)
CO5: Apply the basics of Arduino and Raspberry Pi in interpretation of IoT. (Applying).
CO6: Design a IoT applications for solving real world problems. (Creating).

Syllabus

Module I: Overview of Arduino (6 Hours)

Introduction of Arduino, prototyping environment, electronic components overview, Arduino development environment, Arduino Schematics, Arduino IDE, Compiling Code, Arduino Shields, and Libraries

Module II: Overview of Raspberry Pi (8 hours)

Introduction of Raspberry Pi, basic functionalities of Raspberry Pi board and processor, configuration of Raspberry Pi board, Comparison Rpi model with other models like Arduino, Asus thinker etc., Pin description of Raspberry Pi, on-board components of Rpi.

Module III: Sensors and actuators for Arduino (8 hours)

How **Sensors** Work, Analog and Digital Sensors, Pull-Up/Down resistors and Examples of sensors, connecting different sensors such as: Humidity, Heat/Temperature, proximity, IR Motion, Accelerometer, Sound, Light, distance, Pressure, Thermal, Infrared, LDR etc. to Arduino Board, Pulse Width Modulation, **Actuators**, Relay Switch, Servo Motor, Putting Things Together, Sensing the World, Reading from Analog Sensors, Making Sounds, Sending Bits, Master Communication, Slave Operation

Module IV: Sensors and actuators for Raspberry Pi (8 hours)

Sensors Interfacing- Temperature and Humidity Sensor (DHT11), Motion Sensor (PIR), Obstacle detection using Ultrasonic sensor, etc. Communicating using RPi- GSM interfacing, accessing on-board Wi-Fi Connecting Database with RPi, integration of RPi with Arduino board. LAMP Web-server, GPIO Control over Web Browser, Creating Custom Web Page for LAMP, communicating data using on-board module, home automation using Pi, Node-RED, MQTT Protocol, Using Node-RED Visual Editor on RPi

Suggested Reading

1. Tim Cox, Raspberry Pi Cookbook for Python Programmers, Packt Publishing Limited, 2014.
2. Eben Upton and Gareth Halfacreee, Raspberry Pi User Guide, John Wiley & Sons, 2016.
3. Michael Margolis, Brian Jepson, Nicholas Robert Weldin, Arduino Cookbook, 3rd Edition, O'Reilly Media, Inc., 2020.
4. John Baichtal, Arduino for Beginners: Essential Skills Every Maker Needs, Que Pub, 2013.

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4
CO 1	H	H		
CO 2	H	H		
CO 3			H	H
CO 4			H	H
CO 5			H	H

CO 6			H	H

CSIP0174: IOT PLATFORM AND SYSTEM DESIGN
(4 Credits – 60 hours)

Course Outcomes

CO1: Recall the fundamental concepts of IoT. (Remembering)
CO2: Explain the hardware and connectivity technologies used in IoT. (Understanding)
CO3: Apply IoT technologies in given applications. (Application)
CO4: Recommend the hardware, connectivity and communication technologies for a given scenario. (Evaluation)
CO5: Develop IoT applications to solve real world problems. (Creating)

Module I (11 hours)
IoT Networking Core Technologies involved in IoT development, Internet web and Networking technologies, Infrastructure, Overview of IoT supported Hardware platforms such as: Raspberry pi, ARM Cortex Processors, Arduino and Intel Galileo boards, Wireless networking equipment and configurations, accessing hardware and device file interactions.

Module II (14 hours)
M2M to IoT Role of M2M in IoT, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Module III (12 hours)
IoT Architecture - State of the Art IoT reference Model and Architecture- Functional View, Information View, Deployment and Operational View, Other Relevant architectural views, Middleware Introduction-FiWare etc., Remote monitoring and sensing, remote controlling and performance analysis, layering concepts, communication pattern, 6LoWPAN, Sensors and sensor Node and interfacing using any Embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino)

Module IV (13 hours)
IoT Application Development Application protocols: MQTT, REST/HTTP, CoAP, MySQL, Back-end Application Designing Apache for handling HTTP Requests, MongoDB Object type Database, HTML, CSS & jQuery for UI Designing, JSON lib for data processing, Security & Privacy during development

Module V (10 hours)
IoT Security and case studies Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities

Suggested Readings
1. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT.
2. Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things”, John Wiley and Sons.
3. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, Apress Publications.
4. CunoPfister, “Getting Started with the Internet of Things”, O’Reilly Media.
5. Zach Shelby, Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, John Wiley and Sons.
6. Dr. OvidiuVermesan, Dr. Peter Friess, “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers.

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4	Module 5
CO1	L	H	H	L	
CO2	L	H	H	L	
CO3	H	M	M	H	
CO4	H	M	M	H	
CO5					H

CSSS0175: SMART SENSOR AND SENSOR NETWORKING
(4 Credits-60 Hours)

Course Outcomes
CO1: To recall the basic concept of smart sensors and applications; (Remembering)
CO2: Explain the smart sensor term; to know its characteristics, architecture, software level and applications; (Understanding)
CO3: To apply different data gathering technology, energy model and security applications, reliability and fault tolerance; (Application)
CO4: To analyse the use of different smart sensors and to design a sensor network. (Analyse)
CO5: To create an efficient sensor network (Create)

Module I (13 hours)
Smart sensors fundamentals: Basic sensor technology Sensor systems; Smart sensors definitions;

Smart sensors: Characteristics; Smart sensors architectures; Smart sensors buses and interfaces; Smart sensors software; Data acquisition methods for smart sensors; Virtual sensor systems; Smart sensors for electrical and non-electrical variables; Operating systems for sensor networks;

Module II (13 hours)
Sensor networks architectures: Single node architecture; Multi node architectures; Design principles; Energy efficient topologies; Wired sensor networks and wireless sensor networks; Applications;
Sensor networks standards; platforms and tools: IEEE 802.15.4 and IEEE 802.11; Berkeley motes; Operating systems, application domains of sensor networks. enabling technologies: hardware/software platforms

Module III (17 hours)
Communication protocols: Physical layer; MAC protocols; Link layer protocols; Localization and positioning; Routing protocols; Transport layer; wireless sensor architecture and protocol stack. stack layers: roles and challenges. network capacity, routing in sensor network, Localization and Synchronization, sensor fusion paradigms, distributed sensor networks

Module IV (17 hours)
Data gathering and processing: Protocols for gather information; Data processing techniques; Routing and information aggregation in sensor networks
Energy management: Energy consumption of sensor nodes; Techniques for reducing consumption and communication energy; Energy aware routing;
Security, reliability and fault-tolerance: Security and privacy protection; Reliability support; Fault-tolerance;

Suggested Readings
1. Anna Hac, "Wireless Sensor Network Designs," John Wiley & Sons, December 2003, 391 pages.
2. Edgar H. Callaway, Jr. and Edgar H. Callaway, "Wireless Sensor Networks: Architectures and Protocols," CRC Press, August 2003, 352 pages
3. N. V. Kirianaki, S. Y. Yurish, N. O. Shpak V. P. Deynega: Data Acquisition and Signal Processing for Smart Sensors, John Wiley, 2004
4. H. Karl, A. Willig: Protocols and Architectures for Wireless Sensor Networks, John Wiley, 2005
5. M. Ilyas, I. Mahgoub (ed.): Handbook of Sensor Networks: Compact Wireless and Wired Sensing Systems, CRC, 2004

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4
CO 1	H	M		
CO 2	L	H	M	
CO 3		M	H	
CO 4			M	H
CO 5			M	H

CSDA0176: DATA ANALYTICS
(4 credits-60 Hours)(L-T-P: 4-0-0)

Course Outcomes:
CO1: Recall the fundamentals of data analysis and their types. (*Remembering*)

CO2: Explain the use of machine learning methods in data analysis. (Understanding)
CO3: Apply various data analytics models to analyse real world data. (Applying)
CO4: Compare various techniques used for Social Media Analytics, Big Data Analytics. (Analysing)
CO5: Integrate Data Science capabilities into the formation of situation analysis (Evaluating)
CO6: Formulate and use appropriate models of data analysis to solve hidden solutions to business-related challenges (Creating)

Module I: Introduction to Data Analytics (13 Hours)

Data Analytics Life Cycle, Types of Data Analysis: primary types of data analysis including, descriptive, predictive, diagnostic, and exploratory, Characteristics of Data Analytics, Applications of Data Analysis, Types of Jobs in Data Analytics.

Module II: Statistical Data Analysis and Machine Learning (15 Hours)

Overview of Machine Learning, Regression Methods (Ordinary least squared, Lasso and Ridge Regression), Classification Methods: KNN Classificationand Decision Tree Classification); Unsupervised Machine Learning - Clustering Methods (K-Means, Fuzzy c-means Clustering). Principal Component Analysis (PCA) Clustering), ANOVA.

Module III: Supervised Learning with Regression and Classification (16 Hours)

Bias-Variance Dichotomy, Model Validation Approaches, Logistic Regression, Linear Discriminant Analysis, Quadratic Discriminant Analysis, Support Vector Machines. Neural Networks, Ensemble Learning: Random Forest, Deep Learning: Convolutional Neural Network, Recurrent Neural Network, LSTM.

Module IV: Social Media Analytics, Business Analytics, and Big Data Analytics (16 Hours)

Social Media Analytics: Overview of Social Media Analytics, Seven Layers of Social Media Analytics, Social Network Analysis (Link Prediction, Community Detection, and Influence Maximization), Text Analytics/Mining (Text Categorization, Document or Text Summarization, and Sentiment Analysis), Trend Analytics Business Analytics: An Overview of Business Analytics, The Business Analytics Life Cycle, Basic Tools Used in Business Analytics, Financial Analytics, Market Analytics, Customer Analytics, and Employee Analytics Big Data Analytics: An Overview of Big Data, Hadoop, Hadoop Distributed File System, Interacting with HDFS from Python Applications.

Suggested Readings:

1. Vijay Kotu ,Bala Deshpande, Data Science: Concepts and Practice, second Edetion, Morgan Kaufmann
2. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk from The Frontline. O'Reilly.
3. Glenn J. Myatt, Making Sense of Data: A Practical Guide to Exploratory Data Analysis and Data Mining, Wiley.
4. Joel Grus, Data Science from Scratch, O'Reilly.
5. Davy Cielen, Arno D. B. Meysman, Mohamed Ali, Introducing Data Science Big Data, Machine Learning, And More, Using Python Tools, Manning publications.
6. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press.
7. Hadley Wickham, Garrett Grolemund, R for data science: Import, Tidy, Transform, Visualize, And Model Data, O'Reilly.
8. Rafael A. Erizarry. Introduction to data science: Data Analysis and Prediction Algorithms, CRC Press.

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2		H	H	
CO 3		M	M	H
CO 4				H
CO 5		M	M	M
CO 6		M	M	H

MADM0025: DISCRETE MATHEMATICS WITH APPLICATIONS

(4 credits – 60 hours)

Course Outcomes

1. Interpret a given logic sentence in terms of predicates, quantifiers, and logical connectives. (Understanding)
2. Solve a given problem using deductive logic and prove the solution based on logical inference. (Applying)
3. Classify the algebraic structure for a given a mathematical problem. (Analysing)

4. Evaluate Boolean functions and simplify expressions using the properties of Boolean algebra (Evaluating)
5. Develop the given problem as graph networks and solve with techniques of graph theory. (Creating)

Module I: Sets, Relation and Function (14 lectures)
Operations and Laws of Sets, Cartesian Products, Binary Relation, Partial Ordering Relation, Equivalence Relation, Image of a Set, Sum and Product of Functions, Bijective functions, Inverse and Composite Function, Size of a Set, Finite and infinite Sets, Countable and uncountable Sets, Cantor's diagonal argument and The Power Set theorem, Schroeder-Bernstein theorem. Principles of Mathematical Induction: The Well-Ordering Principle, Recursive definition, The Division algorithm: Prime Numbers, The Greatest Common Divisor: Euclidean Algorithm, The Fundamental Theorem of Arithmetic.

Module II: Introduction to Counting (8 lectures)
Basic counting techniques-inclusion and exclusion, pigeon-hole principle, permutation and combination.

Module III: Propositional Logic: (12 lectures)
Syntax, Semantics, Validity and Satisfiability, Basic Connectives and Truth Tables, Logical Equivalence: The Laws of Logic, Logical Implication, Rules of Inference, The use of Quantifiers. Proof Techniques: Some Terminology, Proof Methods and Strategies, Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof of Necessity and Sufficiency.

Module IV: Algebraic Structures and Morphism (14 lectures)
Algebraic Structures with one Binary Operation, Semi Groups, Monoids, Groups, Congruence Relation and Quotient Structures, Free and Cyclic Monoids and Groups, Permutation Groups, Substructures, Normal Subgroups, Algebraic Structures with two Binary Operation, Rings, Integral Domain and Fields. Boolean Algebra and Boolean Ring, Identities of Boolean Algebra, Duality, Representation of Boolean Function, Disjunctive and Conjunctive Normal Form

Module V: Graphs and Trees (12 lectures)
Graphs and their properties, Degree, Connectivity, Path, Cycle,Sub Graph, Isomorphism, Eulerian and Hamiltonian Walks, Graph Colouring, Colouring maps and Planar Graphs, Colouring Vertices, Colouring Edges, List Colouring, Perfect Graph, definition properties and Example, rooted trees, trees and sorting, weighted trees and prefix codes, Bi-connected component and Articulation Points, Shortest distances.

Suggested Readings

1. Kenneth H. Rosen, Discrete Mathematics and its Applications, Tata McGraw – Hill
2. Susanna S. Epp, Discrete Mathematics with Applications,4th edition, Wadsworth Publishing Co. Inc.
3. C L Liu and D P Mohapatra, Elements of Discrete Mathematics A Computer Oriented Approach, 3rd Edition by, Tata McGraw – Hill.
4. J.P. Tremblay and R. Manohar, Discrete Mathematical Structure and Its Application to Computer Science", TMG Edition, Tata Mcgraw - Hill
5. Norman L. Biggs, Discrete Mathematics, 2nd Edition, Oxford University Press.
6. Discrete Mathematics, Schaum's Outlines Series, Seymour Lipschutz, Marc Lipson, Tata McGraw – Hill

Mapping of COs to syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H				
CO 2		H			
CO 3			H		
CO 4			M	H	
CO 5					H

LABORATORY COURSES

CSNT6086: COMPUTER NETWORKS LAB

(2 credits)

Course Outcomes

1. Recall different basic networking commands and utilities and lean different network topologies and associated network terminologies such as routing tables, ARP table etc. (Remembering)
2. Distinguish different header values of different layer protocols in a packet by using tools such as Wireshark, tcpdump etc. (Analyzing)
3. Interpret the knowledge to view fragmentation, segmentation behavior of packets in a network. (Understanding)
4. Apply the knowledge to analyze fragmentation, segmentation behavior of packets in a normal network and hybrid network demanding special flag value set. (Applying)
5. Design network topology implementing different routing protocols that best suits a real time demand. (Creating)
6. CO6: Judge which protocol operates in which layer and why by analyzing and observing network traces. (Evaluating)

Mapping of COs to Syllabus

Course Outcomes	M1	M2	M3	M4	M5
CO1			H		
CO2		H			H
CO3	L		H	H	
CO4	H		M	H	H
CO5			H		
CO6	M	H	L	H	

CSCD6085: COMPILER DESIGN LAB

(2 credits)

Course Outcomes

1. Recall and illustrate the different syntax of compiler construction tools like LEX and YACC. (UNDERSTANDING, REMEMBERING)
2. Experiment with regular expression to match the pattern. (APPLYING)
3. Solve various problem using LEX and YACC. (CREATING)
4. Interpret the techniques of parsing practically. (UNDERSTANDING)
5. Analyze different rules using standard parser generator YACC. (ANALYZING)
6. Evaluate problems using both LEX and YACC together. (EVALUATING)

Module I

1. Introduction to LEX and YACC. Preferable on UNIX but any other version is also acceptable.
2. Writing simple scanner for accepting and validating floating point numbers and fixed point numbers
3. Writing simple scanners for tokenizing C or BASIC programs. The Program will output the list of token to a file and classify them by type of token
4. Writing a program to pick out comments in a C ++ program or a JAVAProgram

Module II

1. Developing a rudimentary C Preprocessor capable of handling the “define, ifdef, ifndef, include” directives. More ambitious students can implement substitution of Macros with arguments.
2. Converting simple finite Automata into programs.
3. Write a program using LEX to find number of character, words and lines in an input file
4. Write a program using LEX to find all the words starting with a specific alphabet
5. Write a program using LEX to find number of comment lines in a C input file.
6. Write a program using LEX to identify an identifier.
7. Write a program using LEX to extract all the numbers from an input string.
8. Write a program using LEX to find and display all the floating point numbers from an input string.

Module III

1. Using LEX find a specific word and reverse the same and display.
2. Using LEX, display a word in pyramidal order.
3. Write a program to identify shortest string from an input file and reverse the string.
4. Find all the even numbers and find their summation.

5. Find the largest number from an input string and reverse it.
6. Find all vowels from an input string
7. Using LEX find the summation of mathematical series.
8. Write a program to recognize the language {a,b,ab,aab,aaab,……….}
9. Find all the numbers from an input file and check whether these are Armstrong number or not.
10. Extract all the words ending with punctuation symbol/
11. From a C source file, extract the following syntax,
    a. Printf("Anything");
12. From a C source file, validate the format of "For loop".
13. From a C source file, validate the format of "Do – while loop".
14. From a C source file, validate the format of "If –then-else " statement.
15. Validate the email address using LEX
16. Identify an input number as binary number and convert it to its corresponding decimal Number

Module IV

1. Implementation of YACC for various parser to parse string
2. Using YACC, develop a simple calculator for various arithmetic operation
3. Validate a phone number with respect to ISD code, STD code and 6 digit number. If it s validated then reverse the number (excluding ISD and STD code)
4. Find and display all the keywords from a C input file

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2		H		
CO 3		M	H	
CO 4			M	H
CO 5				M
CO 6			M	M

CSPL6069: PROGRAMMING FOR PROBLEM SOLVING LAB

(2 credits)

Course Outcomes

1. Relate the programming logic (Remembering)
2. Illustrate the theoretical concepts learnt in C programming language. (Understanding)
3. Apply existing algorithms in writing programs using C language and also do graphics programming. (Applying)
4. Analyze their skills for choosing the right data structure, functions, data types and develop logic to write programs in C. (Analyzing)
5. Evaluate the sorting and searching algorithms through implementation in terms of correctness and computation cost. (Evaluating)
6. Combine the various concepts and ideas leant in C to plan, propose and develop a product. (Creating)

Mapping of COs to Syllabus

Course Outcomes	M1	M2	M3	M4	M5	M6
CO1	H				L	
CO2	H	H				
CO3				H	M	
CO4	L				H	H
CO5	M	L		H		
CO6			H		H	M

CSOP6070: OBJECT ORIENTED PROGRAMMING LAB

(2 credits)

Course Outcomes

1. List various GUI and thus will be able to select the suitable GUI to resolve a given problem. (Remembering)
2. Compare the various utility class like vector, stack, Hash Table, String Tokenizer, etc. (Understanding)
3. Apply their knowledge to solve practical problems like reading from a dataset, writing into a file and develop games using JAVA program. (Applying)

4. Analyse the efficiency of various programs with respect to time and space complexity. They will also be able to modify a weak program into a more efficient one. (Analyzing)
5. Evaluate the performance of various swing GUI components and design various applications using Swings, depending upon the problem domain. (Evaluating)
6. Design various methods for drawing lines, rectangles, polygons and ovals and based on their practical knowledge will be able to develop cost effective and user-friendly applications. (Creating)

List of Experiments:
1. Program on concept of classes and objects.
2. Programs on use of memory management.
3. Programs using polymorphism – i) operator overloading ii) Dynamic binding
4. Programs on use of operator overloading.
5. Programs on exception handling and use of templates.
6. Programs on file handling
7. Design problem on stock and accounting of a small organization, railway reservation, payroll preparation and optimization problem.

Mapping of COs to Syllabus

Course Outcomes	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7
CO1	H		M	M			
CO2		M	H				
CO3					M	H	
CO4		H			H		L
CO5					H		
CO6		L		H			H

CSDE6109: DIGITAL ELECTRONICS LAB
(2 credits)

Course Outcomes
1. Recall the truth table of all logic gates. (Remembering)
2. Explain the working of combinational and sequential logic circuits. (Understanding)
3. Model the structure and behavior of digital logic circuits using hardware description language. (Applying)
4. Illustrate the truth table and timing diagram for combinational and sequential logic circuits. (Analysis)
5. Design combinational and sequential logic circuits for given problem statements. (Creating)

List of Experiments
1. To study the Truth tables of logic gates
2. To realize half/full adder and half/full adder subtractor
3. Simulation with VDHL
   a. Adders
   b. Subtractors
   c. Logic gates
   d. MUX and DEMUX

Mapping of Cos to syllabus

Course Outcomes	Experiment 1	Experiment 2	Experiment 3
CO 1	H		
CO 2	H	M	
CO 3	H	M	
CO 4		H	L
CO 5			H

CSDS6072: DATA STRUCTURE AND ALGORITHM LAB
(2 credits)

Course Outcomes
1. Explain the concept of different data types, primitive, derived and their representation and application through coding. (Understanding)
2. Apply the concept of ADT and linear and nonlinear data types and their representation. (Applying)

3. Apply these data types in various applications like arithmetic expression evaluation and conversion. (Applying)
4. Explain the concept of Graphs and Trees and their real time application. (Understanding)
5. Develop various searching and sorting techniques. (Creating)
6. Choose and implement efficient data structures and apply them to solve problems. (Evaluating)

Solution of problems on
1. dynamic memory allocation
2. structures and pointers to structures
3. Arrays
4. Stacks and Stack application, Queues
5. Linked Lists, Circular and Doubly Linked Lists.
6. Binary Trees
7. Searching and data modification: Linear Search, Binary Search, Hashing.
8. Sorting Techniques: Selection, Insertion, Bubble, Merge, Heap, Quick, Radix, and Merge-Sort.

Mapping of Cos to syllabus

Course Outcomes	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8
CO1	H	M	M					
CO2	H	H	H					
CO3			M	H	M			
CO4				H	H	M		
CO5				L	M	H		
CO6							H	H

CSRD6074: DATABASE MANAGEMENT SYSTEMS LAB
(2 credits)

Course Outcomes
1. Define various types of SQL commands and structure of PL/SQL programming (Remembering)
2. Explain which command would be used for a given query (Understanding)
3. Apply correctly use the techniques, components and tools of a typical database management system to build a comprehensive database information system (Applying)
4. Apply SQL commands and PL/SQL programs to solve problems related to database tables. (Applying)
5. Compare and contrast the various ways of solving a query for optimization. (Analysing)
6. Evaluate and justify the database designed for any database project (Evaluating)
7. Design schema diagrams for handling database projects (Creating)

(10 different Programs to be created and executed on the following areas)
1. Use of SQL Syntax: Insertion, Deletion Join), Updating using SQL.
2. Program segments in embedded SQL using C as host language to find the average grade point of a student, etc.
3. Program for Log based data recovery technique.
4. Program on data recovery using check point technique.
5. Concurrency control problem using lock operations.
6. Use of package (ORACLE) for programming approaches.
7. Use of package (DB2) for programming approaches.
8. Programs on JDBC/ODBC to employee’s / student’s information of a particular department.

Mapping of COs to Syllabus

Course Outcomes	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8
CO 1		H						
CO 2	H	M						
CO 3		M		M	H			H
CO 4	H	H						
CO 5			H					
CO 6			M	H	H			
CO 7			M			H	H	M

CSAD6075: DESIGN AND ANALYSIS OF ALGORITHMS LAB

(2 credits)

Course Outcomes

1. List existing algorithms and recall how to analyse them using graph notation. (Remembering)
2. Demonstrate the existing algorithms. (Understanding)
3. Apply existing algorithms in designing different applications. (Applying)
4. Analyze execution time of standard algorithms. (Analyzing)
5. Evaluate algorithms in terms of time and space efficiency. (Evaluating)
6. Create efficient applications by using right algorithm depending on input pattern and size. (Creating)

Syllabus

1. Using Graph notation to prove that bubble sort algorithm has time complexity (n^2)
2. Implement the Dynamic programming technique and Analyse the algorithm using the graph notation.
3. Implement the Greedy programming technique and Analyse the algorithm using the graph notation.
4. Implement the Divide and Conquer technique and Analyse the algorithm using the graph notation.
5. Design a small file compressor and de-compressor by using Huffman coding technique

Mapping of COs to Syllabus

Course Outcomes	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5
CO 1	H				
CO 2		H		H	
CO 3			H		
CO 4		M	M	M	
CO 5					H
CO 6					M

CSDT6076: ADVANCED DATA STRUCTURES LAB

(3 Credits)

Course Outcomes:

1. Demonstrate and explain the various operations of Binary search trees. (Understanding)
2. Develop a program to implement B-Trees and 2-3 Trees. (Applying)
3. Develop a program and test for the pattern matching algorithms like Bayer-Moore and Knuth-Morris-Pratt algorithms. (Creating)
4. Demonstrate the implementation of compression algorithms using program. (Understanding)
5. Develop algorithms for text processing applications. (Creating)

Program List:

Experiment No. **Module 1**	**List of Experiments**
1	Implementation of BST and AVL trees.
2	Implementation of 2-3 trees, B-trees.
3	Implementation of Red Black Trees
Module 2	
4	Pattern matching using Boyer-Moore algorithm.
5	Knuth-Morris-Pratt algorithm for pattern matching.
Module 3	
6	Huffman Algorithm for data compression.
7	Finding Longest Common Subsequence using a dynamic programming technique.
8	Implementation of Standard tries, Suffix tries and Compressed tries
Module 4	
9	Construction of Priority Search Trees, Searching in a Priority Search Tree.
10	Construction of Priority range Trees
Module 5	
11	Implementation of Quad Trees

Suggested Readings:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson, 2004.
2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					
CO 2		H				
CO 3			M			
CO 4				H	M	
CO 5						H

CSAA6078: ADVANCED ALGORITHM LAB

(3 Credits)

Course Outcomes

1. Recall and explain the fundamentals of design and analysis of basic data structures and experiment with the implementation process. (Remembering, Understanding, Applying)
2. Examine and evaluate the concepts in the specification and analysis of programs. (Analysing, Evaluating)
3. Elaborate the principles for good program design, especially the uses of data abstraction. (Creating)

Module 1:

1. Program to find Breadth First Search of a graph.
2. Program to find Depth First Search of a graph.
3. Program to find strongly connected components of a graph.
4. Implement Prim's algorithm to find a minimal spanning tree of a graph.
5. Implement Kruskal's algorithm to find a minimal spanning tree of a graph.
6. Implement Dijkstra's algorithm to find the shortest path in a graph.

Module 2:

1. Implementation of algorithms to compute a maximum weight maximal independent set.
2. Implementation of graph matching algorithms.
3. Implementation of Ford-Fulkerson Method to compute maximum flow.
4. Implementation of Edmond-Karp maximum-flow algorithm.

Module 3:

1. Implement Strassen's Algorithm.
2. Implement Floyd Warshall Algorithm.

Mapping of COs to Syllabus:

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H	M	
CO 2	M	H	M
CO 3		M	H

CSDV6079: DATA VISUALISATION LAB

(2 credits)

Course Outcomes

1. Recall the design process to develop visualization methods and visualization systems, and methods for their evaluation. (Remembering)
2. Create and process data and visual mapping and the visualization (Creating).
3. Illustrate an understanding of large-scale abstract data. (Understanding)
4. Analyse data in various perspectives. (Analysing)
5. Evaluate the results generated from various applications. (Evaluating)
6. Create visualization methods for different applications. (Creating)

List of Experiments

1. Program to recursively subdivide a tetrahedron to form a 3D Sierpinski gasket. The number of recursive steps is to be specified by the user.
2. Program to implement Liang-Barsky line clipping algorithm.
3. Program to draw a color cube and spin it using OpenGL transformation matrices.
4. Program to create a house-like figure and rotate it about a given fixed point using OpenGL functions.
5. Program to implement the Cohen-Sutherland line-clipping algorithm. Make provision to specify the input line, window for clipping and view port for displaying the clipped image.

6. Program to create a cylinder and a parallelepiped by extruding a circle and quadrilateral respectively. Allow the user to specify the circle and the quadrilateral.
7. Program, using OpenGL functions, to draw a simple shaded scene consisting of a teapot on a table. Define suitably the position and properties of the light source along with the properties of the properties of the surfaces of the solid object used in the scene.
8. Program to draw a color cube and allow the user to move the camera suitably to experiment with perspective viewing. Use OpenGL functions.
9. Program to fill any given polygon using scan-line area filling algorithm. (Use appropriate data structures.)
10. Program to display a set of values {fij} as a rectangular mesh. Project: 11. Develop a suitable Graphics package to implement the skills learnt in the theory and the exercises indicated in Part A. Use the OpenGL..
11. Program to recursively subdivide a tetrahedron to form 3D Sierpinski gasket. The number of recursive steps is to be specified by the user.
12. Program to implement Liang-Barsky line clipping algorithm.
13. Program to draw a color cube and spin it using OpenGL transformation matrices.
14. Program to create a house-like figure and rotate it about a given fixed point using OpenGL functions.
15. Program to implement the Cohen-Sutherland line-clipping algorithm. Make provision to specify the input line, window for clipping and view port for displaying the clipped image.
16. Program to create a cylinder and a parallelepiped by extruding a circle and quadrilateral respectively. Allow the user to specify the circle and the quadrilateral.
17. Program, using OpenGL functions, to draw a simple shaded scene consisting of a tea pot on a table. Define suitably the position and properties of the light source along with the properties of the properties of the surfaces of the solid object used in the scene.
18. Program to draw a color cube and allow the user to move the camera suitably to experiment with perspective viewing. Use OpenGL functions.
19. Program to fill any given polygon using scan-line area filling algorithm. (Use appropriate data structures.) Program to display a set of values {fij} as a rectangular mesh.
20. Project: 1. Develop a suitable Graphics package to implement the skills learnt in the theory and the exercises indicated in Part A. Use the OpenGL.

CSEN6080: DATA ENCRYPTION AND COMPRESSION LAB

(3 Credits)

Course Outcomes

1. Recall the different encryption techniques adopted in both traditional and modern cryptographic mechanisms. (Remembering)
2. Interpret cryptographic algorithms, and their countermeasures. (Understanding)
3. Apply fundamental cryptographic approaches in solving related problems. (Applying)
4. Analyse the working of the different encryption and compression algorithms. (Analysing)
5. Compare and contrast the working of different data encryption and compression mechanisms. (Evaluating)
6. Choose appropriate encryption and compression algorithms to build real-world systems. (Creating)

Module 1:

1. Implementation of run length encoding
2. Implementation of Lempel-Ziv coding

Module 2:

1. Implementation of Huffman Encoding of a sequence
2. Implementation of Huffman Decoding of a compressed bit sequence.

Module 3:

1. Implementation of RC4 algorithm.
2. Implementation of S-DES algorithm for data encryption

Module 4:

1. Implementation of RSA Algorithm

Module 5:

1. Implementation of SHA
2. Implementation of MD5

Module 6:
1. Implementation of JPEG algorithm.

Mapping of COs to Syllabus:

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				
CO 2	M	H	M			
CO 3		M	H	M		
CO 4			M	H	M	
CO 5				L	H	M
CO 6					M	H

CSMI6081: MINI PROJECT WITH SEMINAR
(2 Credits)

Course Outcomes
1. Recall the software development life cycle and fundamental phases of system/application/software design and research. (Remembering)
2. Explain how to carry out a project work and explain the importance of different phase of a system design, workflow and time estimation with research outlook. (Understanding)
3. Implement a system and plan how to perform research for real time application along with hardware and softwares. (Applying)
4. Compare the feasibility of a project in terms of time, effort and money.(Analyze)
5. Evaluate a project based on its efficiency applicability robustness, user friendliness etc., with socio economic factors (Evaluating)
6. Design applications by critically examining and scientifically designing each phase of the project.(Creating)

CSOS6082: OPERATING SYSTEMS LAB
(2 Credits)

Course Outcomes
1. Recall and label the basic commands in Linux. (Remembering)
2. Classify system calls, library functions calls to write on standard output device (Understanding)
3. Experiment with shell programs.(Applying)
4. Analyze and compare between different file systems like ext4/FAT/NTFS.(Analyzing)
5. Construct programs on process scheduling, page replacement algorithms.(Creating)
6. Evaluate free space management using programs.(Evaluating)

List of Experiments
1. Simple Unix-C programs: Programs using system calls, library function calls to display and write strings on standard output device and files.
2. Programs using fork system calls.
3. Programs for error reporting using errno, perror( ) function.
4. Programs using pipes.
5. Shell programming.
6. Programs to simulate process scheduling like FCFS, Shortest Job First and Round Robin.
7. Programs to simulate page replacement algorithms like FIFO, Optimal and LRU.
8. Programs to simulate free space management.
9. Programs to simulate virtual memory.
10. Programs to simulate deadlock detection.
11. Study of file systems: UNIX/FAT/NTFS.
12. Study of Windows registry.

Suggested readings
E-resource for learning: Linux-Ubuntu, www.spoken-tutorial.org

Mapping of COs to Syllabus

Course Outcomes	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp 10	Exp 11	Exp 12
CO1	H		M			L						
CO2	H	M	M				L					

CO3		H		M	H							
CO4											H	
CO5						H	H			H		
CO6								H	M			M

CSDC6083: DATA COMMUNICATION LAB

(2 Credits)

Course Outcomes

1. Define various networking devices and various networking commands(REMEMBERING)
2. Illustrate different network topology (UNDERSTANDING)
3. Apply different networking protocol in different network topology. (APPLYING)
4. Compare different topology and functioning of different protocols. (ANALYSING)
5. Assess the types of network required for an organization, Depending on availability of hardwares and softwares (CREATING)
6. Construct a HTTP server and implement various commands (EVALUATING)

Experiments can be done using simulation software like CISCO Packet Tracer or any other relevant simulation software or by using hardware.

1. PC-to-PC communications under WinXP/Win98 direct cable connection with null modem
   a. Using serial ports and RS-232 C cable connection, and
   b. Using parallel ports and direct parallel cable connection.
2. PC-to-PC communications under WinXP/Win98 dial-up networking with modem and 4- line exchange.
3. PC-to-PC communications under WinXP/Win98 hyper terminal with modem and 4-line exchange.
4. Simple file transfer between two systems (without protocols): By opening socket connection to a server on one system and sending a file from one system to another.
5. Writing a Chat application:
   a. One-One: By opening socket connection and displaying what is written by one party to the other.

b. Many-Many (Broad cast): Each client opens a socket connection to the chat server and writes to the socket. Whatever is written by one party can be seen by all other parties.

6. Introduction to Packet Tracer
7. Simulation of Telnet: Provide a user interface to contact well-known ports, so that client- server interaction can be seen by the user.
8. TFTP- Client: To develop a TFTP client for file transfer.
9. HTTP-Server: Develop a HTTP server to implement the commands – GET, POST, HEAD, DELETE. The server must handle multiple clients.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M		
CO 2		H	M	
CO 3		H	H	H
CO 4		M	M	
CO 5		M	M	M
CO 6			M	H

CSMI6084: MINI PROJECT I

(2 Credits)

Course Outcomes

1. Recall the software development life cycle and fundamental phases of system/application/software design and research. (Remembering)
2. Explain how to carry out a project work and explain the importance of different phase of a system design, workflow and time estimation with research outlook. (Understanding)
3. Implement a system and plan how to perform research for real time application. (Applying)
4. Compare the feasibility of a project in terms of time, effort and money.(Analyze)
5. Evaluate a project based on its efficiency applicability robustness, user friendliness etc., with socio economic factors (Evaluating)
6. Design applications by critically examining and scientifically designing each phase of the project.(Creating)

CSMI6091: MINI PROJECT II
(2 credits)

Course Outcomes
1. Recall the software development life cycle and fundamental phases of system/application/software design and research. (Remembering)
2. Explain how to carry out a project work and explain the importance of different phase of a system design, workflow and time estimation with research outlook. (Understanding)
3. Implement a system and plan how to perform research for real time application. (Applying)
4. Compare the feasibility of a project in terms of time, effort and money.(Analyze)
5. Evaluate a project based on its efficiency applicability robustness, user friendliness etc., with socio economic factors (Evaluating)
6. Design applications by critically examining and scientifically designing each phase of the project.(Creating)

CSDI6092: DISSERTATION- I / INDUSTRIAL PROJECT
(10 Credits)

Course Outcomes
1. Recall the enhanced research areas which can be undertaken (Remembering).
2. Illustrate the research gap within the topic that he / she undertakes (Understanding).
3. Apply algorithm to solve the problem stated (Applying).
4. Analyse and categorize the data to be collected to carry on with the research (Analysis).
5. To evaluate the outcome which is expected from the research (Evaluating).
6. Create and implement the methodology to have an outcome (Creation).

CSDI6093: DISSERTATION II
(16 Credits)

Course Outcomes
1. Recall and relate desertation phase I to identify the basic problem specific outcome (Remembering).
2. Illustrate the research gap within the topic that he / she undertake (Understanding).
3. Make use of the algorithm implemented in Phase I for accuracy (Application).
4. Compare the results with the existing system to identify its accuracy (Analysis).
5. Evaluate and summarize the outcome which is expected from the research (Evaluating).
6. Creating an outcome based on the methodology implemented (Creation).

CSPP6094: PARALLEL AND DISTRIBUTED ALGORITHMS LAB
(2 credits)

Course Outcomes
1. List the MPI, OpenMP, Pthread, and Java Thread data types and functions. (Remembering)
2. Explain the MPI, OpenMP, Pthread, and Java Thread primitives available for parallel and distributed programming. (Understanding)
3. Apply MPI, OpenMP, and Pthread primitives to implement parallel and distributed programs. (Applying)
4. Analyze errors in parallel/distributed programs due to data races, deadlocks, overlapping buffers, type mismtches, and leaks. (Analyzing)
5. Evaluate the efficiency of given parallel/distributed programs. (Evaluating)
6. Formulate a parallel/distributed approach to solve a given problem. (Creating)

List of Experiments
1. Introduction to distributed memory programming with MPI
2. Introduction to shared memory programming with OpenMP/Pthreads
3. Pthreads: Starting, Running, and Stopping Threads; Producer-Consumer Synchronization and Semaphores; Barriers and Condition Variables
4. Write programs to parallelize the Trapezoidal Rule
5. Write programs to parallelize sorting algorithms
6. Write programs to parallelize Matrix-Vector and Matrix-Matrix Multiplication
7. Write programs to implement multi-threaded linked list
8. Write programs to parallelize tree search
9. Write programs to parallelize n-body solvers

10. Introduction to Java Threads

Suggested Readings
1. Peter Pacheco, An Introduction to Parallel Programming, Morgan Kaufmann, 2011.
2. Michael J Quinn, Parallel Programaming in C with MPI and OpenMP, McGraw Hill, 2017.
3. Ananth Grama, George Karypis, Vipin Kumar and Anshul Gupta, Introduction to Parallel Computing, Pearson Education India, 2004.

Mapping of COs to Syllabus

Course Outcomes	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp 10
CO 1	H	H	H							
CO 2	H	H	H							
CO 3	H	H	H							
CO 4				H	H	H				
CO 5							H	H	H	H

CSAC6095: ADVANCED COMPUTER ARCHITECTURE LAB
(2 credits)

Course Outcomes
1. Describe techniques for building instruction, arithmetic and memory access pipelines. (Remembering)
2. Discuss the basic concepts associated with parallel computing environments, pipelining, and parallel programming. (Understanding)
3. Apply program transformation techniques to remove data dependencies. (Applying)
4. Analyze code segments to identify data dependencies. (Analysing)
5. Assess collision free schedules for pipelines. (Evaluating)
6. Develop programs for different parallel processing models including shared memory programming and distributed computing. (Creating)

List of Experiments
1. Introduction to distributed memory programming with MPI
2. Introduction to shared memory programming with OpenMP/Pthreads
3. Pthreads: Starting, Running, and Stopping Threads; Producer-Consumer Synchronization and Semaphores; Barriers and Condition Variables
4. Write programs to parallelize the Trapezoidal Rule
5. Write programs to parallelize sorting algorithms
6. Write programs to parallelize Matrix-Vector and Matrix-Matrix Multiplication
7. Write programs to implement multi-threaded linked list
8. Write programs to parallelize tree search
9. Write programs to parallelize n-body solvers
10. Introduction to Java Threads

Suggested Readings
1. Peter Pacheco, An Introduction to Parallel Programming, Morgan Kaufmann, 2011.
2. Michael J Quinn, Parallel Programming in C with MPI and OpenMP, McGraw Hill, 2017.
3. Ananth Grama, George Karypis, Vipin Kumar and Anshul Gupta, Introduction to Parallel Computing, Pearson Education India, 2004.

Mapping of COs to Syllabus

Course Outcomes	M1	M2	M3	M4
CO1		H		
CO2	H	M	M	H
CO3			H	
CO4			H	
CO5		H		

CSML6096: MACHINE LEARNING LAB
(2 Credits)

Course Outcomes
1. Apply various classification algorithms to solve classification problem on real world data. (Applying)

2. Apply Clustering algorithms to solve any clustering problem. (Applying)
3. Analyse the performance of various classification algorithms. (Analysing)
4. Select appropriate models for solving a specific problem. (Evaluating)
5. Design neural network based classifiers to classify real world data. (Creating)

List of Experiments
1. Write a program to implement Linear Regression. Use an appropriate dataset to illustrate the working of linear regression.
2. Write a program to implement Decision Tree. Illustrate the classification of sample data using an appropriate dataset.
3. Write a program to demonstrate the classification of sample data using KNN algorithm.
4. Write a program to implement Bayes Classifier for the classification of sample data.
5. Write a program to implement logistic regression for the classification of sample data.
6. Write a program to implement Support Vector Machine. Illustrate the classification of sample data using an appropriate dataset.
7. Write a program to demonstrate the classification of sample data using Random Forest algorithm.
8. Performance analysis of various classification methods using standard matrices applied on confusion matrix.
9. Write a program to implement K-Means Clustering Algorithm.
10. Write a program to implement Agglomerative Clustering Algorithm.
11. Write a program to implement a classifier using MLP. Use appropriate dataset to demonstrate the process of classification.
12. Write a program to implement a sample CNN. Use appropriate dataset to test the performance of the classifier.
13. Implement transfer learning using state of art CNN models. Use appropriate dataset to test the performances of such models.

Mapping of COs to Syllabus

Course Outcome	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp 10	Exp 11	Exp 12	Exp 13
CO 1	H	H	H	H	H	H	H				H	H	
CO 2									H	H			
CO 3								H					H
CO 4											H		H
CO 5											H	H	

CSCC6097: COMPUTATIONAL COMPLEXITY LAB
(2 credits)

Course Outcomes
1. Classify decision problems into appropriate complexity classes, including P, NP, PSPACE and complexity classes based on randomized machine models and use this information effectively. (Understanding)
2. State precisely what it means to reduce one problem to another, and construct reductions for simple examples. (Remembering)
3. Classify optimization problems into appropriate approximation complexity classes and use this information effectively. (Applying)
4. Use the concept of interactive proofs in the analysis of optimization problems. (Applying)

Experiments:
1. Programs to illustrate space complexity, complexity classes, and hierarchy theorems.
2. Problems and proofs on reductions of decision and optimization problems.
3. Problems on randomness in computation, combinatorial optimization problem, polynomial approximations schemes.
4. Proofs such as interactive proofs and their relation to approximation.

Suggested Readings
- Computational Complexity - A Modern Approach, Sanjeev Arora and Boaz Barak, Cambridge University Press, 2009.
- Computational Complexity Theory, Steven Rudich and Avi Wigderson, American Mathematical Society.

Mapping of COs to Syllabus

Course Outcomes	Exp 1	Exp 2	Exp 3	Exp 4
CO 1	H	M		
CO 2	M	H	M	
CO 3		L	H	M

CO 4			L	H

CSDS6098: DISTRIBUTED SYSTEMS LAB
(2 credits)

Course Outcomes:
1. Describe the basic technique of establishing a client-server network using python socket programming. (Remembering)
2. Discuss the basic concepts associated with peer-to-peer networking using python socket libraries. (Understanding)
3. Apply consensus algorithms to a distributed computer network using python language. (Applying)
4. Analyze how common logical clocks can properly synchronize events in a distributed environment. (Analyzing)
5. Assess the map-reduce paradigm used in Hadoop and evaluate the time associated with task completion in such a platform. (Evaluating)
6. Develop programs to solve various problems associated with distributed systems. (Creating)

List of programs:

Module I
Implement client-server application using socket programming.

Module II
Implement peer-to-peer application using socket programming.

Module III
Implement consensus algorithms to allow agreement among processes running in a peer-to-peer environment.

Module IV
Implement algorithms to synchronize clocks to create a common logical clock among peers in a distributed environment.

Module V
Understand the concept of map-reduce and implement it in a distributed environment.

Suggested Readings
P. K. Sinha, *Distributed Operating Systems*: Concepts And Design, PHIG. Coulouris, J. Dollimore and T. Kindberg, Distributed Systems: Concepts And Design, Pearson

Mapping of COs to Syllabus

Course Outcomes	M1	M2	M3	M4	M5
CO1	H	M	L		
CO2	M	H	L		
CO3		L	H	M	
CO4		L	M	H	
CO5					H
CO6		L	H	H	M

CSDM6099: DATA MINING LAB
(2 credits)

Course Outcomes
1. Recall the concepts related to ETL. (Remembering)
2. Interpret the association rules, classification and clusters in large data sets. (Understanding)
3. Perform the preprocessing of data and apply mining techniques on it. (Applying)
4. Solve real world problems in business and scientific information using data mining. (Creating)
5. Classify web pages, extracting knowledge from the web. (Analyzing)
6. Assess data mining techniques and methods to large data sets. (Evaluating)
7. Compare and contrast the various classifiers. (Analyzing)

List of Experiments
1. Creation of a Data Warehouse.
2. Implement Apriori Algorithm.
3. Implement FP-Growth Algorithm.
4. Implement K-means clustering.
5. Implement One Hierarchical clustering algorithm.
6. Implement Bayesian Classification.

7. Implement Decision Tree.
8. Implement Support Vector Machines.
9. Applications of classification for web mining.
10. Case Study on Text Mining or any commercial application.

Mapping of COs to Syllabus

Course Outcomes	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9
CO1	H	M							
CO2		H	M	M					
CO3			H	H	L				
CO4					H				
CO5						M		M	
CO6								H	H
CO7						H	H		

CSCG6100: COMPUTATIONAL GEOMETRY LAB

(2 credits)

Course Outcomes

1. Construct algorithms for simple geometrical problems (Applying)
2. Apply geometric techniques to real-world problems in graphics. (Applying)
3. Analyze computational geometrical algorithms for small domain problems. (Analyzing)
4. Develop efficient computational geometrical algorithms. (Creating)

Implement the following task constructing algorithms in C language.

1. Area of a Polygon
2. Triangulating a polygon
3. Convex Hull in two dimensions
4. Convex Hull in three dimensions
5. Delaunay triangulation
6. Segment/ray-segment intersection
7. Segment/ray-triangle intersection
8. Point in polygon
9. Point in polyhedron
10. Intersecting convex polygons
11. Minkowski convolution with a convex polygon
12. Multilink robot arm reachability

Suggested Readings

1. Computational Geometry in C, Joseph O'Rourke, Cambridge University Press
2. http://www.science.smith.edu/~jorourke/books/ftp.html

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	M			
CO 2		H	M		
CO 3	M	M	H	M	M
CO 4			M	H	

CSAS6101: ADVANCED OPERATING SYSTEMS LAB

(2 credits)

Course Outcomes

1. Demonstrate the understanding on shell designing and scripting (Understanding)
2. Build and experiment with distributed operating systems algorithms (Applying)
3. Recall the basic concepts of distributed mutual exclusions (Remembering)
4. Experiment with the applications of distributed scheduling algorithms (Applying)
5. Construct a multithreaded program to understand the implementation issues of multiprocessor system.(Creating)
6. Design a program to classify and compare the security threats relating to virus (Understanding)

List of Experiments
1. Design and develop a shell that supports atleast 10 commands.
2. Design and develop a program to implement Lamport's algorithm.
3. Use ECOS operating system to develop a program for controlling accessing to a pool of resources using mutexes and condition variables.
4. Develop a program for a forward scheduling for unequal distribution.
5. Design a multi-class multithreaded program which simulates multiple sleeping barbers, wherein all in one barbershop having a finite number of chairs in the waiting room. Each customer is instantiated from a single customer class & each barber is instantiated from a single barber class.
6. Develop a program to identify the virus classification, such as boot sector infector, file infector and macro virus.

Suggested Readings
1. Milan Milenkovic, Operating Systems Concepts and Design, TMH.
2. M. Singhal and N.G. Shivaratri, Advanced Concepts in Operating Systems, TMH.
3. A. Silberschatz, P.B. Galvin and G. Gagne, Operating System Concepts, John Wiley and Sons.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2		H		
CO 3		H		
CO 4		H		
CO 5			H	M
CO 6				H

CSSN6102: SPEECH AND NATURAL LANGUAGE PROCESSING LAB

Course Outcomes
1. List the functions provided by NLTK for natural language processing. (Knowledge)
2. Explain of the various NLTK functions and corpora available for natural language processing. (Understanding)
3. Implement NLTK programs for part of speech tagging, syntax analysis, semantic analysis etc. (Applying)
4. Analyze the structure and meaning of given text. (Analyzing)
5. Evaluate the performance of classifiers used for text classification. (Evaluating)
6. Combine different NLTK functions to build applications for natural language processing and understanding. (Creating)

Module I (4 Hours)
Natural Language Toolkit (NLTK): Installation and getting started; Accessing text corpora; Ngrams; Conditional Freqquency Distribution; Regular expressions for detecting word patterns; Regular expressions for tokenizing text

Module II (3 Hours)
Using a tagger; Tagged corpora; Automatic tagging, Ngram tagging;

Module III (4 Hours)
Classify text; supervised classification; Naive Bayes classifiers; Information extraction; Chunking; Named entity recognition; Relation extraction

Module IV (4 Hours)
Parsing with context free grammars; Dependency grammar; Grammar development; Grammatical features; Processing feature structures; Natural language understanding; Propositional logic; First order logic

Suggested Readings
1. Steven Bird, Ewan Klein, Edward Loper, Natural Language Processing with Python, O'Reilly Media.
2. Jacob Perkins, Python Text Processing with NLTK 2.0 Cookbook, O'Reilly Media.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H	M		
CO2		H	H	
CO3		M		H
CO4			L	H
CO5		L	H	
CO6	L		H	H

CSMP6103: MAJOR PROJECT-PHASE 1
(2 credits)

Course Outcomes
1. Recall the software development life cycle and fundamental phases of system/application/software design and research. (Remembering)
2. Explain how to carry out a project work and explain the importance of different phase of a system design, workflow and time estimation with research outlook. (Understanding)
3. Implement a system and plan how to perform research for real time application. (Applying)
4. Compare the feasibility of a project in terms of time, effort and money. (Analyze)
5. Evaluate a project based on its efficiency applicability robustness, user friendliness etc., with socio economic factors (Evaluating)
6. Design applications by examining and scientifically designing each phase of the project.(Creating)

CSMP6104: MAJOR PROJECT - PHASE II
(3 credits)

Course Outcomes
1. Define and choose the Software Development Life Cycle and fundamental phases of system / application / software design and research. (Remembering)
2. Demonstrate how to carry out a project work and understand the importance of different phases of a system design, workflow and time estimation with research outlook. (Understanding)
3. Construct a system and identify how to perform research for real time application. (Applying)
4. Analyze the feasibility of a project in terms of time, effort and money. (Analyzing)
5. Evaluate a project based on its efficiency, applicability, robustness, user friendliness etc., with socioeconomic impact. (Evaluating)
6. Design applications by examining and scientifically designing each phase of a project work. (Creating)

CSDA6105: DATA STRUCTURES AND ALGORITHM LAB
(1 credit) (L-T-P:0-0-2)

Course Outcomes
1. Explain the concept of different data types, primitive, derived and their representation and application through coding. (Understanding)
2. Apply the concept of ADT and linear and nonlinear data types and their representation. (Applying)
3. Apply these data types in various applications like arithmetic expression evaluation and conversion. (Applying)
4. Explain the concept of Graphs and Trees and their real time application. (Understanding)
5. Develop various searching and sorting techniques. (Creating)
6. Choose and implement efficient data structures and apply them to solve problems. (Evaluating)

Solution of problems on
1. dynamic memory allocation
2. structures and pointers to structures
3. Arrays
4. Stacks and Stack application,Queues
5. Linked Lists, Circular and Doubly Linked Lists.
6. Binary Trees
7. Searching and data modification: Linear Search, Binary Search, Hashing.
8. Sorting Techniques: Selection, Insertion, Bubble, Merge, Heap, Quick, Radix, and Merge-Sort.

Mapping of COs to syllabus

Course Outcome	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8
CO1	H	M	M					
CO2	H	H	H					
CO3			M	H	M			
CO4				H	H	M		
CO5				L	M	H		
CO6							H	H

CSRA6108: INTRODUCTION TO RASPBERRY PI AND ARDUINO LAB

(2 credits – 30 hours) (L-T-P:0-0-2)

Course Outcomes

At the end of this course students will demonstrate the ability to:

CO1: Recall the basic concept of Internet of Things. (Remembering)
CO2: Discover the interfacing of various sensors and actuators with Arduino/Raspberry Pi. (Understanding)
CO3: Compare the configuration and architecture of Arduino and Raspberry Pi. (Analysing)
CO4: Demonstrate the ability to transmit data wirelessly between different devices. (Applying).
CO5: Assess various SQL queries from MySQL database. (Evaluating)
CO6: Design mechanism to upload/download sensor data on cloud and server. (Creating)

List of Experiments

1. Familiarization of Arduino and Raspberry Pi with their necessary software installation.
2. Program to interface LED/Buzzer with (a) Arduino and (b) Raspberry Pi and demonstrate ON/OFF for 1 second after every 2 second.
3. Program to interface Ultrasonic Sensor with (a) Arduino and (b) Raspberry Pi and print the reading.
4. Program to interface DHT11 sensor with Arduino and print temperature and humidity reading.
5. Program to interface servo motor using relay with (a) Arduino and (b) Raspberry Pi and demonstrate ON/OFF of motor using a push button.
6. Program the (a) Arduino and (b) Raspberry Pi to upload the temperature and humidity to thingspeak cloud.
7. Program the (a) Arduino and (b) Raspberry Pi to retrieve temperature and humidity data from thingspeak cloud.
8. Installation of MySQL data base on Raspberry Pi and perform basic SQL queries.
9. Program the Raspberry Pi to publish temperature data to MQTT Broker.
10. Program the Raspberry Pi to subscribe to MQTT broker for temperature data and print it.
11. Write a program to create TCP server on Raspberry Pi and send response of the humidity data to the TCP client when requested.
12. Write a program to create UDP server on Raspberry Pi and send response of the humidity data to the TCP client when requested

Suggested Readings

E-resource for learning: IoT,https://nptel.ac.in/courses/106/105/106105166/

Mapping of COs to Syllabus

Course Outcomes	Experiment											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H	M	M	M								
CO2	M	M	H	H	H	M	M					
CO3	H				M							
CO4						M	M		H	H	M	M
CO5								H				
CO6						H	H		M	M	H	H

VALUE ADDED COURSES

CSCS6106: INTRODUCTION TO CYBER SECURITY

Duration: 30 hours

Objectives

This course is designed to explore cyber security as a potential specialization in an IT career. Today's interconnected world makes everyone more susceptible to cyber-attacks. It explores cyber trends, threats—along with the broader topic of cyber security in a way that will matter to the user. For instance, students will learn how to protect personal privacy online while gaining additional insight on the challenges companies, and governmental and educational institutions face today.

Course/Learning Outcomes

1. Understand the importance of safe on-line behaviors (Understanding)
2. Analyzing the different types of malware and attacks (Analysing)
3. Identifying the protection strategies used organizations against attacks (Applying)

Module I: The Need for Cyber security (5 lecturers)

The Need for Cyber security, Personal Data: Introduction to Personal Data, cyber security definition, Online and Offline Identity, Computing Devices, Personal Data as a Target, Organizational Data: Introduction to Organizational Data, Types of Organizational Data, Confidentiality, Integrity, and Availability, The Impact of a Security Breach: The Consequences of a Security Breach, Security Breach Example 1, Security Breach Example 2, Security Breach Example 3, Attackers and Cyber security Professionals, The Profile of a Cyber Attacker, Types of Attackers, Internal and External Threats, Cyber warfare: Overview of Cyber warfare, The Purpose of Cyber warfare, The Need for Cyber security

Module II: Attacks, Concepts and Techniques (7 lecturers)

Introduction: Attacks, Concepts and Techniques, Analyzing a Cyberattack, Security Vulnerability and Exploits, Finding Security Vulnerabilities, Types of Security Vulnerabilities, Categorizing Security Vulnerabilities, Identify Vulnerability Terminology, Types of Malware and Symptoms, Types of Malware, Symptoms of Malware, Identify Malware Types, Methods of Infiltration, Social Engineering: Wi-Fi Password Cracking, Phishing, Vulnerability Exploitation: DoS, DDos, and SEO, SEO Poisoning , The Cybersecurity Landscape: Identify the Attack Type, Blended Attack, Impact Reduction, Attacks, Concepts and Techniques

Module III: Protecting Your Data and Privacy (5 lecturers)

Introduction: Protecting Data and Privacy, Protecting Devices and Network, Use Wireless Networks Safely, Protect Your Computing Devices , Use Unique Passwords for Each Online Account, Use Passphrase Rather Than a Password, Email and Web Browser Privacy

Module IV: Protecting the Organization (10 lecturers)

Introduction: Protecting the Organization, Firewalls: Firewall Types, Identify the Firewall Type, Port Scanning, Identify the Port Scan Response, Security Appliances, Identify the Security Appliance, Detecting Attacks in Real Time, Detecting Malware, Detecting Attacks in Real Time, Protecting Against Malware, Security Best Practices, Behavior Approach to cyber security, Behavior-Based Security, Behavior-Based Security, NetFlow and Cyber attacks, Cisco's Approach to Cyber security, CSIRT, Security Playbook, Tools for Incident Prevention and Detection, IDS and IPS, Identify Cyber security Approach Terminology, Behavior-Based Security, Behavior-Based Security, NetFlow and Cyber attacks, Cisco's Approach to Cyber security, CSIRT, Security Playbook, Tools for Incident Prevention and Detection, IDS and IPS, Identify Cyber security Approach Terminology.

Module V: Will Future Be in Cyber security? (3 lecturers)

Introduction, Cyber security Legal and Ethical Issues, Education and Careers, Legal and Ethical Issues in Cyber security Careers, Legal Issues in Cyber security, Ethical Issues in Cyber security, Cyber security Jobs

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	M			
CO 2		H	M		
CO 3			H	H	M

DEPARTMENT OF CIVIL ENGINEERING

VISION

To be a recognized leader in Civil Engineering education and learning experiences providing state of the art education guided by innovative research and consultancy, inclusive technology and managerial skills for industry as well as societal needs towards sustainable development.

MISSION

1. To make the department a center of excellence in Civil Engineering education which equips students with a strong conceptual foundation coupled with practical insight to meet the global industrial and environmental challenges.
2. To produce spiritually inspired socially committed and intellectually competent professionals of high caliber and strong ethical principles to serve the society and nation through teamwork and societal leadership.
3. To establish the department as a recognized center of research for developing sustainable solutions to engineering problems by providing knowledge base and consultancy services to the community.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

1. To equip the students with necessary technical skills and professional expertise that make them competent for immediate employment or to pursue postgraduate studies in Civil Engineering disciplines.
2. To produce graduates who are spiritually motivated for life-long learning and morally committed for successful careers as civil engineers, managers, administrators, educators, engineering consultants and entrepreneurs.
3. To enhance students' abilities to identify and take up project and research topics which would be highly useful for the society considering the present environmental and industrial needs of the country.
4. To make the students able to communicate their innovative ideas to be effective in collaboration with other civil engineering teams that will make them achieve leadership positions to solve different challenges of civil engineering problems.
5. To develop a sense of understanding of the multidisciplinary approach and an ability to relate engineering issues to the broader context of individuals and society for sustainable development.

PROGRAM OUTCOMES – UG PROGRAMMES

PO 1: **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PO 3: **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6: **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11: **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES – B.TECH CIVIL ENGINEERING

PSO 1: **Professional skills:** The ability to analyse and design civil engineering structures as per the provisions in Indian standards and other relevant codes like buildings, bridges, tunnels, highways, railways, airports, docks and harbors, water and sewage treatment plants etc.

PSO 2: **Problem solving and managerial skills**: The ability to manage large infrastructural projects by making use of latest project management techniques for optimum utilisation of resources.

PSO 3: **Innovation and entrepreneurship**: Acquire state-of-the-art scientific knowledge and identify solutions to problems in various civil engineering domains that will create new horizons for entrepreneurial ventures.

PSO 4: **Research and development:** To create an eco-system of research to cater to the needs of society and industrial requirements.

BTECH CIVIL ENGINEERING- List of courses

Course Code	Course Title	Course Number
CHCE0027	Engineering Chemistry	1.1
MACL0012	Mathematics I - Calculus and Linear Algebra	1.2
EEBE0038	Basic Electrical Engineering	1.3
CHCE6007	Engineering Chemistry Lab	1.4
EEBL6027	Basic Electrical Engineering Laboratory	1.5
MNWM6023	Workshop/Manufacturing Practice	1.6
PSEP0039	Engineering Physics: Mechanics	2.1
MAIN0013	Mathematics II-Multiple Integrals, Numerical Methods and Differential Equations	2.2
CSPS0079	Programming for Problem Solving	2.3
EGEH0111	English	2.4
PSEG6017	Physics Lab for Engineers	2.5
CVED6024	Engineering Graphics and Design	2.6
EG0C6005	Oral Communication Practice Lab	2.7
CSPL6069	Programming for Problem Solving Lab	2.8
ECBE0051	Basic Electronics	3.1
BOBE0002	Biology for Engineering	3.2
MNEM0034	Engineering Mechanics	3.3
CVES0046	Energy Science and Engineering	3.4
MATD0028	Mathematics III- Transform Calculus and Discrete Mathematics	3.5
CVIC0054	Introduction to Civil Engineering	3.6
ECBE6040	Basic Electronics Lab	3.7
CVCA6025	Computer Aided Civil Engineering Drawing Lab	3.8
BTIA8	Internship Activity	3.9
BTIP910	Student Induction Program- Universal Human Values II	3.10
MNME0041	Elements of Mechanical Engineering	4.1
CVIS0053	Instrumentation and Sensor Technologies for Civil Engineering Applications	4.2
CVEG0047	Engineering Geology	4.3
CVDP0048	Disaster Preparedness & Planning	4.4
CVFM0049	Introduction to Fluid Mechanics	4.5
CVSM0050	Introduction to Solid Mechanics	4.6
CVSG0051	Surveying & Geomatics	4.7
CVMT0052	Materials, Testing and Evaluation	4.8
CVIS6031	Instrumentation & Sensor Technologies for Civil Engineering Applications Lab	4.9
CVEG6026	Engineering Geology Lab	4.10
CVFM6027	Introduction to Fluid Mechanics Lab	4.11
CVSM6028	Introduction to Solid Mechanics Lab	4.12
CVSG6029	Surveying & Geomatics Lab	4.13
CVMT6030	Materials, Testing and Evaluation Lab	4.14
MTOB0086	Organizational Behaviour	4.15
CVMM0056	Mechanics of Materials	5.1
CVHE0057	Hydraulic Engineering	5.2
CVSE0058	Structural Engineering	5.3

CVGE0059	Geotechnical Engineering	5.4
CVHW0060	Hydrology & Water Resources Engineering	5.5
CVEE0061	Environmental Engineering	5.6
CVTE0062	Transportation Engineering	5.7
MTPP0105	Professional Practice, Law & Ethics	5.8
CVHE6031	Hydraulic Engineering Lab	5.9
CVGE6032	Geotechnical Engineering Lab	5.10
CVEE6033	Environmental Engineering Lab	5.11
CVTE6034	Transportation Engineering Lab	5.12
BTIP12	Internship Seminar	5.13
CVCM0063	Construction Engineering & Management	6.1
CVEC0064	Engineering Economics, Estimation & Costing	6.2
CVCS0065	Design of Concrete Structures I	6.3
CVED0066	Civil Engineering Design I	6.4
CVSA0068	Structural Analysis I	6.5
CVGI0070	Geographic Information Systems and Science	6.6
CVHS0071	Soft Skills and Interpersonal Communication	6.7
CVSS0072	Design of Steel Structures	6.8
CVRS0073	Repairs and Rehabilitation of Structures	6.9
CVPT0074	Physicochemical Process of Water and Waste Water Treatment	6.10
CVRE0075	Railway Engineering	6.11
CVOC0076	Open Channel Flow	6.12
CVSM0077	Soil Mechanics II	6.13
CVEC6035	Engineering Economics, Estimation & Costing Lab	6.14
BTIP13	Internship (Survey Camp)	6.15
MBLS0001	Life Science	7.1
CVCS0090	Design of Concrete Structures II	7.2
CVHS0067	Design of Hydraulic Structures and Irrigation Engineering	7.3
CVPC0091	Prestressed Concrete	7.4
CVSA0092	Structural Analysis II	7.5
CVPH0093	Port and Harbor Engineering	7.6
CVTM0094	Traffic Engineering and Management	7.7
CVMS0095	Metro Systems and Engineering	7.8
CVRG0103	Remote Sensing and GIS	7.9
CVMP6049	Project-I Minor Project	7.10
CVIT6041	Industrial Training	7.11
CVBE0096	Bridge Engineering	8.1
CVBH0097	Basics of Computational Hydraulics	8.2
CVSH0098	Solid and Hazardous Waste Management	8.3
CVEE0099	Earthquake Engineering	8.4
CVST0100	Structural Dynamics	8.5
CVMM0107	Structural Analysis by Matrix Methods	8.6
CVEL0101	Environmental Law and Policy	8.7
CVSE0102	Sustainable Engineering and Technology/Economic Policies in India	8.8
CVPJ6043	Project-II	8.9

MAPPING OF POS, PSOS VS. COURSES

Course	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
1.1	H	L		L		M	M		M	M		L	L			M
1.2	L	H	M		M	M		M	H	M	M	M		M		M
1.3	M	M		L	L				L					L	L	
1.4	M	M	M	L	L		M		L			L	L			M
1.5	M	M		L	L				L					L	L	
1.6					H				M			H		L	M	
2.1	H	M		L		M	M		M	M		L	L			M

2.2	L	H	M		M	M		M	H	M	M	M		M		M
2.3	L	M			M											M
2.4						L			L	M						L
2.5	H	M		L		M	M		M	M		L	L			M
2.6	L		M		H								M			
2.7						L			L	M						L
2.8	L	M			M											M
3.1	M	M		L	L				L					L	L	
3.2							M									L
3.3	H	M		L		M	L					L	M		L	
3.4	M		L		M		H					M			M	L
3.5	L	H	M		M	M		M	H	M	M	M		M		M
3.6	L	L	L	L	L	M	L	M			M	L	L	M		
3.7	M	M		L	L				L					L	L	
3.8	L		M		H								M			
3.9	M	H	M	L	M	M	L	L	H	M	M	M	H	M		
3.10						M	L	H	M	L		L		L		
4.1	H	M		L		M	M		M	M		L	M		L	
4.2	M	M		L	H				L					L	L	
4.3	M						L					L	L	L		
4.4			H	M	M	H	H		M	M		M	M	M		L
4.5	M	M		L	L								M	L		M
4.6	H	M	M	L		L						L	M		L	M
4.7	M		L		M				H	M			H	M		
4.8	M					L							M		L	M
4.9	M	M		L	H				L					L	L	
4.10	M						L					L	L	L		
4.11	M	M		L	L								M	L		M
4.12	H	M	M	L		L						L	M		L	M
4.13	M		L		M				H	M			H	M		
4.14	M					L							M		L	M
4.15								H	H	M	M	L		M	M	
5.1	H	M	M	L		L						L	M		L	M
5.2	M	H		L	M								H	M		M
5.3	M	H	M	M	L							L	M	M		M
5.4	M	M	H				L					L	M	M		
5.5	H	H	M	M			M		M			L	M	M		
5.6	H	M	M			H	H					L	H		M	
5.7	H	M	M			L							H	M		
5.8						L		H	M	M	H	M		M		
5.9	M	H		L	M								H	M		M
5.10	M	M	H				L					L	M	M		
5.11	H	M	M			H	H					L	H		M	
5.12	H	M	M			L							H	M		
5.13		M	M	M	H	L	L	L	H	M	M	M	M	H		M
6.1	M				M	M		M	H	M	H	L		M		
6.2		M			M						H			M		
6.3	H	M	H	H					M			M	H	H		
6.4	M	M	H	M	H		H					L	H			M
6.5	M	H	M	H	L							M	H	H		M
6.6	M	M			H	L					L	L	M			M
6.7						M		M	H	H	M			M		
6.8	H	M	H	H					M			M	H	H		
6.9	H				H		M		M			M	M			M
6.10	M	M			M		H					M	H			M
6.11	M	L				L							H			

6.12	M	M	M	M									M			L
6.13	M	M	H				L					L	M	M		
6.14		M			M						H			M		
6.15		M	M	M	H	L	L	L	H	M	M	M	M	H		M
7.1	M						M		H				H			L
7.2	H	M	H	H					M			M	H	H		
7.3	H	H	M	M			M		M			L	M	H		
7.4	H	M	H	H					M			M	H	H		
7.5	M	H	M	H	L							M	H	H		M
7.6	M	L				L							H			
7.7	M	M			M		H					M	H			M
7.8	M	M	H		H	L	L						H	M		
7.9	M	M			M		H					M	H			M
7.10	H	H	H	M	M				H	M		H	H			M
7.11		M	M	M	H	L	L	L	H	M	M	M	M	H		M
8.1	H	M	H	H					M			M	H	H		
8.2	M	M	M	M	H								M			M
8.3	L		M			M	M				H	L	M			
8.4	M	H				M	M					M	H			M
8.5	M	H	M	H	L							M	H	H		M
8.6	M	H	M	H	L							M	H	H		M
8.7			L			M	H	H	L	M	L	M		M		H
8.8	M			L		M	H	M	M	M	L	M		H		M
8.9	H	H	H	M	M				H	M		H	H			

DETAILED SYLLABUS
THEORY COURSES

CVES0046: ENERGY SCIENCE AND ENGINEERING
(2 credits) (L:T:P: 1-1-0)

Objective

The objective of this Course is to provide an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternative energy sources and their technology and application. The class will explore society's present needs and future energy demands, examine conventional energy sources and systems, including fossil fuels and nuclear energy, and then focus on alternatives, renewable energy sources such as solar, biomass (conversions), wind power, waves and tidal, geothermal, ocean thermal, hydro and nuclear. Energy conservation methods will be emphasized from a Civil Engineering perspective. The knowledge acquired lays a good foundation for design of various civil engineering systems/ projects dealing with these energy generation paradigms in an efficient manner.

Course/Learning Outcomes

Upon successful completion of the course, the students will be able to:
1. List and generally explain the main sources of energy and their primary applications nationally and internationally
2. Estimate the energy demands and make comparisons among energy uses, resources, and technologies.
3. Analyze the challenges and problems associated with the use of various energy sources, including fossil fuels, regarding future supply and the impact on the environment.

Module I (4 hours)

Introduction to Energy Science: Scientific principles and historical interpretation to place energy use in the context of pressing societal, environmental and climate issues; Introduction to energy systems and resources; Introduction to Energy, sustainability & the Environment.

Module II (6 hours)

Energy Sources: Overview of energy systems, sources, transformations, efficiency, and storage. Fossil fuels (coal, oil, oil-bearing shale and sands, coal gasification) -past, present & future, Remedies & alternatives for fossil fuels - biomass, wind, solar, nuclear, wave, tidal and hydrogen; Sustainability and environmental trade-offs of different energy systems; possibilities for energy storage or regeneration (Ex. Pumped storage hydro power projects, superconductor-based energy storages, high efficiency batteries)

Module III (6 hours)

Energy & Environment: Energy efficiency and conservation; introduction to clean energy technologies and its importance in sustainable development; Carbon footprint, energy consumption and sustainability; introduction to the economics of energy; How the economic system determines production and consumption; linkages between economic and environmental outcomes; How future energy use can be influenced by economic, environmental, trade, and research policy.

Module IV (7 hours)

Civil Engineering Projects connected with the Energy Sources: Coal mining technologies, Oil exploration offshore platforms, Underground and under-sea oil pipelines, solar chimney project, wave energy caissons, coastal installations for tidal power, wind mill towers; hydro power stations above-ground and underground along with associated dams, tunnels, penstocks, etc.; Nuclear reactor containment buildings and associated buildings, design and construction constraints and testing procedures for reactor containment buildings; Spent Nuclear fuel storage and disposal systems

Module V (7 hours)

Engineering for Energy conservation: Concept of Green Building and Green Architecture; Green building concepts (Green building encompasses everything from the choice of building materials to where a building is located, how it is designed and operated);

LEED ratings; Identification of energy related enterprises that represent the breath of the industry and prioritizing these as candidates; Embodied energy analysis and use as a tool for measuring sustainability. Energy Audit of Facilities and optimization of energy consumption

Suggested Readings

1. Boyle, Godfrey (2004), Renewable Energy (2nd edition). Oxford University Press
2. Boyle, Godfrey, Bob Everett, and Janet Ramage (Eds.) (2004), Energy Systems and Sustainability: Power for a Sustainable Future. Oxford University Press
3. Schaeffer, John (2007), Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy Technologies and

Sustainable Living, Gaiam
4. Jean-Philippe; Zaccour, Georges (Eds.), (2005), Energy and Environment Set: Mathematics of Decision Making, Loulou, Richard; Waaub, XVIII,
5. Ristinen, Robert A. Kraushaar, Jack J. A Kraushaar, Jack P. Ristinen, Robert A. (2006) Energy and the Environment, 2nd Edition, John Wiley
6. UNDP (2000), Energy and the Challenge of Sustainability, World Energy assessment
7. E H Thorndike (1976), Energy & Environment: A Primer for Scientists and Engineers, Addison-Wesley Publishing Company
8. Related papers published in international journals

Mapping of COs to Syllabus

Course Outcomes	CO 1	CO 2	CO 3
Module I	H		
Module II	H		
Module III		H	
Module IV			H
Module V		H	

CVEG0047: ENGINEERING GEOLOGY

(1 credit)

Objective

The objective of this Course is to focus on the core activities of engineering geologists – site characterization and geologic hazard identification and mitigation. Through lectures, labs, and case study examination student will learn to couple geologic expertise with the engineering properties of rock and unconsolidated materials in the characterization of geologic sites for civil work projects and the quantification of processes such as rock slides, soil-slope stability, settlement, and liquefaction.

Course/Learning Outcomes

At the end of the course, the students will be able to:

1. Study of physical properties and identification of rocks, minerals depending on geological classification.
2. Apply geological principles to rock masses and discontinuities for use in engineering design e.g., rock slopes, foundation.

Module I: 2 Hours

Introduction-Branches of geology useful to civil engineering, scope of geological studies in various civil engineering projects. Department dealing with this subject in India and their scope of work- GSI, Granite Dimension Stone Cell, NIRM. Mineralogy- Mineral, Origin and composition. Physical properties of minerals, susceptibility of minerals to alteration, basic of optical mineralogy, SEM, XRD., Rock forming minerals, megascopic identification of common primary & secondary minerals.

Module II 4 Hours

a. Petrology- Rock forming processes. Specific gravity of rocks. Ternary diagram. Igneous petrology- Volcanic Phenomenon and different materials ejected by volcanoes. Types of volcanic eruption. Concept of Hot spring and Geysers. Characteristics of different types of magma. Division of rock on the basis of depth of formation, and their characteristics. Chemical and Mineralogical Composition. Texture and its types. Various forms of rocks. IUGS Classification of phaneritic and volcanic rock.. Field Classification chart. Structures. Classification of Igneous rocks on the basis of Chemical composition. Detailed study of Acidic Igneous rocks like Granite, Rhyolite or Tuff, Felsite, Pegmatite, Hornfels. Metamorphic Aureole, Kaolinization. Landform as Tors. Engineering aspect to granite. Basic Igneous rocks Like Gabbro, Dolerite, Basalt. Engineering aspect to Basalt. Sedimentary petrology- mode of formation, Mineralogical Composition. Texture and its types, Structures, Gradation of Clastic rocks. Classification of sedimentary rocks and their characteristics. Detailed study of Conglomerate, Breccia, Sandstone, Mudstone and Shale, Limestone.
b. Metamorphic petrology- Agents and types of metamorphism, metamorphic grades, Mineralogical composition, structures & textures in metamorphic rocks. Important Distinguishing features of rocks as Rock cleavage, Schistosity, Foliation. Classification. Detailed study of Gneiss, Schist, Slate with engineering consideration.

Module III 1 Hour

Physical Geology- Weathering. Erosion and Denudation. Factors affecting weathering and product of weathering. Engineering consideration. Superficial deposits and its geotechnical importance: Water fall and Gorges, River meandering, Alluvium, Glacial deposits, Laterite (engineering aspects), Desert Landform, Loess, Residual deposits of Clay with flints, Solifluction deposits, mudflows, Coastal deposits.

Module IV 2 Hours

Strength Behavior of Rocks- Stress and Strain in rocks. Concept of Rock Deformation & Tectonics. Dip and Strike. Outcrop and width of outcrop. Inliers and Outliers. Main types of discontinuities according to size. Fold- Types and nomenclature, Criteria for their recognition in field. Faults: Classification, recognition in field, effects on outcrops. Joints & Unconformity; Types, Stresses responsible, geotechnical importance. Importance of structural elements in engineering operations. Consequences of failure as land sliding, Earthquake and Subsidence. Strength of Igneous rock structures.

Module V 2 Hours
Geological Hazards- Rock Instability and Slope movement: Concept of sliding blocks. Different controlling factors. Instability in vertical rock structures and measures to prevent collapse. . Types of landslide. Prevention by surface drainage, slope reinforcement by Rock bolting and Rock anchoring, retaining wall, Slope treatment. Case study on black clay. Ground water: Factors controlling water bearing capacity of rock. Pervious & impervious rocks and ground water. Lowering of the water table and Subsidence. Earthquake: Magnitude and intensity of earthquake. Seismic sea waves. Revelation from Seismic Records of structure of earth. Case Study on Elevation and Subsidence in Himalayan region in India. Seismic Zone in India

Module VI 2 Hours
Rock masses as construction material: Definition of Rock masses. Main features constituting rock mass. Main features that affect the quality of rock engineering and design. Basic elements and structures of rock that are relevant in civil engineering areas. Main types of works connected to rocks and rock masses. Important variables influencing rock properties and behavior such as Fresh rock Influence from some minerals. Effect of alteration and weathering. Measurement of velocity of sound in rock. Classification of Rock material strength. Core logging. Rock Quality Designation. Rock mass description.

Module VII 1 Hour
Geology of dam and reservoir site- Required geological consideration for selecting dam and reservoir site. Failure of Reservoir. Favorable & unfavorable conditions in different types of rocks in presence of various structural features, precautions to be taken to counteract unsuitable conditions, significance of discontinuities on the dam site and treatment given to such structures.

Module VIII 1 Hour
Rock Mechanics- Subsurface investigations in rocks and engineering characteristics or rocks masses; Structural geology of rocks. Classification of rocks, Field & laboratory tests on rocks, Stress deformation of rocks, Failure theories and shear strength of rocks, Bearing capacity of rocks.

Suggested Readings

1. Engineering and General Geology, Parbin Singh, 8th Edition (2010), S K Kataria & Sons.
2. Text Book of Engineering Geology, N. Chenna Kesavulu, 2nd Edition (2009), Macmillan Publishers India.
3. Geology for Geotechnical Engineers, J.C.Harvey, Cambridge University Press (1982).

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2
Module I	H	L
Module II	M	H
Module III	H	L
Module IV	L	H
Module V	H	M
Module VI	H	M
Module VII	L	H
Module VIII	M	H

CVDP0048: DISASTER PREPAREDNESS & PLANNING MANAGEMENT

2 Credits - (L:T:P: 1:1:0)

Objectives
The objectives of the course are to understand basic concepts in Disaster Management , definitions and terminologies used in Disaster Management, types and Categories of Disasters, the Challenges posed by Disasters and the Impacts of Disasters Key Skills

COURSE/LEARNING OUTCOMES
Upon successful completion of the course, the students will be able to:

1. Define the application of Disaster Concepts to Management
2. Explain the Relationship between Development and Disasters.
3. Make use of the understanding of different categories of Disasters

Module I: 2 Hours
Introduction - Concepts and definitions: disaster, hazard, vulnerability, risks- severity, frequency and details, capacity, impact,

prevention, mitigation).

Module II: 8 Hours
Disasters - Disasters classification; natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); man made disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills, transportation accidents, terrorist strikes, etc.); hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility.

Module III: 6 Hours
Disaster Impacts - Disaster impacts (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate change and urban disasters.

Module IV: 8 Hours
Disaster Risk Reduction (DRR) - Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post- disaster environmental response (water, sanitation, food safety, waste management, disease control, security, communications); Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

Module V: 6 Hours
Disasters, Environment and Development - Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land- use changes, urbanization etc.), sustainable and environmental friendly recovery; reconstruction and development methods.

Suggested Readings
1. http://ndma.gov.in/ (Home page of National Disaster Management Authority)
2. http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs).
3. Pradeep Sahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall.
4. Singh B.K., 2008, Handbook of Disaster Management: Techniques & Guidelines, Rajat Publication.
5. Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation
6. Disaster Medical Systems Guidelines. Emergency Medical Services Authority, State of California, EMSA no.214, June 2003
7. Inter Agency Standing Committee (IASC) (Feb. 2007). IASC Guidelines on Mental Health and Psychosocial Support in Emergency Settings. Geneva: IASC

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I	H	L	L	
Module II	M	H	L	
Module III		M	H	L
Module IV		L	M	H
Module V			H	

CVFM0049: INTRODUCTION TO FLUID MECHANICS
2 credits (L: T:P:2-0-2)

Objectives
The objective of this course is to introduce the concepts of fluid mechanics useful in Civil Engineering applications. The course provides a first level exposure to the students to fluid statics, kinematics and dynamics. Measurement of pressure, computations of hydrostatic forces on structural components and the concepts of Buoyancy all find useful applications in many engineering problems. Training to analyse engineering problems involving fluids – such as those dealing with pipe flow, open channel flow, jets, turbines and pumps, dams and spillways, culverts, river and groundwater flow - with a mechanistic perspective is essential for the civil engineering students. The topics included in this course are aimed to prepare a student to build a good fundamental background useful in the application-intensive courses covering hydraulics, hydraulic machinery and hydrology in later semesters.

Course/Learning Outcomes
At the end of the course, the student will be able to:
1. CO1: Understand and define the broad principles of fluid statics, kinematics and dynamics
2. CO2: Classify fluid flow; apply the continuity, momentum and energy principles

3. CO3: Apply dimensional analysis, and application of fluid mechanics problem to pipe flow , pressure measurements and hydrostatic forces

Module I: 6 Hours
Basic Concepts and Definitions – Distinction between a fluid and a solid; Density, Specific weight, Specific gravity, Kinematic and dynamic viscosity; variation of viscosity with temperature, Newton law of viscosity; vapour pressure, boiling point, cavitation; surface tension, capillarity, Bulk modulus of elasticity, compressibility.

Module II: 8 Hours
Fluid Statics - Fluid Pressure: Pressure at a point, Pascal's law, pressure variation with temperature, density and altitude. Piezometer, U-Tube Manometer, Single Column Manometer, U-Tube Differential Manometer, Micro-manometers. pressure gauges, Hydrostatic pressure and force: horizontal, vertical and inclined surfaces. Buoyancy and stability of floating bodies.

Module III: 8 Hours
Fluid Kinematics- Classification of fluid flow : steady and unsteady flow; uniform and non-uniform flow; laminar and turbulent flow; rotational and irrotational flow; compressible and incompressible flow; ideal and real fluid flow; one, two and three dimensional flows; Streamline, path line, streak line and stream tube; stream function, velocity potential function. One-, two- and three -dimensional continuity equations in Cartesian coordinates

Module IV : 8 Hours
Fluid Dynamics- Surface and body forces; Equations of motion - Euler's equation; Bernoulli's equation – derivation; Energy Principle; Practical applications of Bernoulli's equation: venturi meter, orifice meter and pitot tube; Momentum principle; Forces exerted by fluid flow on pipe bend; Vortex Flow – Free and Forced; Dimensional Analysis and Dynamic Similitude - Definitions of Reynolds Number, Froude Number, Mach Number, Weber Number and Euler Number; Buckingham's π-Theorem.

Suggested Readings
1. Fluid Mechanics and Machinery, C.S.P.Ojha, R. Berndtsson and P. N. Chandramouli, Oxford University Press, 2010
2. Hydraulics and Fluid Mechanics, P M Modi and S M Seth, Standard Book House
3. Theory and Applications of Fluid Mechanics, K. Subramanya, Tata McGraw Hill
4. Fluid Mechanics with Engineering Applications, R.L. Daugherty, J.B. Franzini and E.J. Finnemore, International Student Edition, McGraw Hill.
5. MOOCs Link : https://swayam.gov.in/nd1_noc20_ce59/preview

Mapping of COs to syllabus

Course Outcomes	CO1	CO2	CO3
Module I	H	L	L
Module II	H	L	L
Module III	L	H	L
Module IV	L	M	H

CVSM0050: INTRODUCTION TO SOLID MECHANICS
2 credits- (L:T:P: 2-0-0)

Objective
The objective of this Course is to introduce to continuum mechanics and material modelling of engineering materials based on first energy principles: deformation and strain; momentum balance, stress and stress states; elasticity and elasticity bounds; plasticity and yield design.

COURSE/LEARNING OUTCOMES
On completion of the course, the student will be able to:
1. Describe the concepts and principles, understand the theory of elasticity including strain/displacement and Hooke's law relationships; and perform calculations, relative to the strength and stability of structures and mechanical components.
2. Define the characteristics and calculate the magnitude of combined stresses in individual members and complete structures; analyze solid mechanics problems using classical methods and energy methods.
3. Analyze various situations involving structural members subjected to combined stresses by application of Mohr's circle of stress; locate the shear center of thin wall beams.
4. Calculate the deflection at any point on a beam subjected to a combination of loads; solve for stresses and deflections of beams under unsymmetrical loading; apply various failure criteria for general stress states at points; solve torsion problems in bars and thin-walled members.

Module I : 2 Hours

a. Simple Stresses and Strains- Concept of stress and strain, St. Venant's principle, stress and strain diagram,Elasticity and plasticity – Types of stresses and strains, Hooke's law – stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain.
b. Poisson's ratio and volumetric strain – Elastic moduli and the relationship between them – Bars of varying section – composite bars – Temperature stresses. Strain Energy – Resilience – Gradual, sudden, impact and shock loadings – simple applications.

Module II: 2 Hours
Compound Stresses and Strains- Two dimensional system, stress at a point on a plane, principal stresses and principal planes, Mohr circle of stress, ellipse of stress and their applications. Two dimensional stress-strain system, principal strains and principal axis of strain, circle of strain and ellipse of strain. Relationship between elastic constants.

Module III: 3 Hours
Bending moment and Shear Force Diagrams- Bending moment (BM) and shear force (SF) diagrams.BM and SF diagrams for cantilevers simply supported and fixed beams with or without overhangs. Calculation of maximum BM and SF and the point of contraflexure under concentrated loads, uniformly distributed loads over the whole span or part of span, combination of concentrated loads (two or three) and uniformly distributed loads, uniformly varying loads, application of moments.

Module IV: 2 Hours
a. Flexural Stresses-Theory of simple bending – Assumptions – Derivation of bending equation: M/I = f/y = E/R - Neutral axis – Determination of bending stresses – Section modulus of rectangular and circular sections (Solid and Hollow), I,T, Angle and Channel sections – Design of simple beam sections.
b. Shear Stresses- Derivation of formula – Shear stress distribution across various beam sections like rectangular, circular, triangular, I, T angle sections.

Module V :3 Hours
Slope and deflection- Relationship between moment, slope and deflection, Moment area method, Macaulay's method. Use of these methods to calculate slope and deflection for determinate beams.

Module VI: 2 Hours
Torsion- Derivation of torsion equation and its assumptions. Applications of the equation of the hollow and solid circular shafts, torsional rigidity, Combined torsion and bending of circular shafts, principal stress and maximum shear stresses under combined loading of bending and torsion. Analysis of close-coiled-helical springs.

Module VIII: 1 Hour
Thin Cylinders and Spheres- Derivation of formulae and calculations of hoop stress, longitudinal stress in a cylinder, and sphere subjected to internal pressures.

Suggested Readings
1. Timoshenko, S. and Young, D. H., "Elements of Strength of Materials", DVNC,New York, USA.
2. Kazmi, S. M. A., "Solid Mechanics" TMH, Delhi, India.
3. Hibbeler, R. C. Mechanics of Materials. 6th ed. East Rutherford, NJ: Pearson Prentice Hall, 2004
4. Crandall, S. H., N. C. Dahl, and T. J. Lardner. An Introduction to the Mechanics of Solids. 2nd ed. New York, NY: McGraw Hill, 1979
5. Laboratory Manual of Testing Materials - William Kendrick Hall
6. Mechanics of Materials - Ferdinand P. Beer, E. Russel Jhonston Jr., John T. DEwolf – TMH 2002.
7. Strength of Materials by R. Subramanian, Oxford University Press, New Delhi. MOOCs Link: https://swayam.gov.in/nd1_noc20_ce34/preview

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I	H	M	L	
Module II	M	H		
Module III			H	
Module IV		H		
Module V				H

CVSG0051: SURVEYING AND GEOMATICS
2 credits

Objectives
Objectives of this course is to introduce the students to various types of surveying and to prepare them to work with survey

observations and perform calculations.

COURSE/LEARNING OUTCOMES

On completion of the course the students will be able to:

1. Identify different types of surveying and their applicability.
2. Recognise the importance and uses of remote sensing and other modern techniques in various civil engineering works.
3. Execute traverse calculations; determine latitudes, departures, and coordinates of control points and balancing errors in a traverse. Use appropriate software for calculations and mapping.
4. Operate the techniques, skills, and applicable tools of the discipline for application in engineering and surveying activities.

Module I: Introduction to Surveying (4 hours)

Principles, Linear, angular and graphical methods, Survey stations, Survey lines- ranging, Bearing of survey lines, Levelling: Plane table surveying, Principles of levelling- booking and reducing levels; differential, reciprocal leveling, profile levelling and cross sectioning. Digital and Auto Level, Errors in levelling; contouring: Characteristics, methods, uses; areas and volumes.

Module II: Triangulation and Trilateration (6 Hours)

Theodolite survey: Instruments, Measurement of horizontal and vertical angle; Horizontal and vertical control - methods - triangulation – network- Signals. Baseline - choices - instruments and accessories - extension of base lines – corrections - Satellite station - reduction to centre - Intervisibility of height and distances – Trigonometric leveling - Axis single corrections.

Module III: Curves (5 hours)

Elements of simple and compound curves – Method of setting out– Elements of Reverse curve - Transition curve – length of curve – Elements of transition curve - Vertical curves

Module IV: Modern Field Survey Systems (6 Hours)

Principle of Electronic Distance Measurement, Modulation, Types of EDM instruments, Distomat, Total Station – Parts of a Total Station – Accessories –Advantages and Applications, Field Procedure for total station survey, Errors in Total Station Survey; Global Positioning Systems- Segments, GPS measurements, errors and biases, Surveying with GPS, Co-ordinate transformation, accuracy considerations.

Module V: Photogrammetry Surveying (6 Hours)

Introduction, Basic concepts, perspective geometry of aerial photograph, relief and tilt displacements, terrestrial photogrammetry, flight planning; Stereoscopy, ground control extension for photographic mapping- aerial triangulation, radial triangulation, methods; photographic mapping- mapping using paper prints, mapping using stereoplotting instruments, mosaics, map substitutes.

Module VI: Remote Sensing (3 Hours)

Introduction –Electromagnetic Spectrum, interaction of electromagnetic radiation with the atmosphere and earth surface, remote sensing data acquisition: platforms and sensors; visual image interpretation; digital image processing.

Suggested Readings

1. Madhu, N, Sathikumar, R and Satheesh Gobi, Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson India, 2006.
2. Manoj, K. Arora and Badjatia, Geomatics Engineering, Nem Chand & Bros, 2011
3. Bhavikatti, S.S., Surveying and Levelling, Vol. I and II, I.K. International, 2010
4. Chandra, A.M., Higher Surveying, Third Edition, New Age International (P) Limited, 2002.
5. Anji Reddy, M., Remote sensing and Geographical information system, B.S. Publications, 2001.
6. Arora, K.R., Surveying, Vol-I, II and III, Standard Book House, 2015.

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I	H			
Module II	H			
Module III	H			
Module IV				H
Module V		H		M
Module VI		M		H

CVMT0052: MATERIALS, TESTING AND EVALUATION

(2 credits - 30 Hours)(L:T:P:1-1-0)

Objective

The objective of this Course is to deal with an experimental determination and evaluation of mechanical characteristics and advanced behavior of metallic and non-metallic structural materials. The course deals with explanation of deformation and fracture behavior of structural materials. The main goal of this course is to provide students with all information concerning principle, way of measurement, as well as practical application of mechanical characteristics.

- Make measurements of behavior of various materials used in Civil Engineering.
- Provide physical observations to complement concepts learnt
- Introduce experimental procedures and common measurement instruments, equipment, devices.
- Exposure to a variety of established material testing procedures and techniques
- Different methods of evaluation and inferences drawn from observations.

COURSE/LEARNING OUTCOMES

At the end of this course students will be able to:

1. List the different materials used in civil engineering applications.
2. Execute planning an experimental program, selecting the test configuration, selecting the test specimens and collecting raw data.
3. Compare and explain various modes of failure in compression, tension, and shear.

Module I (5 hours)

Introduction to Engineering Materials covering, Cements, M-Sand, Concrete (plain, reinforced and steel fibre/ glass fibre-reinforced, light-weight concrete, High Performance Concrete, Polymer Concrete) Ceramics, and Refractories, Bitumen and asphaltic materials, Timbers, Glass and Plastics, Structural Steel and other Metals, Paints and Varnishes, Acoustical material and geo-textiles, rubber and asbestos, laminates and adhesives, Graphene, Carbon composites and other engineering materials including properties and uses of these

Module II (5 hours)

Introduction to Material Testing covering, What is the “Material Engineering”?; Mechanical behavior and mechanical characteristics; Elasticity – principle and characteristics; Plastic deformation of metals; Tensile test – standards for different material (brittle, quasi-brittle, elastic and so on) True stress – strain interpretation of tensile test; hardness tests; Bending and torsion test; strength of ceramic; Internal friction, creep – fundamentals and characteristics; Brittle fracture of steel – temperature transition approach; Background of fracture mechanics; Discussion of fracture toughness testing – different materials; concept of fatigue of materials; Structural integrity assessment procedure and fracture mechanics

Module III (5 hours)

Standard Testing & Evaluation Procedures covering, Laboratory for mechanical testing; Discussion about mechanical testing; Naming systems for various irons, steels and nonferrous metals; Discussion about elastic deformation; Plastic deformation; Impact test and transition temperatures; Fracture mechanics – background; Fracture toughness – different materials; Fatigue of material; Creep.

Tutorials (15 hours)

From the above modules covering, understanding i) Tests & testing of bricks, ii) Tests & testing of sand, iii) Tests & testing of concrete, iv) Tests & testing of soils, v) Tests & testing of bitumen & bituminous mixes, vi) Tests & testing of polymers and polymer based materials, vii) Tests & testing of metals & viii) Tests & testing of other special materials, composites and cementitious materials. Explanation of mechanical behavior of these materials.

Suggested Readings

1. Chudley, R., Greeno (2006), 'Building Construction Handbook' (6th ed.),R. Butterworth- Heinemann
2. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, ' Highway Materials and Pavement Testing', Nem Chand& Bros, Fifth Edition
4. Various related updated & recent standards of BIS, IRC, ASTM, RILEM, AASHTO, etc. corresponding to materials used for Civil Engineering applications
5. Kyriakos Komvopoulos (2011), Mechanical Testing of Engineering Materials, Cognella
6. E.N. Dowling (1993), Mechanical Behaviour of Materials,Prentice Hall International Edition
7. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards (post 2000)
8. Related papers published in international journals

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3
Module I	H		
Module II		H	
Module III			M

CVIS0053: INSTRUMENTATION AND SENSOR TECHNOLOGIES FOR CIVIL ENGINEERING APPLICATIONS

(2 credits- 30 Hours)

COURSE/LEARNING OUTCOMES

After completing the course students will be able to:

1. Explain the noise added during measurements and transmission, the measurement of electrical variables and the requirements during the transmission of measured signals.
2. Identify the requirements in the calibration of sensors and instruments.
3. Analyze the errors during measurements
4. Decide proper sensor technologies for specific applications
5. Construct Instrumentation/Computer Networks
6. Design and set up measurement systems and do the studies

Module I:

Fundamentals of Measurement, Sensing and Instrumentation: definition of measurement and instrumentation, physical variables, common types of sensors; Describe the function of these sensors; Use appropriate terminology to discuss sensor applications; and qualitatively interpret signals from a known sensor type, types of instrumentation, Sensor Specifics, Permanent installations, Temporary installations;

Module II:

Sensor Installation and Operation: i) Prediction of the response of sensors to various inputs; ii) Construction of a conceptual instrumentation and monitoring program; iii order and methodology for sensor installation; and iv) Differentiate between types of sensors and their modes of operation and measurement and v) Approach to Planning Monitoring Programs, Define target, Sensor selection, Sensor siting, Sensor Installation & Configuration, Advanced topic, Sensor design, Measurement uncertainty

Module III:

Data Analysis and Interpretation covering a) Fundamental statistical concepts, b) Data reduction and interpretation, c) Piezometer, Inclinometer, Strain gauge, etc. d) Time domain signal processing, e) Discrete signals, Signals and noise and f) a few examples of statistical information to calculate are: Average value (mean), On average, how much each measurement deviates from the mean (standard deviation), Midpoint between the lowest and highest value of the set (median), Most frequently occurring value (mode), Span of values over which your data set occurs (range)

Module IV:

Frequency Domain Signal Processing and Analysis covering Explain the need for frequency domain analysis and its principles; Draw conclusions about physical processes based on analysis of sensor data; Combine signals in a meaningful way to gain deeper insight into physical phenomena, Basic concepts in frequency domain signal processing and analysis, Fourier Transform, FFT (Fast Fourier Transform), Example problems: Noise reduction with filters, Leakage, Frequency resolution

Tutorials from the above modules demonstrating clearly the understanding and use for the sensors and instruments used for the problems posed and inferences drawn from the measurement and observations made along with evaluation report

Suggested Readings

1. Alan S Morris (2001), Measurement and Instrumentation Principles, 3rd/e, Butterworth Heinemann
2. David A. Bell (2007), Electronic Instrumentation and Measurements 2nd/e, Oxford Press
3. S. Tumanski (2006), Principle of Electrical Measurement, Taylor & Francis
4. lya Gertsbakh (2010), Measurement Theory for Engineers, Springer

CVIC0054: INTRODUCTION TO CIVIL ENGINEERING

(3 Credits) (L: T:P :3-0-0)

Objective

The Objective of this course is to give an understanding to the students of the vast breadth and numerous areas of engagement available in the overall field of Civil Engineering, to motivate the students to pursue a career in one of the many areas of Civil Engineering with deep interest and keenness and to expose the students to the various avenues available for doing creative and innovative work in this field by showcasing the many monuments and inspiring projects of public utility.

COURSE /LEARNING OUTCOMES

After finishing this course students will be able to:

1. Know what constitutes civil engineering and explore various possibilities of a career in this field and
2. define the Sustainability of the Environment, including its Aesthetics, Identify the potentials of Civil Engineering for Employment creation and its Contribution to the GDP
3. Identify the various areas available to pursue and specialize within the overall field of Civil Engineering
4. Identify the vast interfaces this field has with the society at large.

5. Design creative and innovative work and showcase monuments, heritage structures, nationally important heritage infrastructure, and impressive projects to serve as sources of inspiration.

Modules I (6 Hours)

a. Basics of Engineering and Civil Engineering; Broad disciplines of Civil Engineering; Importance of Civil Engineering, Possible scopes for a career.
b. History of Civil engineering: Early constructions and developments over time; Ancient monuments & Modern marvels; Development of various materials of construction and methods of construction; Works of Eminent civil engineers.
c. Overview of National Planning for Construction and Infrastructure Development; Position of construction industry vis-à-vis other industries, five year plan outlays for construction; current budgets for infrastructure works;
d. Fundamentals of Architecture & Town Planning: Aesthetics in Civil Engineering, Examples of great architecture, fundamentals of architectural design & town planning; Building Systems (HVAC, Acoustics, Lighting, etc.); LEED ratings; Development of Smart cities.

Module II: 6 Hours

Pre-industrial revolution days, Agricultural revolution, first and second industrial revolutions, IT revolution; Recent major Civil Engineering breakthroughs and innovations; Present day world and future projections, Ecosystems in Society and in Nature; the steady erosion in Sustainability; Global warming, its impact and possible causes; Evaluating future requirements for various resources; GIS and applications for monitoring systems; Human Development Index and Ecological Footprint of India Vs other countries and analysis;

Module III (6 Hours)

a. Fundamentals of Building Materials: Stones, bricks, mortars, Plain, Reinforced & Prestressed Concrete, Construction Chemicals; Structural Steel, High Tensile Steel, Carbon Composites; Plastics in Construction; 3D printing; Recycling of Construction & Demolition wastes.
b. Basics of Construction Management & Contracts Management: Temporary Structures in Construction; Construction Methods for various types of Structures; Major Construction equipment; Automation & Robotics in Construction; Modern Project management Systems; Advent of Lean Construction; Importance of Contracts Management.

Module IV (8 Hours)

Environmental Engineering & Sustainability: Water treatment systems; Effluent treatment systems; Solid waste management; Sustainability in Construction; Geotechnical Engineering: Basics of soil mechanics, rock mechanics and geology; various types of foundations; basics of rock mechanics & tunneling ;Hydraulics, Hydrology & Water Resources Engineering: Fundamentals of fluid flow, basics of water supply systems; Underground Structures; Underground Structures Multipurpose reservoir projects Ocean Engineering: Basics of Wave and Current Systems; Sediment transport systems; Ports & Harbours and other marine structures Power Plant Structures: Chimneys, Natural & Induced Draught Cooling towers, coal handling systems, ash handling systems; nuclear containment structures; hydro power projects; Structural Engineering: Types of buildings; tall structures; various types of bridges; Water retaining structures; Other structural systems; Experimental Stress Analysis; Wind tunnel studies; Surveying & Geomatics: Traditional surveying techniques, Total Stations, Development of Digital Terrain Models; GPS, LIDAR; Traffic & Transportation Engineering: Investments in transport infrastructure development in India for different modes of transport; Developments and challenges in integrated transport development in India: road, rail, port and harbour and airport sector; PPP in transport sector; Intelligent Transport Systems; Urban Public and Freight Transportation; Road Safety under heterogeneous traffic; Sustainable and resilient pavement materials, design, construction and management; Case studies and examples.

Module V (4 hours)

Repairs & Rehabilitation of Structures: Basics of corrosion phenomena and other structural distress mechanisms; some simple systems of rehabilitation of structures; non-Destructive testing systems; Use of carbon fibre wrapping and carbon composites in repairs. Industrial lectures: Case studies of large civil engineering projects by industry professionals, covering comprehensive planning to commissioning;

Module VI (6 Hours)

Civil Engineering Projects – Environmental Impact Analysis procedures; Waste (materials, manpower, equipment) avoidance/ Efficiency increase; Advanced construction techniques for better sustainability; Techniques for reduction of Greenhouse Gas emissions in various aspects of Civil Engineering Projects; New Project Management paradigms & Systems (Ex. Lean Construction), contribution of Civil Engineering to GDP, Contribution to employment(projects, facilities management), Quality of products, Health & Safety aspects for stakeholders; Innovations and methodologies for ensuring Sustainability during Project development.

Module VII (6 hours)

Computational Methods, IT, IoT in Civil Engineering: Typical software used in Civil Engineering- Finite Element Method, Computational Fluid Dynamics; Computational Geotechnical Methods; highway design (MX), Building Information Modelling;

Highlighting typical available software systems (SAP, STAAD, ABAQUS, MATLAB, ETAB, NASTRAN, NISA, MIKE 21, MODFLOW, REVIT, TEKLA, AUTOCAD, GEOSTUDIO, EDUSHAKE, MSP, PRIMAVERA, ArcGIS, VisSIM, …)

Module VIII (3 hours)
Basics of Professionalism: Professional Ethics, Entrepreneurial possibilities in Civil Engineering, Possibilities for creative & innovative working, technical writing Skills enhancement; Facilities Management; Quality & HSE Systems in Construction.

Suggested Readings

1. Chen, W.F and Liew,J Y R (Eds)., The Civil Engineering Hand Book, Second Edition, CRC press (Taylor and Francis.
2. Dalal, K. R.,Essentials of Civil Engineering,Charotar Publishing House
3. Gopi ,S., Basic Civil Engineering , Pearson Publishers
4. Kandya, A.A.,Elements of Civil Engineering,Charotar Publishing house
5. Rangawala, S. C.,and dalal, K.B.,Engineering materials, Charotar publishing House.
6. Rangawala, S. C.,and dalal, K.B.,Building Construction , Charotar publishing House.

Mapping of COs to Syllabus:

Course Outcomes	CO1	CO2	CO3	CO4
Module I	H	L		M
Module II			H	
Module III		H		
Module IV		H		
Module V				
Module VI			H	
Module VII			H	

CVMM0056: MECHANICS OF MATERIALS

(3 Credits-45 hours) (L:T:P:3-0-0)

***Objectives**: The objective of this Course is to introduce to continuum mechanics and material modeling of engineering materials based on first energy principles: deformation and strain; momentum balance, stress and stress states; elasticity and elasticity bounds; plasticity and yield design. The subject of mechanics of materials involves analytical methods for determining the strength, stiffness (deformation characteristics), and stability of the various members in a structural system.*

COURSE /LEARNING OUTCOMES

At the end of the course, the student will be able to:

CO1. Explain deformation and strain under different load action and response in terms of forces and moments
CO2. Analyse the structures under axial and torsional loading, and buckling
CO3. Calculate the stresses and deflections of indeterminate beams.
CO4. Apply principles of engineering, basic science, and math to model, analyze, design and realize physical systems, components or processes

Module I : 12 Hours

Deformation and Strain covering description of finite deformation, Infinitesimal deformation; Analysis of statically determinate trusses; Stability of dams, retaining walls and chimneys; Stress analysis of thin, thick and compound cylinder;
Generalized state of stress and strain: Stress and strain tensor, Yield criteria and theories of failure; Tresca, Von-Mises, Hill criteria, Haigh-Westerguard's stress space.

Module II: 12 Hours

Momentum Balance and Stresses covering Forces and Moments Transmitted by Slender Members, Shear Force and Bending Moment Diagrams, Momentum Balance, Stress States / Failure Criterion
Mechanics of Deformable Bodies covering Force-deformation Relationships and Static Indeterminacy, Uniaxial Loading and Material Properties, Trusses and Their Deformations, Statically Determinate and Indeterminate Trusses,

Module III:9 Hours

Force-Stress-Equilibrium covering Multiaxial Stress and Strain

Displacement – Strain covering Multiaxial Strain and Multiaxial Stress-strain Relationships
Elasticity and Elasticity Bounds covering Stress-strain-temperature Relationships and Thin-walled Pressure Vessels, Stress and strain Transformations and Principal Stress, Failure of Materials,

Module IV: 12 hours
Bending: Stress and Strains; Deflections and Torsion covering Pure Bending, Moment-curvature Relationship, Beam Deflection, Symmetry, Superposition, and Statically Indeterminate Beams, Shear and Torsion, Torsion and Twisting, Thermoelectricity, Energy methods, Variational Methods; Strain energy, elastic, complementary and total strain energy, Strain energy of axially loaded bar, Beam in bending, shear and torsion; General energy theorems, Castigliano's theorem, Maxwell Bettie's reciprocal theorem; Virtual work and unit load method for deflection, Application to problems of beams and frames.
Structural stability; Stability of columns, Euler's formula, end conditions and effective length factor, Columns with eccentric and lateral load; Plasticity and Yield Design covering 1D-Plasticity – An Energy Approach, Plasticity Models, Limit Analysis and Yield Design

Suggested Reading

1. Norris, C.H. and Wilber, J. B. and Utku, S. "Elementary Structural Analysis" Mc Graw Hill, Tokyo, Japan.
2. Timoshenko, S. and Young, D. H., "Elements of Strength of Materials", DVNC, New York, USA.
3. Kazmi, S. M. A., 'Solid Mechanics" TMH, Delhi, India.
4. Hibbeler, R. C. Mechanics of Materials. 6th ed. East Rutherford, NJ: Pearson Prentice Hall, 2004
5. Crandall, S. H., N. C. Dahl, and T. J. Lardner. An Introduction to the Mechanics of Solids. 2nd ed. New York, NY: McGraw Hill, 1979
6. Gere, J. M., and S. P. Timoshenko. Mechanics of Materials. 5th ed. Boston: PWS Kent Publishing, 1970.
7. Ashby, M. F., and D. R. H. Jones. Engineering Materials, An Introduction to their Properties and Applications. 2nd ed. Butterworth Heinemann.
8. Collins, J. A. Failure of Materials in Mechanical Design. 2nd ed. John Wiley & Sons, 1993.
9. Courtney, T. H. Mechanical Behavior of Materials. McGraw-Hill, 1990. MOOCs Link: https://swayam.gov.in/nd1_noc20_ce50/preview

Mapping of COs to Syllabus

	CO1	CO2	CO3	CO4
Module I	H			
Module II		H	H	
Module III	H	M		M
Module IV		H		M

CVHE0057: HYDRAULIC ENGINEERING
(2 Credits-30 hours) (L:T:P:2-0-0)

Objectives
To introduce the students to various hydraulic engineering problems like open channel flows and hydraulic machines. At the completion of the course, the student should be able to relate the theory and practice of problems in hydraulic engineering

COURSE /LEARNING OUTCOMES
At the end of the course, the student will be able to:
CO1. Define different types of flows, classify different types of flow in an open channel and pipe flow, apply their knowledge of fluid mechanics in addressing problems in open channels.
CO2. Solve problems in uniform, gradually and rapidly varied flows in steady state conditions solve problems in uniform, gradually and rapidly varied flows in steady state conditions.
CO3. Analyze and design artificial channels with rigid and mobile boundary and pipe networks.

Module I: (2 hours)
Laminar Flow- Laminar flow through: circular pipes, annulus and parallel plates. Stoke's law, Measurement of

viscosity.

Module II: (4 hours)
Turbulent Flow- Reynolds experiment, Transition from laminar to turbulent flow. Definition of turbulence, scale and intensity, Causes of turbulence, instability, mechanism of turbulence and effect of turbulent flow in pipes. Reynolds stresses, semi-empirical theories of turbulence, Prandtl's mixing length theory, universal velocity distribution equation. Resistance to flow of fluid in smooth and rough pipes, Moody's diagram.

Module III: (4 hours)
Boundary Layer Analysis-Assumption and concept of boundary layer theory. Boundary-layer thickness, displacement, momentum & energy thickness, laminar and turbulent boundary layers on a flat plate; Laminar sub-layer, smooth and rough boundaries. Local and average friction coefficients. Separation and Control.

Module IV: (3 hours)
Dimensional Analysis and Hydraulic Similitude: Dimensional homogeneity, Rayleigh method, Buckingham's Pi method and other methods. Dimensionless groups. Similitude, Model studies, Types of models. Application of dimensional analysis and model studies to fluid flow problems.

Module V: (2 hours)
Introduction to Open Channel Flow-Comparison between open channel flow and pipe flow, geometrical parameters of a channel, classification of open channels, classification of open channel flow, Velocity Distribution of channel section.

Module VI: (3 hours)
Uniform Flow-Continuity Equation, Energy Equation and Momentum Equation, Characteristics of uniform flow, Chezy's formula, Manning's formula. Factors affecting Manning's Roughness Coefficient "n_. Most economical section of channel. Computation of Uniform flow, Normal depth.

Module VII: (4 hours)
Non-Uniform Flow- Specific energy, Specific energy curve, critical flow, discharge curve Specific force Specific depth, and Critical depth. Channel Transitions. Measurement of Discharge and Velocity – Venturi Flume, Standing Wave Flume, Parshall Flume, Broad Crested Weir. Measurement of Velocity- Current meter, Floats, Hot-wire anemometer. Gradually Varied Flow-Dynamic Equation of Gradually Varied Flow, Classification of channel bottom slopes, Classification of surface profile, Characteristics of surface profile. Computation of water surface profile by graphical, numerical and analytical approaches. Direct Step method, Graphical Integration method and Direct integration method.

Module VIII: (3 hours)
Hydraulic Jump- Theory of hydraulic jump, Elements and characteristics of hydraulic jump in a rectangular Channel, length and height of jump, location of jump, Types, applications and location of hydraulic jump. Energy dissipation and other uses, surge as a moving hydraulic jump. Positive and negative surges. Dynamics of Fluid Flow-Momentum principle, applications: Force on plates, pipe bends, moments of momentum equation,

Module IX: (3 hours)
Flow through Pipes: Loss of head through pipes, Darcy-Wiesbatch equation, minor losses, total energy equation, hydraulic gradient line, Pipes in series, equivalent pipes, pipes in parallel, flow through laterals, flows in dead end pipes, siphon, power transmission through pipes, nozzles. Analysis of pipe networks: Hardy Cross method, water hammer in pipes and control measures, branching of pipes, three reservoir problems.

Module X: (2 hours)
Computational Fluid Dynamics: Basic equations of fluid dynamics, Grid generation, Introduction to inviscid incompressible flow, Boundary layer flow as applicable to C.F.D. Hydro informatics: Concept of hydro informatics – scope of internet and web-based modelling in water resources engineering.

Suggested Readings

1. Hydraulics and Fluid Mechanics, P.M. Modi and S.M. Seth, Standard Book House
2. Theory and Applications of Fluid Mechanics, K. Subramanya, Tata McGraw Hill.
3. Open channel Flow, K. Subramanya, Tata McGraw Hill.

4. Open Channel Hydraulics, Ven Te Chow, Tata McGraw Hill.
5. Burnside, C.D., "Electromagnetic Distance Measurement," Beekman Publishers, 1971. MOOCs, Link: https://nptel.ac.in/courses/105/103/105103096/

Mapping of COs to Syllabus

	CO1	CO2	CO3
Module I	H		
Module II	H		
Module III			H
Module IV			H
Module V	H	M	L
Module VI		H	
Module VII		H	
Module VIII			
Module IX	H		M
Module X			H

CVSE0058: STRUCTURAL ENGINEERING
(3 Credits - 45 Hours) (L:T:P:2-1-0)
***Objectives**: This course aims at providing students with a solid background on principles of structural engineering design. Students will be exposed to the theories and concepts of both concrete and steel design and analysis both at the element and system levels. Hands-on design experience and skills will be gained and learned through problem sets and a comprehensive design project. An understanding of real-world open-ended design issues will be developed. Weekly recitations and project discussions will be held besides lectures.*
Prerequisites: Engineering Mathematics, Engineering Physics, Introduction to solid mechanics

COURSE/LEARNING OUTCOMES
At the end of the course, the student will be able to:

CO1. Describe the behaviour and properties of concrete and steel
CO2. *Examine determinate and indeterminate trusses, beams, and frames*
CO3. *Execute the knowledge of structural mechanics in addressing design problems of structural engineering*
CO4. *Demonstrate the concepts of Prestressed Concrete and fireproofing of structures*

Module I: (9 hours)
Introduction-Concepts of energy principles, safety, sustainable development in performance; what makes a structure; principles of stability, equilibrium; what is a structural engineer, role of engineer, architect, user, builder; what are the functions' what do the engineers design, first principles of process of design.
Planning and Design Process; Materials, Loads, and Design Safety; Behaviour and Properties of Concrete and Steel; Wind and Earthquake Loads.

Module II: (12 hours)
Materials and Structural Design Criteria: Introduction to the analysis and design of structural systems. Analyses of determinate and indeterminate trusses, beams, and frames, and design philosophies for structural engineering. Laboratory experiments dealing with the analysis of determinate and indeterminate structures;

Module III: (15 hours)
Design of Structural Elements: Concrete Elements, Steel Elements, Structural Joints; Theories and concepts of both concrete and steel design and analysis both at the element and system levels. Approximate Analysis Methods as a Basis for Design; Design of Reinforced Concrete Beams for Flexure; Design of Reinforced Concrete Beams for Shear; Bond, Anchorage, and Serviceability; Reinforced Concrete Columns; Reinforced Concrete Slabs; Introduction to

Steel Design; Tension Members and Connections; Bending Members; Structural Systems

Module V: (9 hours)
System Design Concepts: Special Topics that may be Covered as Part of the Design Project Discussions; Cable Structures; Prestressed Concrete Bridges; Constructability and Structural Control; Fire Protection

Suggested Readings

1. Nilson, A. H. Design of Concrete Structures. 13th edition. McGraw Hill, 2004
2. McCormac, J.C., Nelson, J.K. Jr., Structural Steel Design. 3rd edition. Prentice Hall,N.J., 2003.
3. Galambos, T.V., Lin, F.J., Johnston, B.G., Basic Steel Design with LRFD, Prentice Hall, 1996
4. Segui, W. T., LRFD Steel Design, 2nd Ed., PWS Publishing, Boston.
5. Salmon, C.G. and Johnson, J.E., Steel Structures: Design and Behavior, 3rd Edition, Harper & Row, Publishers, New York, 1990.
6. MacGregor, J. G., Reinforced Concrete: Mechanics and Design, 3rd Edition, Prentice Hall, New Jersey, 1997.
7. Nawy, E. G., Reinforced Concrete: A Fundamental Approach, 5th Edition, Prentice Hall, New Jersey.
8. Wang C-K. and Salmon, C. G., Reinforced Concrete Design, 6th Edition, Addison Wesley, New York.
9. Nawy, E. G. Prestressed Concrete: A Fundamental Approach, Prentice Hall, NJ,(2003).
10. Related Codes of Practice of BIS Smith, J. C., Structural Analysis, Harpor and Row, Publishers, New York.
11. W. McGuire, R. H. Gallagher and R. D. Ziemian. “Matrix Structural Analysis", 2nd Edition, John Wiley and Sons, 2000.
12. NBC, National Building Code, BIS (2017).
13. ASCE, Minimum Design Loads for Buildings and Other Structures, ASCE 7-02, American Society of Civil Engineers, Virginia, 2002.

Mapping of COs to Syllabus

	CO1	CO2	CO3	CO4
Module I	H			
Module II		H	H	
Module III			H	
Module IV				H

CVGE0059: GEOTECHNICAL ENGINEERING
(2 Credits - 30 hours) (L:T:P: 2-0-0)

Objectives: To impart knowledge to classify the soil based on index properties and to assess their engineering properties based on the classification. To familiarize the students about the fundamental concepts of compaction, flow through soil, stress transformation, stress distribution, consolidation and shear strength of soils. To impart knowledge of design of both finite and infinite slopes

COURSE/LEARNING OUTCOMES
On completion of this course, students will be able to -
CO1: Characterise and classify the soils based on the index properties
CO2: . Able to estimate seepage, stresses under various loading conditions and compaction characteristics
CO3: Compute and analyze the consolidation settlements
CO4: Investigate the stability of slopes and shear strength characteristics of soil

Module I: (6 hours)
Introduction: Soil formation and structure, definition of soil and soil mechanics, common soil mechanics problems in Civil Engineering, phase diagrams, basic definitions- moisture content, unit weights, degree of saturation, voids ratio, porosity, specific gravity, mass specific gravity, etc. Inter relationship between volume weights, voids ratio-moisture content, unit weight-percent air voids, saturation moisture content, moisture content- specific gravity etc.

Index Properties of Soils: Definitions and importance of index properties, grain size analysis. stokes's law and hydrometer analysis, Atterberg limits, flow Index and toughness Index, consistency and sensitivity of clay, Classification of coarse and fine grained soils as per Indian Standard.

Module II:

Permeability: Soil water, capillary rise, flow of water through soils, Darcy’s law-assumptions and validity, seepage velocity, superficial velocity and their relationships, Coefficient of permeability and its determination, factors affecting permeability, laboratory determination of coefficient of permeability, permeability of layered soils.
Effective stress in soils: Total pressure and effective stress and its importance, principle of effective stress, effect of water table, quick sand phenomenon, seepage pressure, seepage through soils, capillary phenomenon, flownets: Characteristics and uses.

Module III: (6 hours)
Stress Distribution in Soils: Stress distribution in homogeneous and isotropic medium, Boussinesq's and Westerguard's theories for concentrated, circular, rectangular loads and strip load, Newmark's influence chart and its uses. Pressure bulb. Contact pressure.
Compaction of Soil: Definition and object of compaction and concept of OMC and zero air void line, standard and modified proctor tests, factors affecting compaction, effect of compaction on soil properties, field compaction methods- rollers and vibrators, field compaction control- proctor's needle.

Module IV: (3 hours)
Consolidation of Soil: Definition and object of consolidation, comparison between compaction and consolidation, Types of compressibility-initial, primary and secondary consolidation, Mass-spring analogy, Terzaghi's one dimensional consolidation theory – assumptions, limitations and applications, coefficient of consolidation: square root time and logarithm of time fitting methods, computation of total settlement and time rate of settlement, normal, under and over consolidated soils, Pre-consolidation pressure, coefficient of consolidation and their importance, Causes of over-consolidation, importance of consolidation settlement in the design of structures.

Module V: (3 hours)
Shear Strength of Soils: Concept and importance of shear strength, Mohr circle and its characteristics, Mohr’s strength theory, Mohr-Coulomb theory, Types of laboratory tests for strength parameters, Shear strength based on different drainage conditions, Shear strength parameters, factors affecting shear strength of soils, strength envelops, shear strength of sand, critical void ratio, shear strength of clays, vane shear test.

Module VI: (6 hours)
Stability of Slopes: Introduction, types of slopes failures, factor of safety, concept of finite and infinite slopes, Swedish circle method, friction circle method, Taylor’s stability number, stability charts, sliding block analysis.
Soil Exploration: Necessity of sub-soil exploration, borings method of soil exploration, Penetration tests, plate load tests. Types of samplers- undisturbed, disturbed and representative samples, area ratio, recovery ratio, clearance stabilization of bore holes, preparation of soil investigation report, geophysical and advance soil exploration methods.

Suggested Readings
1. Soil Mechanics and Foundation Engineering by K. R. Arora, standard publisher and Distributors, Delhi
2. Basic and Applied Soil Mechanics by Gopal Ranjan and A.S.R Rao, New age international publishers
3. Soil Mechanics and Foundations by B.C Punmia , Ashok Kr Jain and Arun Kr Jain
4. Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering (Civil and Environmental Engineering) by V.N.S. Murthy
5. Soil Mechanics in Engineering Practice by Karl Terzaghi, Ralph B. Peck, and GholamrezaMesri.
6. Fundamentals of Soil Engineering by Taylor, John Wiley & Sons
7. An Introduction to Geotechnical Engineering, by Holtz R.D. and Kovacs, W.D., Prentice Hall, NJ
8. Principles of Geotechnical Engineering, by Braja M. Das, Cengage Learning
9. Principles of Foundation Engineering, by Braja M. Das, Cengage Learning MOOCs Link: https://nptel.ac.in/courses/105/105/105105168/

Mapping of COs to Syllabus

Module	CO1	CO2	CO3	CO4
Module I	H			
Module II	M	H		
Module III		H		
Module IV		M	H	
Module V				H
Module VI				H

CVHW0060: HYDROLOGY AND WATER RESOURCES ENGINEERING

(3 Credits-45 hours) (L-T-P:2-1-0)

Objectives

This course is intended to make the students exposed to the key features of hydrological science including precipitation, data analysis, rainfall-runoff analysis, ground water hydrology, hydrographs, flood routing, hydrological design, risk analysis and uncertaininty.it also familiarizes the students with important aspects of irrigation and dams & spillways.

COURSE /LEARNING OUTCOMES

After the completion of the course, the students will be able to

CO1: Define the various components of the hydrological cycle, discuss the forms of precipitation and precipitation measuring instruments, evaluate the average precipitation depth in a catchment. Understand the abstractions such as infiltration, evaporation, evapotranspiration and depression storage. Define and analyse the infiltration indices

CO2: Discuss the flow duration curve and flow mass curve, understand the concept of hyetograph, hydrograph and the factors affecting runoff hydrograph, discuss the unit hydrograph theory and apply unit hydrograph concept for computing runoff, understand the components of groundwater and groundwater storages. Evaluate the yield of well under saturated or unsaturated aquifers.

CO3: Classify the methods and types of irrigation, analyze the water requirements of crops, understand the various types of soil water, design regime channels, understand canal losses, canal lining and water logging.

CO4: Classify dams; understand the site selection of dams, design gravity and earth dams, analyse estimation of seepage in gravity and earth dam, analyze the storage capacity and yield of reservoirs, understand the concept of regulation of reservoirs, classify the reservoir storages, understand reservoir sedimentation, discuss the various spillway components

Module I: (3 hours)

Introduction - hydrologic cycle, water-budget equation, history of hydrology, World water balance, applications in engineering, sources of data.

Module II: (4 hours)

Precipitation - forms of precipitation, characteristics of precipitation in India, measurement of precipitation, rain gauge network, mean precipitation over an area, depth area- duration relationships, maximum intensity/depth-duration-frequency relationship, Probable Maximum Precipitation (PMP), rainfall data in India.

Module III: (6 hours)

Abstractions from precipitation - evaporation process, evaporimeters, analytical methods of evaporation estimation, reservoir evaporation and methods for its reduction, evapotranspiration, measurement of evapotranspiration, evapotranspiration equations, potential evapotranspiration over India, actual evapotranspiration, interception, depression storage, infiltration, infiltration capacity, measurement of infiltration, modelling infiltration capacity, classification of infiltration capacities, infiltration indices.

Module IV: (6 hours)

Runoff - runoff volume, SCS-CN method of estimating runoff volume, flow duration curve, flow-mass curve, hydrograph, factors affecting runoff hydrograph, components of hydrograph, base flow separation, effective rainfall, unit hydrograph surface water resources of India, environmental flows.

Module V: (6 hours)

Ground-water and well hydrology - forms of subsurface water, saturated formation, aquifer properties, geologic formations of aquifers, well hydraulics: steady state flow in wells, equilibrium equations for confined and unconfined aquifers, aquifer tests.

Module VI: (6 hours)

a. Water withdrawals and uses – water for energy production, water for agriculture, water for hydroelectric generation; flood control. Analysis of surface water supply, Water requirement of crops-Crops and crop seasons in India, cropping pattern, duty and delta;
b. Quality of irrigation water; Soil-water relationships, root zone soil water, infiltration, consumptive use, irrigation requirement, frequency of irrigation; Methods of applying water to the fields: surface, sub-surface, sprinkler and trickle /

drip irrigation.

Module VII: (6 hours)
Distribution systems - canal systems, alignment of canals, canal losses, estimation of design discharge. Design of channels- rigid boundary channels, alluvial channels, Kennedy's and Lacey's theory of regime channels. Canal outlets: non-modular, semi-modular and modular outlets. Water logging: causes, effects and remedial measures. Lining of canals, types of lining. Drainage of irrigated lands: necessity, methods.

Module VIII: (8 hours)
a. Dams and spillways - embankment dams: Classification, design considerations, estimation and control of seepage, slope protection. Gravity dams: forces on gravity dams, causes of failure, stress analysis, elementary and practical profile. Arch and buttress dams.
b. Spillways: components of spillways, types of gates for spillway crests; Reservoirs- Types, capacity of reservoirs, yield of reservoir, reservoir regulation, sedimentation, economic height of dam, selection of suitable site.

Suggested Readings

1. K Subramanya, Engineering Hydrology, Mc-Graw Hill.
2. K N Muthreja, Applied Hydrology, Tata Mc-Graw Hill.
3. K Subramanya, Water Resources Engineering through Objective Questions, Tata Mc-Graw Hill.
4. G L Asawa, Irrigation Engineering, Wiley Eastern
5. L W Mays, Water Resources Engineering, Wiley.
6. J D Zimmerman, Irrigation, John Wiley & Sons
7. C S P Ojha, R Berndtsson and P Bhunya, Engineering Hydrology, Oxford.

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4	CO5
Module I	H				
Module II			H		
Module III			M		
Module IV		H			
Module V				H	
Module VI				H	
Module VII			H	M	
Module VIII			L	M	H

CVEE0061: ENVIRONMENTAL ENGINEERING
(2 credits-30 hours) (L-T-P:2-0-0)

Objectives
Starting with an introductory lesson on environment vis-a-vis pollution of its components, this course basically deals with various issues related to water supply to community as well as waste water treatment and disposal which constitutes a prime area of practice for civil engineers. Through this course students will get familiarize with land pollution, noise pollution and air pollution.

COURSE/LEARNING OUTCOMES
After successfully studying this course, students will be able to:
1. Relate the impact of humans on environment and environment on humans
2. Summarize the principles and operation of water, waste water, solid waste and air pollution treatment systems and the required appurtenances and accessories.
3. Plan strategies to control, reduce and monitor pollution and select the most appropriate technique for the treatment of water, wastewater solid waste and contaminated air.
4. Adapt with basic environmental legislation

Module I: 8 hours
a. Water: -Sources of Water and quality issues, water quality requirement for different beneficial uses, Water quality standards, water quality indices, water safety plans, Water Supply systems, need for planned water supply schemes, Water demand industrial and agricultural water requirements, Components of water supply system; Transmission of water, Distribution system, Various valves used in W/S systems, service reservoirs and design.
b. Water Treatment: aeration, sedimentation, coagulation flocculation, filtration, disinfection, advanced treatments like adsorption, ion exchange, membrane processes

Module II: 7 Hours
Sewage- Domestic and Stormwater, Quantity of Sewage, Sewage flow variations. Conveyance of sewage- Sewers, shapes design parameters, operation and maintenance of sewers, Sewage pumping; Sewerage, Sewer appurtenances, Design of sewerage systems. Small bore systems, Storm Water- Quantification and design of Storm water; Sewage and Sullage, Pollution due to improper disposal of sewage, National River cleaning plans, Wastewater treatment, aerobic and anaerobic treatment systems, suspended and attached growth systems, recycling of sewage – quality requirements for various purposes.

Module III: 3 Hours
Air - Composition and properties of air, Quantification of air pollutants, Monitoring of air pollutants, Air pollution- Occupational hazards, Urban air pollution automobile pollution, Chemistry of combustion, Automobile engines, quality of fuel, operating conditions and interrelationship. Air quality standards, Control measures for Air pollution, construction and limitations

Module IV: 2 Hours
Noise- Basic concept, measurement and various control methods.

Module V: 5 Hours
Solid waste management-Municipal solid waste, Composition and various chemical and physical parameters of MSW, MSW management: Collection, transport, treatment and disposal of MSW. Special MSW: waste from commercial establishments and other urban areas, solid waste from construction activities, biomedical wastes, Effects of solid waste on the environment: effects on air, soil, water surface and ground health hazards. Disposal of solid waste-segregation, reduction at source, recovery and recycle. Disposal methods- Integrated solid waste management. Hazardous waste: Types and nature of hazardous waste as per the HW Schedules of regulating authorities.

Module VI: 3 Hours
Building Plumbing-Introduction to various types of home plumbing systems for water supply and waste water disposal, high rise building plumbing, Pressure reducing valves, Break pressure tanks, Storage tanks, Building drainage for high rise buildings, various kinds of fixtures and fittings used.

Module VII: 2 Hours
Government authorities and their roles in water supply, sewerage disposal. Solid waste management and monitoring/control of environmental pollution.

Suggested Readings

1. Introduction to Environmental Engineering and Science by Gilbert Masters, Prentice Hall, New Jersey.
2. Introduction to Environmental Engineering by P. Aarne Vesilind, Susan M. Morgan, Thompson /Brooks/Cole; Second Edition 2008.
3. Peavy, H.s, Rowe, D.R, Tchobanoglous, G. *Environmental Engineering*, Mc-Graw Hill International Editions, New York 1985. 4. MetCalf and Eddy. *Wastewater Engineering, Treatment, Disposal and Reuse*, Tata McGraw-Hill, New Delhi.
4. Manual on Water Supply and Treatment. Ministry of Urban Development, New Delhi.
5. Plumbing Engineering. Theory, Design and Practice, S.M. Patil, 1999
6. Integrated Solid Waste Management, Tchobanoglous, Theissen & Vigil. McGraw Hill Publication
7. Manual on Sewerage and Sewage Treatment Systems, Part A, B and C. Central Public Health and Environmental Engineering Organization, Ministry of Urban Development.

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I	L	H	M	
Module II		H	M	
Module III		H	M	
Module IV		H	M	
Module V	H	H	M	L
Module VI		H		
Module VII				H

CVTE0062: TRANSPORTATION ENGINEERING

(2 credits-30 hours) (L-T-P:2-0-0)

Objective
This course introduces Transportation Engineering, a core civil engineering practice in the field with prime focus on the highway engineering sector. On completion a student should be competent enough for planning and designing of different types of roads with necessary quality control in road construction and maintenance.

COURSE/LEARNING OUTCOMES

On completion of the course, the students will be able to:

1. Carry out traffic studies and surveys involved in planning and highway alignment
2. Design the geometric elements of highways and expressways and flexible and rigid pavements as per IRC
3. Implement traffic regulation and control measures
4. Characterize pavement materials

Module I: (3 hours)

Highway development and planning: Classification of roads, road development in India, Current Road projects in India; highway alignment and project preparation.

Module II: (10 hours)

Geometric design of highways: Introduction; highway cross section elements; sight distance, design of horizontal alignment; design of vertical alignment; design of intersections, problems

Module III: (4 hours)

Traffic engineering & control- Traffic Characteristics, traffic engineering studies, traffic flow and capacity, traffic regulation and control; design of road intersections; design of parking facilities; highway lighting; problems

Module IV: (3 hours)

Pavement materials- Materials used in Highway Construction- Soils, Stone aggregates, bituminous binders, bituminous paving mixes; Portland cement and cement concrete: desirable properties, tests, requirements for different types of pavements. Problems

Module V: (10 hours)

Design of pavements- Introduction; flexible pavements, factors affecting design and performance; stresses in flexible pavements; design of flexible pavements as per IRC; rigid pavements- components and functions; factors affecting design and performance of CC pavements; stresses in rigid pavements; design of concrete pavements as per IRC; problems

Suggested Readings

1. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, 'Highway Engineering', Revised 10th Edition, Nem Chand & Bros, 2017
2. Kadiyalai, L.R., ' Traffic Engineering and Transport Planning', Khanna Publishers.
3. Partha Chakraborty, ' Principles Of Transportation Engineering, PHI Learning,
4. Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski,'Principles of Highway Engineering and Traffic Analysis', 4th Edition, John Wiley
5. Srinivasa Kumar, R, Textbook of Highway Engineering, Universities Press, 2011.
6. Paul H. Wright and Karen K. Dixon, Highway Engineering, 7th Edition, Wiley Student Edition, 2009.

Mapping of Cos to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I	H	L		
Module II		H		
Module III	M	L	H	
Module IV				H
Module V		H		

CVCM0063: CONSTRUCTION ENGINEERING & MANAGEMENT

(3 credits- 45 hours) (L-T-P:3-0-0)

Objective

The objectives of this course are to make students understand the concepts of Project Management for planning to execution of Projects, contracts, equipment, network analysis tools for cost and time estimation etc. which are pertinent to the management of a construction project.

COURSE/LEARNING OUTCOMES

At the end of this course students will be able to:

1. Plan and develop project organization for executing construction projects.
2. Apply knowledge and skills of modern construction practices and techniques.
3. Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.
4. Organize and monitor the construction projects with respect to time and cost

Module I (2 hours)

Basics of Construction- Unique features of construction, construction projects types and features, phases of a project, agencies involved and their methods of execution; Construction project planning- Stages of project planning: pre-tender planning, pre-construction planning, detailed construction planning, role of client and contractor, level of detail.

Module II (8 hours)
Process of development of plans and schedules, work break-down structure, activity lists, assessment of work content, concept of productivities, estimating durations, sequence of activities, activity utility data; Techniques of planning- Bar charts, Gantt Charts. Networks: basic terminology, types of precedence relationships, preparation of CPM networks: activity on link and activity on node representation, computation of float values, critical and semi critical paths, calendaring networks. PERT- Assumptions underlying PERT analysis, determining three time estimates, analysis, slack computations, calculation of probability of completion.

Module III (8 hours)
Construction Methods basics: Types of foundations and construction methods; Basics of Formwork and Staging; Common building construction methods (conventional walls and slabs; conventional framed structure with blockwork walls; Modular construction methods for repetitive works; Precast concrete construction methods; Basics of Slip forming for tall structures; Basic construction methods for steel structures; Basics of construction methods for Bridges.

Module IV (4 hours)
Construction Equipment basics: Conventional construction methods vs Mechanized methods and advantages of latter; Equipment for Earthmoving, Dewatering; Concrete mixing, transporting & placing; Cranes, Hoists and other equipment for lifting; Equipment for transportation of materials. Equipment Productivities

Module V (8 hours)
Planning and organizing construction site and resources- Site: site layout including enabling structures, developing site organization, Documentation at site; Manpower: planning, organizing, staffing, motivation; Materials: concepts of planning, procurement and inventory control; Equipment: basic concepts of planning and organizing; Funds: cash flow, sources of funds; Histograms and S-Curves. Earned Value; Resource Scheduling- Bar chart, line of balance (LOB) technique, resource constraints and conflicts; resource aggregation, allocation, smoothing and leveling. Common Good Practices in Construction

Module VI (8 hours)
Project Monitoring & Control- Supervision, record keeping, periodic progress reports, and periodical progress meetings. Updating of plans: purpose, frequency and methods of updating. Common causes of time and cost overruns and corrective measures. Basics of Modern Project management systems such as Lean Construction; Use of Building Information Modelling (BIM) in project management; Quality control: concept of quality, quality of constructed structure, use of manuals and checklists for quality control, role of inspection, basics of statistical quality control. Safety, Health and Environment on project sites: accidents; their causes, effects and preventive measures, costs of accidents, occupational health problems in construction, organizing for safety and health.

Module VII (5 hours)
Contracts Management basics: Importance of contracts; Types of Contracts, parties to a contract; Common contract clauses (Notice to proceed, rights and duties of various parties, notices to be given, Contract Duration and Price. Performance parameters; Delays, penalties and liquidated damages; Force Majeure, Suspension and Termination. Changes & variations, Dispute Resolution methods.

Module VIII (2 hours)
Construction Costs: Make-up of construction costs; Classification of costs, time-cost trade-off in construction projects, compression and decompression.

Suggested Readings

1. Varghese, P.C., “Building Construction”, Prentice Hall India, 2007.
2. National Building Code, Bureau of Indian Standards, New Delhi, 2017.
3. Chudley, R., Construction Technology, ELBS Publishers, 2007.
4. Peurifoy, R.L. Construction Planning, Methods and Equipment, McGraw Hill, 2011
5. Nunnally, S.W. Construction Methods and Management, Prentice Hall, 2006
6. Jha, Kumar Neeraj., Construction Project management, Theory & Practice, Pearson Education India, 2015
7. Punmia, B.C., Khandelwal, K.K., Project Planning with PERT and CPM, Laxmi Publications, 2016.

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I	H			
Module II	H			

Module III		H	M	
Module IV		~~M~~ H	~~H~~ M	
Module V			H	
Module VI			H	
Module VII			M	
Module VIII				H

CVEC0064: ENGINEERING ECONOMICS, ESTIMATION & COSTING

(3 credits- 45 hours) (L-T-P:3-0-0)

Objectives

This subject will introduce the students to the basics of estimation of quantity and cost of civil engineering projects including the methods of tendering and contracting. It also deals with the valuation of properties.

COURSE / LEARNING OUTCOMES

At the end of the course students will be able to:

1. Identify fiscal and monetary policies and how this affects the economy.
2. Interpret the function of market and prices, identify key microeconomic indicators and measures of economic growth, change and development details of rate analysis for various task.
3. Relate the knowledge of the laws of supply, demand and equilibrium to analyse the responses of market, explain the concepts of gross domestic product, inflation and unemployment and how they are measured detailing of various structures specification.
4. Develop quantity estimates of civil engineering materials required in a particular project and the cost of the project and conduct property valuation and tendering process.

Module I: (3 hours)

Basic Principles and Methodology of Economics. Demand/Supply – elasticity –Government Policies and Application. Theory of the Firm and Market Structure. Basic Macro-economic Concepts (including GDP/GNP/NI/Disposable Income) and Identities for both closed and open economies. Aggregate demand and Supply (IS/LM). Price Indices (WPI/CPI), Interest rates, Direct and Indirect Taxes

Module II: (2 hours)

Public Sector Economics –Welfare, Externalities, Labour Market. Components of Monetary and Financial System, Central Bank – Monetary Aggregates; Commercial Banks & their functions; Capital and Debt Markets. Monetary and Fiscal Policy Tools & their impact on the economy – Inflation and Phillips Curve.

Module III: (3 hours)

Elements of Business/Managerial Economics and forms of organizations. Cost & Cost Control –Techniques, Types of Costs, Lifecycle costs, Budgets, Break even Analysis, Capital Budgeting, Application of Linear Programming. Investment Analysis – NPV, ROI, IRR, Payback Period, Depreciation, Time value of money (present and future worth of cash flows). Business Forecasting – Elementary techniques. Statements – Cash flow, Financial. Case Study Method.

Module IV: (2 hours)

Indian economy - Brief overview of post-independence period – plans. Post reform Growth, Structure of productive activity. Issues of Inclusion – Sectors, States/Regions, Groups of people (M/F), Urbanization. Employment–Informal, Organized, Unorganized, Public, Private. Challenges and Policy Debates in Monetary, Fiscal, Social, External sectors.

Module V: (7 hours)

Estimation / Measurements for various items- Introduction to the process of Estimation; Use of relevant Indian Standard Specifications for the same, taking out quantities from the given requirements of the work, comparison of different alternatives, Bar bending schedules, Mass haul Diagrams, Estimating Earthwork and Foundations, Estimating Concrete and Masonry, Finishes, Interiors, MEP works; BIM and quantity take-offs; adding equipment costs; labour costs; rate analysis; Material survey-Thumb rules for computation of materials requirement for different materials for buildings, percentage breakup of the cost, cost sensitive index, market survey of basic materials. Use of Computers in quantity surveying

Module VI: (6 hours)

Specifications-Types, requirements and importance, detailed specifications for buildings, roads, minor bridges and industrial structures.

Rate analysis-Purpose, importance and necessity of the same, factors affecting, task work, daily output from different equipment/ productivity.

Module VII: (hours)

Tender- Preparation of tender documents, importance of inviting tenders, contract types, relative merits, prequalification. general and special conditions, termination of contracts, extra work and Changes, penalty and liquidated charges, Settlement of disputes, R.A. Bill & Final Bill, Payment of advance, insurance, claims, price variation, etc. Preparing Bids- Bid Price build-up: Material, Labour, Equipment costs, Risks, Direct & Indirect Overheads, Profits; Bid conditions, alternative specifications; Alternative Bids. Bid process management .
Introduction to Acts pertaining to-Minimum wages, Workman's compensation, Contracts, Arbitration, Easement rights.

Suggested Readings

1. Mankiw Gregory N. (2002), Principles of Economics, Thompson Asia
2. V. Mote, S. Paul, G. Gupta(2004), Managerial Economics, Tata McGraw Hill
3. Misra, S.K. and Puri (2009), Indian Economy, Himalaya
4. Pareek Saroj (2003), Textbook of Business Economics, Sunrise Publishers
5. M Chakravarty, Estimating, Costing Specifications & Valuation
6. Joy P K, Handbook of Construction Management, Macmillan
7. B.S. Patil, Building & Engineering Contracts
8. Relevant Indian Standard Specifications.
9. World Bank Approved Contract Documents.
10. FIDIC Contract Conditions.
11. Acts Related to Minimum Wages, Workmen's Compensation, Contract, and Arbitration
12. Typical PWD Rate Analysis documents.
13. UBS Publishers & Distributors, Estimating and Costing in Civil Engineering: Theory and Practice including Specification and Valuations,2016
14. Dutta, B.N., Estimating and Costing in Civil Engineering (Theory & Practice), UBS Publishers, 2016

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I		M	H	
Module II	H			
Module III			H	
Module IV	H			
Module V		M		H
Module VI		H	H	M
Module VII			H	H

CVCS0065: DESIGN OF CONCRETE STRUCTURES I

(3 credits – 45 hours)

Objectives

The objective of this course is to familiarize the students with all fundamental concepts of reinforced cement concrete design. RCC has been the predominant structural entity in the present day civil engineering constructions. The main goal of this course is to provide students with all information concerning different principles, ways of analyzing, as well as structural designing and detailing of RCC elements. The knowledge acquired will lay a good foundation for analysis and design of various civil engineering structures/systems in a reliable manner.

COURSE/LEARNING OUTCOMES

After completion of the course students will be able to:

1. Explain the design philosophies of reinforced concrete structures.
2. Analyse reinforced concrete structural systems for bending, shear, bond and torsion.
3. Carry out analysis and design of concrete structural elements such as beams, columns, slabs and footings.

Module I: (8 hours)

Introduction to loads, stresses and design philosophies: Study of the strength, behavior, and design of indeterminate reinforced concrete structures, load and stresses, load combinations, working stress and limit state approach

Module II: (12 hours)

Design for bending, shear, bond and torsion: Analysis and design of sections in bending – working stress and limit state method, rectangular and T-sections, beams with reinforcement in compression, design for shear and bond, mechanism of shear and bond failure, design of shear using limit state concept, development length of bars, design of sections in torsion

Module III: (9 hours)

Design of slabs Design of one-way slab, design of two-way slabs, design of flat slab – direct method, circular slab, slab type staircase, placement of reinforcement in slabs, voided slab

Module IV: (8 hours)
Design of compression members: Short column, columns with uni-axial and bi-axial bending, long columns, use of design charts

Module V: (8 hours)
Design of foundation Wall footing, isolated and combined footing for columns

Suggested Readings

1. IS 456-2000 - Code of practice for R.C.C design.
2. S. Unnikrishnan Pillai and Devadas Menon, Reinforced Concrete Design, Tata McGraw- Hill
3. S. Ramamrutham and R. Narayan, Design of Reinforced Concrete Structures, Dhanpat Rai Publishing Company (P) Ltd.
4. P. C. Varghese, Limit State Design of Reinforced Concrete, Prentice Hall of India Ltd
5. N. Krishna Raju, Structural Design and Drawing - Reinforced Concrete and Steel, Universities Press Ltd.
6. Dr. B.C Punmia, Ashok Kr Jain and Arun Kr Jain, Reinforced Concrete Structures Vol. I, Laxmi Publications
7. S.S. Bhavikatti, Design of R.C.C structural Elements Vol. I, New age international publishers.
8. H. Mehra and V. N Vazirani, Limit State Design, Khanna Publishers MOOCs Link: https://nptel.ac.in/courses/105/105/105105105/

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3
Module I	H	H	
Module II		M	
Module III			H
Module IV			H
Module V			H

CVED0066: CIVIL ENGINEERING DESIGN I

(3 credits – 45 hours)(L:T:P:2:1:0)

Objectives
The objective of this course is to familiarize the students with all fundamental concepts of civil engineering design. The main goal of this course is to provide students with all information concerning risk and vulnerability, health and safety in civil engineering design. The course will lay a good foundation for computer aided drawing and design of civil engineering structures in a reliable manner through application of state of the art techniques like geomatics, GIS etc.

COURSE/LEARNING OUTCOMES
After completion of the course students will be able to:

1. Model the structural behaviour of different reinforced concrete structural elements through CAD techniques.
2. Design and detail different elements of reinforced concrete structural systems subjected to gravity and lateral loads.
3. Carry out environmental impact assessment, risk and vulnerability analysis in design.

Module I: Concept of civil engineering design (12 hours)
Concept of design and its contribution to the quality of life, introduction to civil engineering design, the role of geomatics, the environment, and scientific laws in design

Module II: Introduction to design of civil engineering infrastructure (18 hours)
Design of buildings and civil engineering infrastructure, site appraisal, risk and vulnerability in design, health and safety in civil engineering design, environmental impact assessment

Module III: Computer aided drawing and design (15 hours)
Civil engineering drawing, CAD techniques, introduction to GIS techniques, application of GIS in civil engineering projects

Suggested Readings

1. B. L. Davies, A. J. Robotham, A. Yarwood, Computer Aided Drawing and Design, Springer-Science + Business Media, B.V.
2. S. Choudhury, D. Chakrabarti, S. Choudhury, An Introduction to Geographic Information Technology, I. K. International
3. S. Labi, Introduction to Civil Engineering Systems, Wiley
4. C. D. Ghilani, Elementary Surveying: An Introduction to Geomatics, Pearson
5. B. M. Ayyub, Vulnerability, Uncertainty and Risk: Analysis, Modeling and Management, ASCE
6. Institution of Civil Engineers, The Management of Health and Safety in Civil Engineering
7. S. C. Basu Roy, Handbook of Modern Technology in Civil Engineering, A. Nabhi Publication
8. N. S. Raman, A. R. Gajbhiye, S. R. Khandeswar, Environmental Impact Assessment, I. K. International

9. N. Madhu, R. Sathikumar and Satheesh Gobi, Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson India
10. Manoj, K. Arora and Badjatia, Geomatics Engineering, Nem Chand & Bros

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3
Module I			H
Module II		H	
Module III	H		

CVHS0067: DESIGN OF HYDRAULIC STRUCTURES & IRRIGATION ENGINEERING

(3 Credits – 45 hours)

Objective

This course aims at the implementation of the principles of fluid mechanics, hydraulics and geotechnical engineering for the design of various hydraulic structures like dams, weirs, cross-drainage structures etc. The course will also introduce the various design procedures for lined and unlined canals.

COURSE OUTCOMES/ LEARNING OUTCOMES

The students will be able to

1. Perform the stability analysis of gravity dams
2. Explain the causes of failure of different types of dams and their design criteria
3. Design minor irrigation structures such as regulators, cross drainage works etc.

Module I (10 hours)

Diversion head works- layout and functions of components, Weir and barrage- Causes of failure of weirs on permeable soils - Bligh's theory. Design of vertical drop weir. Khosla's theory of independent variables- Khosla's corrections-Use of Khosla's charts.

Module II (10 hours)

Irrigation canals, canal alignment- cross section of unlined canals- Design of canals through alluvial soils-Kennedy's theory and Lacey's theory. Cross drainage works-Types, selection of suitable type, Type of aqueducts. Regulation Works - Canal falls-necessity, classification. Canal regulators- Regulator cum road bridge- Head regulators and cross regulators.

Module III (15 hours)

Dams-Types, Gravity dam – selection of site- forces acting - stability analysis and modes of failure – Principal and shear stresses - Problems - Elementary profile –limiting height of gravity dams- high and low dams- Practical profiles, Functions of various components shafts, keys, water stops, and different types of gallery, Grouting. Instrumentation in dams.

Module IV (10 hours)

Arch dams-types, methods for design (list only)-Thin cylinder theory. Earth dams-types, causes for failure and design criteria. Spillways-Types. Effective length of spillway- Ogee type spillway profile. Energy dissipation below spillways - Stilling basins-Indian standard Type I and Type II.

Suggested Readings

1. Garg S.K, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 2006.
2. Modi. P. N., Irrigation Water Resources and Water Power Engineering, Standard Book House, 2009.
3. Punmia B.C. Ashok K Jain, Arun K Jain, B. B. L Pande, Irrigation and Water Power Engineering, Laxmi Publications Pvt. Ltd., 2010.

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3
Module I			H
Module II			H
Module III	H	M	
Module IV		H	

CVSA0068: STRUCTURAL ANALYSIS-I

(3 Credits-45 Hours) (L: T: P: 2:1:0)

Objective

This subject is conceptual applications of principles of mechanics of rigid and deformable bodies in Engineering.

COURSE/LEARNING OUTCOMES

After successful completion of the course students will be able to:

1. Define statically determinate and indeterminate structural members and bending moment shear force, strain energy principles, different methods of finding internal forces and deflections.
2. Classify beams frames and columns in terms of determinacy, stability and dimensions, buckling behaviour of columns and struts with different end conditions.
3. Apply principles of statics etc. to determine the energy principles for analyzing the frames and beams, determination various stresses acting on a body, analysis of various arches, cables and bridges.
4. Analyse indeterminate structural members with different types of loadings, fixity and estimate the safe load carrying capacity of structural members.

Module I: 10 Hours

Fundamentals of Statically Determinate Structures: Types of statically determinate & indeterminate structures, static and kinematic indeterminacy, stability of structures, principle of superposition, Maxwell’s reciprocal theorems. Computation of internal forces in statically determinate structures such as plane truss, plane frame, grids.

Arches, Cables and* Suspension Bridges*: Calculation of internal forces in three hinge arches with circular and parabolic shapes subjected to various types of loading. Forces and end actions in cables due to various types of loading. Unstiffened three hinged parabolic and catenary type suspension bridge.

Module II: 17 Hours

Displacement of Determinate Beams and Plane Truss: Differential equation of elastic curve, relation between moment, slope and deflection, Macaulay’s method, Moment Area Method, Conjugate Beam Method applied to beams. Joint displacement of determinate plane truss using unit load method.

Strain Energy: Strain Energy Resilience, strain energy due to axial loads & flexure, proof resilience, modulus of resilience, impact loads, and sudden loads.

Module III: 10 Hours

Direct and Bending stresses: Members subjected to eccentric loads, middle third rule, kernel of section, chimney subjected to wind pressure, retaining walls, dams subjected to hydraulic pressure.

Columns and Struts: Buckling of columns, different end conditions, effective length, least radius of gyration, Euler's and Rankine's formula, columns with initial curvature, eccentrically loaded columns, columns with lateral loading

Module IV: 8 Hours

Fixed Beams & Consistent Deformation Method: Computation of fixed-end actions for various types of loads and secondary Effects using basic principles beams of varying moment of inertia. Analysis of propped cantilever beams & beams of varying moment of inertia using Consistent Deformation Method

Suggested Readings

1. L.S. Negi, Theory and Problems in Structural Analysis, Tata McGraw Hill Pub, 1997.
2. Junnarkar. S. B and Shah H.J- Mechanics of Structures Vol 1 & Vol.2 – 27th Edition, Charotar Publishers, 2008.
3. Wang C.K. - Intermediate Structural Analysis – Tata McGraw Hill Publishers, 2010.
4. Punmia.B.C, Ashok Kumar Jain and Arun Kumar Jain, " Theory of structures", Laxmi Publications Pvt. Ltd., New Delhi, 2004
5. BhaviKatti, S.S, "Structural Analysis –Vol. 1 & Vol. 2", Vikas Publishing Pvt Ltd., New Delhi, 2008.

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I	H	L	H	
Module II	H	H		
Module III		H	H	M
Module IV			H	H

CVBP0069: BUILDING CONSTRUCTION PRACTICE

(3 credits—45 hours)

Objectives

The objective of this course is to familiarise students about the characteristics of construction materials used in civil engineering and to develop the skills for identification of suitable construction materials for civil engineering projects. The course deals with all the general practices in construction of substructure and superstructure of a building.

COURSE/LEARNING OUTCOMES

After successful completion of the course students will be able to:

1. Understand the construction equipment’s practices and techniques to be used in the field.

2. Select appropriate construction material and heavy equipment based on applications, utilization, productivity, and other factors.
3. Identify the components of building and the factors to be considered in building construction and develop the construction practices and techniques and assess various precautionary measures pertaining to construction materials

Module I: General practices in building construction (18 hours)
Specifications, details and sequence of activities and construction co-ordination, site clearance, marking, earthwork, masonry - stone masonry, bond in masonry, concrete hollow block masonry, flooring, damp proof courses, construction joints, movement and expansion joints, pre cast pavements, building foundations, basements, temporary shed, centering and shuttering, slip forms, scaffoldings, de-shuttering forms, fabrication and erection of steel trusses, frames, braced domes, laying brick, weather and water proof, roof finishes, acoustic and fire protection

Module II: Sub structure construction (14 hours)
Techniques of box jacking, pipe jacking, under water construction of diaphragm walls and basement, tunnelling techniques, piling techniques, well and caisson, sinking cofferdam, cable anchoring and grouting, driving diaphragm walls, sheet piles, shoring for deep cutting, well points, dewatering and stand by plant equipment for underground open excavation

Module III: Super structure construction (13 hours)
Launching girders, bridge decks, offshore platforms, special forms for shells, techniques for heavy decks, in-situ pre-stressing in high rise structures, material handling, erecting light weight components on tall structures, support structure for heavy equipment and conveyors, erection of articulated structures, braced domes and space decks

Suggested Readings
1. B. C. Punmia, Ashok K. Jain, Arun K. Jain, 'Building Construction', Eleventh Edition, Laxmi Publications
2. S. K. Duggal, 'Building Materials', CRC Press
3. M. K. Gupta, 'Practical Handbook on Building Construction', A Nabhi Publication
4. Rangwala, 'Building Construction', Charotar Publications
5. P. Purushothama Raj, 'Building Construction Materials and Techniques', Pearson
6. S. K. Khanna, 'A Textbook of Building Construction', S. Chand

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3
Module I	H	M	
Module II			H
Module III			H

CVGI0070: GEOGRAPHIC INFORMATION SYSTEMS AND SCIENCE
(3 credits – 45 hours) L:T:P:3-0-0)

Objective
This elective course is designed to familiarise the students with the modern tools of geographic information systems (GIS) which are useful for analysis and interpretation of occurrences on the earth's surface. Foundation of GIS will help the students to go ahead for using this tool in decision making and bio-physical modelling.

COURSE/LEARNING OUTCOMES
On completion of the course, the students will be able to:
1. Define the different types of maps, coordinate systems and recognize the importance and ease of surveying using remote sensing.
2. Understand fundamental concepts and practices of Geographic Information Systems (GIS) and advances in Geospatial Information Science and Technology.
3. Apply basic graphic and data visualization concepts and GIS analysis to address geospatial problems and/or research questions and demonstrate the proficiency in the use of GIS tools to create maps that are fit-for-purpose and effectively convey the information they are intended to.

Module I (15 hours)
Investigation of geographic information systems (GIS) and science (GIScience) including theory and applications areas. Use of a current widely-used GIS computer software system.

Module II (15 hours)
Aspects of geographic data entry and editing, spatial analysis, and map development and display to be considered.

Module III (15 hours)

Relationship of GIS to the Global Positioning System (GPS) and satellite generated data.

Suggested Readings

1. Satheesh Gopi, R. Sathikumar, N. Madhu, Advanced Surveying — Total Station, GIS and Remote Sensing, Pearson Education.
2. Paul Longely, M.F. Goodchild, et al., Geographic Information System, Volume I and II, John Wiley and Sons, Inc. 1999.
3. J.B. Cambell, Introduction to Remote Sensing, Taylor and Francis, London, 1996

Mapping of COs to syllabus

Course Outcome	CO1	CO2	CO3
Module I		H	M
Module II	H		
Module III			H

CVIC0071: SOFT SKILLS AND INTERPERSONAL COMMUNICATION

(3 credits – 45 hours)

Objective

The objective of this course is to equip students with the vital communication and soft skills to succeed in the highly competitive international arena. This course specifically aims at imparting fundamental soft skills and their practical social and workplace usage. The course also attempts to enable students to identify and overcome the barriers in interpersonal relationships, and to employ oral and written communication, teamwork, leadership, problem-solving and decision-making skills, to gain best results.

COURSE/LEARNING OUTCOMES

At the end of the course, students will be able to:

1. Understand the significance and essence of a wide range of soft skills.
2. Learn how to apply soft skills in a wide range of routine social and professional settings.
3. Learn how to employ soft skills to improve interpersonal relationships
4. Learn how to employ soft skills to enhance employability and ensure workplace and career success.

Module I (10 hours)

a. Soft Skills: An Introduction – Definition and Significance of Soft Skills; Process, Importance and Measurement of Soft Skill Development.
b. Self-Discovery: Discovering the Self; Setting Goals; Beliefs, Values, Attitude, Virtue.
c. Positivity and Motivation: Developing Positive Thinking and Attitude; Driving out Negativity; Meaning and Theories of Motivation; Enhancing Motivation Levels.

Module II (12 hours)

a. Interpersonal Communication: Interpersonal relations; communication models, process and barriers; team communication; developing interpersonal relationships through effective communication; listening skills; essential formal writing skills; corporate communication styles – assertion, persuasion, negotiation.
b. Public Speaking: Skills, Methods, Strategies and Essential tips for effective public speaking.
c. Group Discussion: Importance, Planning, Elements, Skills assessed; Effectively disagreeing, Initiating, Summarizing and Attaining the Objective.
d. Non-Verbal Communication: Importance and Elements; Body Language.
e. Teamwork and Leadership Skills: Concept of Teams; Building effective teams; Concept of Leadership and honing Leadership skills.

Module III (11 hours)

a. Interview Skills: Interviewer and Interviewee – in-depth perspectives. Before, During and After the Interview. Tips for Success.
b. Presentation Skills: Types, Content, Audience Analysis, Essential Tips – Before, During and After, Overcoming Nervousness.
c. Etiquette and Manners – Social and Business.
d. Time Management – Concept, Essentials, Tips.
e. Personality Development – Meaning, Nature, Features, Stages, Models; Learning Skills; Adaptability Skills.

Module IV (12 hours)

a. Decision-Making and Problem-Solving Skills: Meaning, Types and Models, Group and Ethical Decision-Making, Problems and Dilemmas in application of these skills.
b. Conflict Management: Conflict - Definition, Nature, Types and Causes; Methods of Conflict Resolution.

c. Stress Management: Stress - Definition, Nature, Types, Symptoms and Causes; Stress Analysis Models and 8 Impact of Stress; Measurement and Management of Stress
d. Leadership and Assertiveness Skills: A Good Leader; Leaders and Managers; Leadership Theories; Types of Leaders; Leadership Behaviour; Assertiveness Skills.
e. Emotional Intelligence: Meaning, History, Features, Components, Intrapersonal and Management Excellence; Strategies to enhance Emotional Intelligence.

Suggested Readings

1. Managing Soft Skills for Personality Development – edited by B.N.Ghosh, McGraw Hill India, 2012.
2. English and Soft Skills – S.P. Dhanavel, Orient Blackswan India, 2010.

CVSS0072: DESIGN OF STEEL STRUCTURES

3 credits-45 Hours (L:T:P;2:1:0)

Objectives

This course deals with the basic concepts and their applications in the field of design of steel structures. Keeping in mind the skyrocketing trend of application of steel as a construction material in present day construction engineering, this course is intended to be the stepping stone for the students to the modern construction industry.

COURSE/LEARNING OUTCOMES

1. Define the design approaches using steel sections of various types, identify the advantages of steel structures over concrete structures
2. Classify different types of steel sections and connections that are used in the design of steel structures and compare their adequacy to different types of externally applied loadings.
3. Analyse designed connections and members and inspect the deficiencies in the connections in case the connections turn out to be unsafe and take part in providing remedial measures in case of failure prediction.
4. Estimate the performance of a designed member, examine a steel structure for any faults and defects and take steps to minimize it, predict whether a particular design are sufficient for a given situation.

Module I 5 Hours

Introduction and design approach: Properties of Structural Steel I.S. Rolled Sections, I.S. Specifications, Permissible and Working Stresses, Limit State Design Method

Module II 8 Hours

Connections: Type of Connections, Bolted and Welded Connections, Strength and Efficiency of Bolted and Welded Joints, Design of lap and butt joint, Modes of failure of a Bolted joint, Advantages and Disadvantages of Welded joints, Design of Eccentric Connections

Module III 6 hours

Tension Members: Net Sectional Area, Permissible Stress, Design of Axially Loaded Tension Member, Design of tension members subjected to axial tension and bending, splicing of tension members.

Module IV 10 Hours

Design of compression members: Modes of failure of a column, Buckling Failure, Effective Length, Slenderness Ratio, Design of Concentrically and Eccentrically Loaded Built-Up Compression Members, Laced and Battened Columns Column Base: Centrally and Eccentrically loaded Base Plate Design, Flat Slab Base, Gusseted Base, Grillage Foundation

Module V 10 Hours

Beams: Design Procedure, Simple and Built Up Beams, Laterally Restrained and Unrestrained Beams, Plate Girder: Plate Thickness, Web Crippling, Web Buckling Beam Column: Eccentricity of Load, Interaction Formulae, Design Procedure

Module VI 6 Hours

Introduction to Plastic analysis; Simple cases of beams and frames; All design steps/process to as per the most recent BIS code of practices

Suggested Readings

1. IS 800:2007-Code of practice for Steel Design
2. N.Subramanian, Design of Steel Structures
3. S.S. Bhavikatti, Design of Steel Structures
4. S.Ramamrutham, Design of Steel Structures
5. Dr. B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, Design of Steel Structures
6. MOOCs Link : https://nptel.ac.in/courses/105/105/105105162/

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I	H			
Module II	L	M	H	
Module III				H
Module IV				H
Module V				H
Module VI				H

CVRS0073: REPAIRS AND REHABILITATION OF STRUCTURES

(3 credits-45 Hours) (L:T:P: 2:1:0)

Objective

To make the students gain knowledge on quality of concrete, durability aspects, causes of deterioration, assessment of distressed structures, repairing and retrofitting of structures and demolition procedures.

COURSE OUTCOMES

1. Understand special types of concrete and their use and different engineering properties of hardened concrete.
2. Estimate the properties of concrete using NDTs.
3. Understand various damage detection and rehabilitation techniques in case of RCC structures.

Module I (20 hours)

Properties of hardened concrete, Strength and durability of concrete, Modern trends in concrete manufacture and placement techniques, Methods of transportation, Placing and curing, extreme weather concreting, special concreting methods, Vacuum dewatering of concrete, underwater concreting. Properties and applications of High-performance concrete, reactive powder concrete, Lightweight, heavyweight and mass concrete, fibre reinforced concrete, self-compacting concrete, Fly ash Concrete, Fibre reinforced Concrete, Polymer Concrete, Epoxy resins and screeds for rehabilitation – properties and application, Emerging trends in replacement of fine aggregates.

Module II (15 hours)

Introduction to NDT, Situations and contexts where NDT is needed, classification of NDT procedures, visual inspection, half-cell electrical potential methods, Schmidt Rebound hammer test, resistivity measurement, electromagnetic methods, radiographic testing, ultrasonic testing infrared thermography, ground penetrating radar, radioisotope gauges, other methods.

Module III (10 hours)

Damages in RCC structures- Cracks in concrete, corrosion of reinforcement. Repair, rehabilitation and retrofitting of structures, Damage assessment of concrete/steel structures, materials and methods for repairs and rehabilitation, Damage assessment and Evaluation models, Damage testing methods, Importance of re-analysis, execution of rehabilitation strategy, case studies.

Suggested Readings

1. K. Ravishankar, T. S. Krishnamoorthy, “Structural Health Monitoring, Repair and Rehabilitation of Concrete Structures”, Allied Publishers.
2. Hand book on ‘Seismic Retrofitting of Buildings’ Published CPWD, Indian Building Congress in Association with IIT Madras, Narosa Publishing House.
3. M. Nevile, “Concrete Technology”, Prentice Hall, New York.

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3
Module I	H		
Module II		H	M
Module III			H

CVPT0074: PHYSICOCHEMICAL PROCESSES OF WATER AND WASTE WATER TREATMENT

(3 credits-45 Hours) (L:T:P: 2:1:0)

Objective

This course gives an introduction into the physical and chemical water, wastewater, sludge, solid waste and waste gas treatment processes. The course is useful for students interested in the operation and planning of municipal and industrial water, wastewater and waste treatment plants.

COURSE/LEARNING OUTCOMES

After successful completion of the course students will be able to:

1. Describe the most important physical and chemical water, wastewater, sludge, solid waste and waste gas treatment processes
2. Explain the theoretical background of relevant physical and chemical treatment units
3. Choose favourable treatment methods for specific water, waste and gases
4. Design and dimension the most common physical and chemical unit processes

Module I 5 Hours
Water – Quality, Standards and Criteria: Physical, chemical and biological water quality parameters; Water quality guidelines, criteria and standards; Wastewater Effluent standards

Module II 6 Hours
Purification of water- Natural treatment processes- Physical, chemical and biological processes. Water treatment technologies- overview. Primary, Secondary and tertiary treatment-Unit operations &unit processes

Module III 5 Hours
Screening & Grit removal: Screens; grit channels, aerated grit chambers;

Module IV 7 Hours
Settling Tanks, Coagulation and Flocculation: Theory of settling; Types of settling; Settling Tanks; Coagulation-flocculation; Flash mixing tanks and flocculation tanks; Tube settlers and plate settlers.

Module V 3 Hours
Aeration: Diffused and surface and gas transfer processes.

Module VI 6 Hours
Filtration Systems: Filtration theory and filter hydraulics; Slow sand filters; Rapid gravity filters; Pressure filters; Multimedia filters.

Module VII 5 Hours
Disinfection: Chlorination; Ozonation; UV radiation

Module VIII 8 Hours
Other Water Treatment Technologies: Ion-exchange process; Adsorption process- Adsorption equilibria- adsorption isotherms; membrane processes (nano-filtration, ultrafiltration and reverse osmosis).

Suggested Readings
1. Metcalf and Eddy, “Wastewater Engineering – Treatment and Reuse”, Tata McGraw Hill.
2. Syed R. Qasim, Edward Motley, Guang Zhu, “Water Works Engineering”- Planning, Design and Operation, PHI
3. Weber W.J., “Physico-chemical Processes for Water Quality Control”, John-Wiley
4. Howard S. Peavy, Donald R. Rowe & George Tchobanoglous, “Environmental Engg.”, McGraw Hill
5. Viessman Jr, Hammer J. M, Perez, E.M, and Chadik, P. A, Water Supply and Pollution Control, PHI Learning
6. Hammer, M.J. and Hammer, M.J. Jr., “Water and Wastewater Technology”, PHI Learning

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I				
Module II	H			
Module III		H	H	
Module IV		H	H	H
Module V		H	H	
Module VI		H	H	
Module VII		H	H	
Module VIII			H	H

CVRE0075: RAILWAY ENGINEERING

(3 credits – 45 hours) (L-T-P:3-0-0)

Objective
This elective course is in continuation with the course of Transportation Engineering with prime focus on various aspects of railway engineering. On completion a student should be competent enough in the planning and design of various components related to railway infrastructure.

COURSE/LEARNING OUTCOMES

On completion of the course, the students will be able to:
1. Illustrate the various elements of geometric design of railways.
2. Design Track geometry for a railway line and railway crossings and find solutions to practical problems.
3. Assess the capacity on a railway section.

Module I: Introduction to railways, its component parts and its functions (10 hours)
Railway track gauge, alignment of railway lines, engineering surveys and construction of new lines, tracks and track stresses;

Module II: Railway Alignment (15 hours)
Rails, sleepers; ballast; subgrade and formation, track fittings and fastenings, creep of rails, rail joints and welding of rails;

Module III: Railway Geometric Design (20 hours)
Geometric design of track, curves and super-elevation, points and crossings, track junctions and simple track layouts; track maintenance, track drainage; modern methods of track maintenance, rehabilitation and renewal of track; tractive resistance and power, railway stations and yards; railway tunneling; signaling and interlocking; maintenance of railways and high-speed trains.

Suggested Readings
1. S.P. Arora, S.C. Saxena, A Textbook of Railway Engineering, Dhanpat Rai Publications
2. S. Chandra and M.M. Agarwal, Railway Engineering, University Press, New Delhi
3. S.C. Rangwala, Principles of Railway Engineering, Charotar Publishing House Pvt. Ltd.

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3
Module I	H		
Module II		H	
Module III		H	M

CVOC0076: OPEN CHANNEL FLOW
(3 Credits – 45 hours)

Objective
This course utilizes the concept of Hydraulic engineering to analyze various unsteady flow situations in open channels by numerical techniques. The course also illustrates the procedure of hydraulic routing in open channels.

COURSE/ LEARNING OUTCOMES
1. Ability to develop the open channel flow equations for unsteady cases from the governing equations.
2. Apply FDM techniques to solve unsteady Navier-Stokes and St. Venant’s equations.
3. Apply FVM techniques to solve unsteady Navier-Stokes and St. Venant’s equations.
4. Apply numerical techniques to solve problems related to hydraulic routing

Module I (8 hours)
Unsteady flow in open channels- terminologies, causes, applications, methods of study. Navier- Stokes equations, one- and two- dimensional St. Venant’s Equations, Method of Characteristics.

Module II (15 hours)
Finite difference methods- Explicit and implicit schemes, convergence, stability, MacCormack Scheme, ADI scheme, artificial viscosity, Beam and Warming Schemes.

Module III (15 hours)
Finite volume method- types of grids, approximation of surface and volume integrals, central, upwind and hybrid formulations.

Module IV (7 hours)
Dam break analysis, Hydraulic routing – types, methods of routing.

Suggested Readings
1. Chaudhry, M. H. (2008) "Flow in open channels", Springer.
2. Chaudhry, M. H. (1979) "Applied hydraulic transients", Van Nostrand Reinhold Company.
3. Chung, T. J. (2003) "Computational fluid dynamics", Cambridge.

Mapping of COs to syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I	H			
Module II	M	H		

Module III			H	
Module IV				H

CVSM0077: SOIL MECHANICS II

(3 credits – 45 hours)

Objectives

To apply principles of soil mechanics to engineering problems pertaining to retaining structure , foundation and embankments.

Course /Learning Outcomes

On successful completion of the course students will be able to:

1. Illustrate different construction practices for excavation with advantages and disadvantages of each method.
2. Determine the safety analysis for slopes with different methods
3. Design retaining wall subjected to various loads and sheet pile wall with different methods.

Module I: Earth pressures (15 hours)

Application of soil mechanics to determine earth pressures, earth pressure at rest, Rankine and Coulomb's theories for active and passive states, influence of surcharge, water table, wall friction and deformation on earth pressure. Culmann's graphical method, point of application.

Module II: soil retaining structures (15 Hours)

Analysis of retaining walls, design considerations for retaining walls, cuts, excavations and sheet piles, instrumentation

Module II: Stability of slopes (15 hours)

Finite and infinite slopes, concept of factor of safety, Swedish method, friction circle method, Taylor's stability number and chart, effect of submergence, steady seepage and sudden drawdown conditions.

Suggested Readings

1. Gopal Ranjan, A. S. R Rao, Basic and Applied Soil Mechanics, New Age International Publishers
2. V. N. S. Murthy, Geotechnical Engineering, Marcel Dekker, Inc.
3. Dr. B.C. Punmia, Ashok Kr Jain and Arun Kr Jain, Soil Mechanics and Foundations, Laxmi Publications
4. P. Purushothama Raj, Soil Mechanics and Foundation Engineering, Pearson

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3
Module I	L	H	
Module II		M	H
Module III		H	

CVCS0090: DESIGN OF CONCRETE STRUCTURES II

(3 credits) (L-T-P: 3-0-0)

Objectives

The objective of this course is to introduce the theory and application of analysis and design of reinforced concrete structures and to familiarize the students with professional and contemporary issues in the design and fabrication of reinforced concrete members. The course focuses on understanding the behaviour of reinforced concrete components and systems subjected to gravity as well as lateral loads. This course will enable the students to perform analysis and design of pre-stressed as well as reinforced concrete members and connections with the application of relevant Indian Standard design codes.

COURSE/LEARNING OUTCOMES

After completion of the course students will be able to:

1. Analyse reinforced concrete structural systems under gravity and lateral loads and understand the design features
2. required for the earthquake resistant construction of structures.
3. Design and detail different elements of structural systems such as reinforced concrete water tanks, staircases and
4. retaining walls and columns, and masonry walls under gravity and lateral loads.
5. Design and detail bridge culverts and simple span girders corresponding to the IRC loadings, and understand the concepts of prestressed concrete, design prestressing end block and compute losses in prestress.

Module I: Moment distribution in beams and frames (5 Hours)

Design of continuous beams and building frames, moment redistribution

Module II: Design and detailing for wind and seismic loads (8 Hours)

Estimation of wind and seismic loads, Desirable features of earthquake resistant construction, Detailing for earthquake resistant construction – ductility criteria

Module III: Design of water tanks (8 Hours)
Water tank and staging, introduction, design criteria, design of rectangular and circular water tank, design of Intze tank, staging for overhead tank

Module IV: Introduction to bridge engineering and prestressed concrete (15 Hours)
Investigation for bridges, IRC loadings, design of slab culvert, design of simple span girders, design of end block, prestressed concrete, introduction, pre-stressing system, losses in pre-stress

Module V: Staircases and retaining walls (6 Hours)
Design of staircases, design of cantilever and counter forte type retaining wall, design of masonry walls and columns.

Suggested Readings

1. IS 456-2000 **-** Code of practice for R.C.C design.
2. S. Unnikrishna Pillai and Devadas Menon, Reinforced Concrete Design, Tata McGraw- Hill
3. S. Ramamrutham and R. Narayan, Design of Reinforced Concrete Structures, Dhanpat Rai Publishing Company (P) Ltd.
4. P. C. Varghese, Limit State Design of Reinforced Concrete, Prentice Hall of India Ltd
5. N. Krishna Raju, Structural Design and Drawing - Reinforced Concrete and Steel, Universities Press Ltd.
6. Dr. B.C Punmia, Ashok Kr Jain and Arun Kr Jain, Reinforced Concrete Structures Vol. I, Laxmi Publications
7. S.S. Bhavikatti, Design of R.C.C structural Elements Vol. I, New age international publishers.
8. H. Mehra and V. N Vazirani, Limit State Design, Khanna Publishers

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3
Module I	H		
Module II	H		
Module III		H	
Module IV			H
Module V		H	

CVPC0091: PRESTRESSED CONCRETE

(3 credits) (L-T-P: 3-0-0)

Objective
It deals with the concepts of analysis and design of Prestressed Concrete sections , deflection of prestressed beams , design for flexure , shear , axial force , bond ; Transmission length , Codal provisions.

COURSE/LEARNING OUTCOMES

1. Recognize the different types of prestressed members , to identify the various types of loads acting on the section and analyse the prestressed sections .
2. Differentiate between pre-tensioned and post-tensioned concrete, Short term and long – time deflection.
3. Apply the standard methodologies as per IRC codes to predict the response of the prestressed concrete section
4. Analyse the prestressed concrete beams under various loading; identify the deflection patterns and evaluate the structural design of these structures to determine the reinforcement required and assess the performance of the structure

Module I: 15 Hours
Concept of prestressing materials for prestressed concrete, I.S. specifications; Analysis of prestressed resultant stress at section, thrust line, load balancing concept, stress in tendons, Design of simple section

Module II: 15 Hours
Deflection of prestressed concrete beams; Factors influencing deflection, deflection of uncracked and cracked members, Long time deflection, Codal provisions

Module III: 8 Hours
Design of prestressed concrete sections; Design for flexure, shear, axial force, bond and bearing, Design of prestressed members

Module IV: 7 Hours
Transfer of prestress, Transfer by bond, transmission length, code provisions for bond and transmission length

Suggested Readings

1. N. Rajagopalan , Prestressed Concrete , Narosa Book Distributers Pvt. Ltd.
2. G.S . Pandit , Prestressed Concrete 1st Edition , CBS Publisher
3. Naaman A.E., Prestressed Concrete Analysis and Design Fundamentals, McGraw Hill
4. S. Ramamrutham , Prestressed Concrete , Dhanpat Rai Publishing Company .

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I	H			
Module II		H	M	
Module III				H
Module IV			M	H

CVSA0092: STRUCTURAL ANALYSIS II

(3 credits) (L-T-P: 3-0-0)

Objectives

The course is designed to understand the classical methods of analysis of framed structures for external loads. It also highlights the approximate methods of analysis. Analysis of multistory frames for lateral load is discussed in the course. It also focuses on Matrix method of structural analysis and moving loads and influence lines.

COURSE/LEARNING OUTCOMES:

After successful completion of the course students will be able to

1. Define static and kinematic indeterminacies of structures and influence line diagrams; list different types of loading in a multi-storey frame and state the methods applicable for these loading classes:
2. Construct influence line diagrams for different types of rolling loads and make use of it to interpret the response of a bridge under moving loads,
3. Analyse the frames subjected to gravity load and lateral load as well as structural members subjected to moving loads and estimate the design parameters of the structural members under different load combinations and critical positions of moving loads.

Module I: Approximate Analysis of Multi-Storied Frames (10 hours)

Approximate Analysis of Multi-Storied frames subjected to Vertical Loads, Method of Substitute Frames; Analysis of Building Frames subjected to Horizontal Loads, Portal Method and Cantilever Method

Module II: Matrix Analysis of Framed Structures (18 hours)

Basic concepts of Structural Analysis, Deformation in Framed Structures, Equilibrium, Compatibility, Static and Kinematic Indeterminacy, Action and Displacement Equations, Principle of Superposition, Equivalent joint loads, Energy Concepts, Virtual Work, Flexibility and Stiffness Matrices and their derivation and application, Local and global stiffness matrices, relationship between flexibility and stiffness matrix

Module III: Moving loads and Influence Lines (17 hours)

a. Moving loads and influence lines: Application to determinate structures-influence lines for support reactions, shear force, bending moment for beams, trusses, 3-hinged arch, suspension bridges
b. Muller-Breslau's principles: Influence lines for statically indeterminate beams, influence lines for support reactions, bending moment, shear force in propped cantilever, two span continuous beams and for two hinged arches

Suggested Readings

1. V. N. Vazirani, M. M. Ratwani and S. K. Duggal, Analysis of Structures, Volume I and II, Khanna Publishers
2. R. Vaidyanathan and P. Perumal, Structural Analysis, Volume I and II, Laxmi Publications
3. Thandavamoorthy, Structural Analysis, Oxford Press
4. Gupta, Pandit and Gupta, Theory of Structures, McGraw Hill
2. B. C. Punmia, Theory of Structures, Laxmi Publications
3. S. Ramamrutham, Theory of Structures, Dhanpat Rai Publishing Company (P) Ltd.
4. V. K. M. Selvam, Fundamentals of Limit Analysis of Structures, Dhanpat Rai Publications

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3
Module I	H		
Module II	M		H

Module III	M	H	

CVPH0093: PORT AND HARBOUR ENGINEERING
(3 credits) (L-T-P: 3-0-0)

Objective
The primary objective of the course is to develop a knowledge and understanding of a wide range of port and harbour design and construction issues and of sustainable solutions in the port environment.

COURSE/LEARNING OUTCOMES
On completion of the course, the students will be able to:
1. Explain the significance of ports and harbours as a mode of transport.
2. Demonstrate the fundamental principles of wave hydrodynamics and port cargo handling and the basic design of port layout.
3. Design, plan and integrate port and harbour infrastructure. Explain the construction, maintenance and renovation aspects of ports and inland waterways.

Module I: Harbour Planning (10 Hours)
Types of water transportation, water transportation in India, requirements of ports and harbours, classification of harbours, selection of site and planning of harbours, location of harbour, traffic estimation, master plan, ship characteristics, harbour design, turning basin, harbour entrances, type of docks, its location and number, Site investigations – hydrographic survey, topographic survey, soil investigations, current observations, tidal observations

Module II: Docks and Repair Facilities (15 Hours)
Design and construction of breakwaters, berthing structures - jetties, fenders, piers, wharves, dolphins, trestle, moles, Harbour docks, use of wet docks, design of wet docks, repair docks, lift docks, dry docks, keel and bilge blocking, construction of dry docks, gates for dry docks, pumping plant, floating docks, slipways, locks, size of lock, lock gates, types of gates; Navigational Aids: Requirements of signals, fixed navigation structures, necessity of navigational aids, light houses, beacon lights, floating navigational aids, light ships, buoys, radar

Module III: Dredging and Coastal Protection (10 Hours)
Classification, types of dredgers, choice of dredger, uses of dredged materials, coastal erosion and protection, sea wall, revetment, bulkhead, coastal zone and beach profile

Module IV: Port facilities (10 Hours)
Port development, port planning, port building facilities, transit sheds, warehouses, cargo handling facilities, container handling terminal facilities, shipping terminals, inland port facilities. Inland waterways, Inland water transportation in India, classification of waterways, economics of inland waterways transportation, national waterways.

Suggested Readings
1. S. Seetharaman, “Construction Engineering and Management”, 4th Edition , Umesh publications, New Delhi, 1999.
2. Richard L. Silister, “Coastal Engineering Volume I & II, Elsevier Publishers, 2000.
3. Pera Brunn, “Port Engineering”, 1st Edition, Gulf Publishing Company, 2001

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3
Module I	H		
Module II		H	M
Module III			H
Module IV		M	H

CVTM0094: TRAFFIC ENGINEERING AND MANAGEMENT
(3 credits – 45 hours)

Objective
This elective course is designed to familiarize the students with the concepts of traffic engineering by providing general concepts of planning, functional design, traffic operation and management of road transportation. Forecasting of traffic, probabilistic approach towards traffic flow theory, highway capacity and study of road accidents has been introduced in detail.

COURSE/LEARNING OUTCOMES
On completion of the course, the students will be able to:
1. CO1: Define the traffic components and assess the traffic characteristics and related problems.

2. CO2: To develop a strong knowledge base of traffic planning and its management in any transportation area.
3. CO3: Understand elements of highway safety and approaches to accident Studies.
4. CO4: To provide knowledge of traffic control devices forecasting tools and their techniques in transportation interaction.

Module I: Traffic Forecast and Transportation Demand Management (12 hours)
Traffic Forecast: General travel forecasting principles, Different methods of traffic forecast - Mechanical and Analytical methods, Demand relationships, Methods for future projection; Design Hourly Volume for Varying Demand Conditions: Concept of Design vehicle units and Determination of PCU under mixed traffic conditions, Price-volume relationships, Demand functions. Determination of design hourly volume; Critical Hour concept

Module II: Highway Capacity and Level of Service (7 hours)
Highway Capacity: Factors affecting capacity, level of service; Capacity studies - Capacity of different highway facilities including unsignalised and signalised intersections. Problems in Mixed Traffic flow; Case studies

Module III: Accident Studies (8 hours)
Accident Analysis: Analysis of individual accidents and statistical data; Methods of representing accident rate; Factors influencing traffic accidents; influence of roadway and traffic conditions on traffic safety; accident coefficients; Driver strains due to roadway and traffic conditions.

Module IV: Traffic Flow Theory and Simulation (18 hours)
Traffic Flow Theory: Fundamental flow relationship and their applications, Traffic flow theories and applications; Shock waves; Queuing theory and applications; Probabilistic Aspects of Traffic Flow: Vehicle arrivals, distribution models, gaps and headway distribution models; gap acceptance merging parameters, delay models, applications; Simulation: Fundamental principle, application of simulation techniques in traffic engineering - formulation of simulation models, Case studies.

Suggested Readings
1. L.R. Kadiyali, "Traffic Engineering and Transport Planning", Khanna Publication.
2. C.J. Khisty and B.K. Lall, "Transportation Engineering: An Introduction" Prentice Hall Publication
3. G.V. Rao, "Transportation Engineering", Tata McGraw Hill.
4. S.K. Khanna and C.E.G. Justo, "Highway Engineering", Nem Chand and Bros, Roorkee.

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I	H			M
Module II	M	HF		
Module III			H	
Module IV		H		

CVMS0095: METRO SYSTEMS AND ENGINEERING
(3 credits) (L-T-P: 3-0-0)

Objective
The primary objective of the course is to develop a knowledge and understanding of the Metro rail system and the role of various fields of engineering in construction and smooth functioning of the metro rail network.

COURSE/LEARNING OUTCOMES
On completion of the course, the students will be able to:
1. Explain various components of a metro rail track and outline the process of railway track construction; classify railway stations and recognize the importance of railway track maintenance.
2. Analyse the automatic fare collection system of metro rail network.
3. Design and solve problems related to tunneling and ventilation in underground railway tracks.
4. Analyse, compute and design components related to power supply and substations for metro rail network.

Module I: (3 Hours)
Overview of Metro Systems; Need for Metros; Routing studies; Basic Planning and Financials

Module II: (12 Hours)
Overview and construction methods for: Elevated and underground Stations; Viaduct spans and bridges; Underground tunnels; Depots; Commercial and Service buildings. Initial Surveys & Investigations; Basics of Construction Planning & Management, Construction Quality & Safety Systems. Traffic integration, multimodal transfers and pedestrian facilities; Environmental and social safeguards; Track systems-permanent way. Facilities Management

Module III: (10 Hours)
Signaling systems; Automatic fare collection; Operation Control Centre (OCC and BCC); SCADA and other control systems; Platform Screen Doors.

Module IV: (10 Hours)
Rolling stock, vehicle dynamics and structure; Tunnel Ventilation systems; Air conditioning for stations and buildings; Fire control systems; Lifts and Escalators

Module V: (10 Hours)
OHE, Traction Power; Substations- TSS and ASS; Power SCADA; Standby and Back-up systems; Green buildings, Carbon credits and clear air mechanics.

Suggested Readings
1. Satish Chandra and Agarwal M. M., Railway Engineering, Oxford University Press.
2. S.P. Arora, S.C. Saxena, A Textbook of Railway Engineering, Dhanpat Rai Publications
3. S.C. Rangwala, Principles of Railway Engineering, Charotar Publishing House Pvt. Ltd.

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I	H	M		
Module II	H		M	
Module III		H		
Module IV			H	
Module V				H

CVBE0096: BRIDGE ENGINEERING
(3 credits) (L-T-P: 3-0-0)

Objective
It deals with the concepts of analysis and design of some advanced R.C.C bridges and steel bridges, their foundations and further their inspection and maintenance.

COURSE/LEARNING OUTCOMES
After successful completion of the course students will be able to:
1. Recognize the different types of bridges and their suitability, and identify the various classes of loading acting on the bridges.
2. Analyse and design the superstructure components of RC and steel bridges with respect to various IRC loadings.
3. Analyse and design the substructure components of RC and steel bridges

Module I: 3 Hours
General; classification of bridges, site selection, geometric and hydraulic design consideration

Module II: 7 Hours
Loading standards for highway and railway bridges, general design consideration; optimum spans

Module III: 12 Hours
Concrete bridges: culverts; Slab, T-beam, box girder bridges, balanced cantilever bridge, cable stayed bridge, arch bridge; Special requirements for Prestressed Concrete bridges

Module IV: 8 Hours
Steel bridges: plate girder bridge, truss bridge, suspension cable bridge, cable stayed bridge

Module V: 15 Hours
Substructures: design of piers and abutments, pile and well foundations, bearings and expansion joints, special wearing coats; seismic design considerations; Aerodynamic stability considerations; special durability measures; provisions for inspection and maintenance

Suggested Readings
1. N. Krishna Raju, Design of Bridges , 4th Edition , Oxford and IBH publishing Co. Pvt. Ltd.
2. Jagadeesh and Jayaram , Design of Bridge Structures , PHI Learning Private Ltd.
3. Johnson Victor, Essentials of Bridge Engineering, 6th Edition , Oxford and IBH publishing Co. Pvt. Ltd.

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3
Module I	H		
Module II	H	M	
Module III		H	
Module IV		H	
Module V			H

CVBH0097: BASICS OF COMPUTATIONAL HYDRAULICS

(3 credits) (L-T-P: 3-0-0)

Objectives

This course introduces the governing equations describing the flow and transport in surface and subsurface water systems and the application of finite difference methods for the solution of these governing equations.

COURSE/LEARNING OUTCOMES

After successful completion of the course students can:

1. Explain the one-, two- and three-dimensional flow equations and know when to use their approximations.
2. Analyze a numerical scheme for numerical diffusion, dispersion, stability and convergence.
3. Implement different numerical schemes for hydraulics related problems appearing in civil engineering.

Module I: Introduction to the governing equations of fluid flow (16 Hours)

Concept of control volume and control mass/ system; Reynold's Transport Theorem; Derivation of continuity equation, momentum equation (Navier-Stokes equations) and energy equation for finite control volume and infinitesimally small fluid element fixed in space; Derivation of one-dimensional St. Venant equation to model open-channel flow; Derivation of flow equation in groundwater; Derivation of generalized contaminant transport equation in groundwater for both reactive and non-reactive transport.

Module II: Introduction to finite difference, finite volume and finite element methods (17 Hours)

Classification of partial differential equations- hyperbolic, parabolic and elliptic differential equations; General behavior of different classes of partial differential equation; Finite difference methods: difference equations, explicit and implicit approaches, error and stability analysis of explicit and implicit techniques; Finite Volume Methods: Philosophy, discretization procedure; Finite element method: Rayleigh-Ritz, Collocation and Galerkin methods.

Module III: Application of Finite difference methods in CFD (12 Hours)

Application of Crank Nicholson technique, The Lax-Wendroff Technique and MacCormack's Technique for the solution of Navier-Stokes equations and contaminant transport equation in groundwater and surface water; Introduction to numerical computation in Scilab (Free and opensource).

Suggested Readings

1. Anderson Jr., J.D (1995). Computational Fluid Dynamics - the Basics with applications. McGraw-Hill, Inc., New York.
2. Hoffman, J.D. (2001). Numerical methods for engineers and scientists. Marcel Dekker, Inc., New York.
3. White, F.M. (2008). Fluid Mechanics. Tata McGraw Hill.

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3
Module I	H		
Module II	H	M	
Module III		M	H

CVSH0098: SOLID AND HAZARDOUS WASTE MANAGEMENT

(3 credits) (L-T-P: 3-0-0)

Objective

This course provides an in-depth understanding of solid and hazardous waste characteristics and management. Some basics of radioactive waste characterization and handling are also provided.

COURSE/LEARNING OUTCOMES:

After completion of the course students will be able to

1. Explain municipal solid waste management systems with respect to its physical properties, and associated critical considerations in view of emerging technologies

2. Identify sources, types and composition of solid waste with methods of handling, sampling and storage and treatment of solid waste.
3. Select the appropriate method for solid waste collection, transportation, redistribution and disposal.
4. Describe methods of disposal of hazardous solid waste.

Module I: Municipal Solid Waste Management (16 Hours)
Sources; composition; generation rates; collection of waste; separation, transfer and transport of waste; treatment and disposal options
Hazardous Waste Management: Characterization of waste; compatibility and flammability of chemicals; fate and transport of chemicals; health effects
Radioactive Waste Management**:** Sources, measures and health effects; nuclear power plants and fuel production; waste generation from nuclear power plants; disposal options

Module II: Environmental Risk Assessment (5 Hours)
Defining risk and environmental risk; methods of risk assessment; case studies

Module III: Relevant Regulations (2 Hours)
Municipal solid waste (management and handling) rules; hazardous waste (management and handling) rules; biomedical waste handling rules; fly ash rules; recycled plastics usage rules; batteries (management and handling) rules

Module IV: Physicochemical Treatment of Solid and Hazardous Waste (9 Hours)
Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physicochemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation); ground water contamination and remediation

Module V: Biological Treatment of Solid and Hazardous Waste (8 Hours)
Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation

Module VI: Landfill design (5 Hours)
Landfill design for solid and hazardous wastes; leachate collection and removal; landfill covers; incineration

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I		H	M	
Module II	H			
Module III	H		L	
Module IV	M	H		
Module V	M	H		
Module VI	L	M		H

Suggested Readings

1. Basics of Solid and Hazardous Waste Mgmt. Tech. by Kanti L. Shah *1999,* Prentice Hall.
2. Solid and Hazardous Waste Management 2007 by S.C. Bhatia Atlantic Publishers & Dist.
3. Pichtel, John. Waste Management Practices: Municipal, Hazardous and Industrial. CRC Press, Taylor and Francis Group, 2005.
4. LaGrega, Michael D., Buckingham, Philip L. and Evans, Jeffrey C. Hazardous Waste Management. Waveland Press Inc., Reissue Edition, 2010.
5. Watts, Richard J. Hazardous Wastes - Sources, Pathways, Receptors. Wiley (1 Edition), 1998.
6. www.epa.gov US Environmental Protection Agency
7. www.envfor.nic.in Ministry of Environment, Forest and Climate Change, Government of India

CVEE0099: EARTHQUAKE ENGINEERING

(3 credits) (L-T-P: 3-0-0)

Objective
The main objective of this course is to illustrate the fundamentals of structural and soil dynamics to foresee the potential consequences of strong earthquakes on urban areas and civil infrastructure. The course deals with the problems and solutions in attaining efficient earthquake-resistant structures and facilities. This course will be a stepping stone towards designing, constructing and maintaining structures to perform at earthquake exposure up to the expectations and in compliance with building codes.

COURSE OUTCOMES

On completion of the course students will be able to:

1. Explain the basic elements of engineering seismology and theory of vibrations.
2. Understand the earthquake behaviour of buildings; illustrate the detailing requirements of buildings for earthquake resistant construction; classify the methods of dynamic analysis and translate the analytical outputs into mitigating effects of earthquake on structures and identify the codal provisions for ductile detailing of structures, base isolation techniques, vibration control measures
3. Solve the equations of dynamic motions to compute the magnitude of ground vibrations; predict the liquefaction potential of soil; apply earthquake analysis methods as per Indian Standard Codes to find out the response spectrum of SDOF and MDOF systems.
4. Estimate the seismic performance of building with respect to site specific response and design spectra.

Module I: Elements of seismology (6 Hours)

Causes of earthquake, geological faults, tectonic plate theory, elastic rebound, epicentre, hypocentre, primary, shear and Raleigh waves, seismogram, magnitude and intensity of earthquakes, magnitude and intensity scales, spectral acceleration, information on some disastrous earthquakes

Module II: Analysis of single and multi-degree of freedom systems (6 Hours)

SDOF idealization - equations of motion of SDOF system for mass as well as base excitation, free vibration of SDOF system, response to harmonic excitation, impulse and response to unit impulse, Duhamel integral, introduction to multiple degree of freedom systems, two degree of freedom system, normal modes of vibration, natural frequencies, mode shapes, decoupling of equations of motion, concept of mode superposition (no derivations)

Module III: Elements of seismology (18 Hours)

Causes of earthquake, geological faults, tectonic plate theory, elastic rebound, epicentre, hypocentre, primary, shear and Raleigh waves, seismogram, magnitude and intensity of earthquakes, magnitude and intensity scales, spectral acceleration, information on some disastrous earthquakes

Module IV: Design of earthquake resilient structures (15 Hours)

Response of structures to earthquake, response and design spectra, design earthquake, concept of peak ground acceleration, site specific response spectrum, effect of soil properties and damping, liquefaction of soils, importance of ductility, methods of introducing ductility into RC structures, design methodology, codal provisions and design as per the codes IS 1893, IS 13920 and IS 4326, base isolation techniques, vibration control measures, important points in mitigating effects of earthquake on structures

Suggested Readings

1. Mario Paz, Structural Dynamics: Theory and Computation, CBS Publishers, 2004
2. Manish Shrikhande and Pankaj, Earthquake Resistant Design of Structures, Phi Learning, 2006
3. Vinod Hosur, Earthquake-Resistant Design of Building Structures, Wiley and Sons
4. Anil K. Chopra, Dynamics of Structures Theory and Application to Earthquake Engineering, Pearson Education Singapore Pte Ltd.
5. Sekaran Rajasekaran, Structural Dynamics of Earthquake Engineering: Theory and Application, Woodhead Publishing Limited

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I	H			
Module II	H	M		
Module III	M	H	H	
Module IV		H	H	H

CVST0100: STRUCTURAL DYNAMICS

(3 credits) (L-T-P: 3-0-0)

Objectives

The primary objective of this course is to learn the methods of analysing structures subjected to any kind of dynamic excitation and computing quantities like displacements, forces, stresses, etc. This course will help in understanding the analytical methods and procedures in a way that emphasize physical insight. On completion of this course, the students will be able to apply the structural dynamics theory to real-world problems like seismic analysis and design of structures.

COURSE OUTCOMES

1. The students will understand the fundamental theory of dynamic equations of motion, fundamental analysis methods for dynamic systems, dynamic properties and behaviour of civil structures, modeling approach of dynamic response in civil engineering applications
2. The students will be able to apply knowledge of mathematics, science, and engineering by developing the equations of motion for vibratory systems and solving for the free and forced response.
3. The students will be able to create simple computer models for engineering structures using knowledge of structural dynamics
4. The students will be able to apply structural dynamics theory to earthquake analysis, response, and design of structures and interpret dynamic analysis results for design, analysis and research purposes

Module I: Introduction to dynamic behaviour of structures (6 Hours)
Analysis of the dynamic response of structures and structural components to transient loads and foundation excitation

Module II: SDOF systems (12 Hours)
Analysis of single-degree-of-freedom systems, free vibrations, damped and undamped free vibrations, critical damping, and response, periodic loading expressed in harmonics, dynamic load factor, response of SDOF to impulsive loading, rectangular, triangular pulses, Duhamel Integral, response to general dynamic loading, numerical schemes such as Wilson-Theta, Newmark-Beta, constant linear acceleration, time domain and frequency domain analysis

Module III: MDOF systems (12 Hours)
Multi-degree freedom system, stiffness and flexibility approaches, Lumped-mass matrix, free vibrations, fundamental frequencies and mode shapes, orthogonality of modes, numerical schemes to find mode shapes and frequencies, damped and undamped vibrations of MDOF, response of MDOF to dynamic loading, formulations of equations of motion, normal coordinates, mode superposition method, modal matrix, numerical scheme of Wilson and Newmark

Module IV: Response spectrum analysis (15 Hours)
Response spectrum concepts, simple inelastic structural systems, structural response to earthquake, response spectrum design earth quake, IS code provisions for multistory frames, introduction to systems with distributed mass and flexibility, free vibrations of uniform beams, differential equation and solution boundary conditions, finite difference solution, finite element, Ritz Approach free vibrations of simply supported plate

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I	H			
Module II	M	H		
Module III	M	H	M	
Module IV			H	H

Suggested Readings

1. Sekaran Rajasekaran, Structural Dynamics of Earthquake Engineering: Theory and Application, Woodhead Publishing Limited
2. Anil K. Chopra, Dynamics of Structures, Prentice Hall, Second Edition, ISBN0-13-086973-2
3. Additional Recommended Text: Leonard Meirovitch, Fundamentals of Vibrations, McGraw Hill, ISBN 0070413452

CVEL0101: ENVIRONMENTAL LAWS AND POLICY

(3 credits) (L-T-P: 3-0-0)

Objectives
To explain the role of law, policy and institutions in the conservation and management of natural resources as well as pollution control and to equip the students with the skills needed for interpreting laws, policies and judicial decisions

COURSE/LEARNING OUTCOMES:
After successfully completing the course students will be able to:

1. **CO1**:be familiar with the laws, policies and institutions in the field of environment
2. **CO2**: acquire the skills needed for interpreting laws, policies and judicial decisions in a holistic perspective
3. **CO3**: acquire the ability to evaluate the role of law and policy in conservation and management of natural resources and prevention of pollution

Module I: 9 Hours
Basic Concepts in Environmental Law. An introduction to the legal system; Constitution, Acts, Rules, Regulations; Indian

Judiciary, Doctrine of precedents, judicial review, Writ petitions, PIL–liberalization of the rule of locus standi, Judicial activism. Introduction to environmental laws in India; Constitutional provisions, Stockholm conference; Bhopal gas tragedy; Rio conference. General principles in Environmental law: Precautionary principle; Polluter pays principle; Sustainable development; Public trust doctrine. Overview of legislations and basic concepts.

Module II: 9 Hours
Forest, Wildlife and Biodiversity related laws Evolution and Jurisprudence of Forest and Wildlife laws; Colonial forest policies; Forest policies after independence Statutory framework on Forests, Wildlife and Biodiversity: IFA, 1927; WLPA, 1972; FCA, 1980; Biological Diversity Act, 2002; Forest Rights Act, 2006. Strategies for conservation–Project Tiger, Elephant, Rhino, leopard

Module III: 13 hours
Air, Water and Marine Laws National Water Policy and some state policies Laws relating to prevention of pollution, access and management of water and institutional mechanism: Water Act, 1974; Water Cess Act, 1977, EPA, 1986. Pollution Control Boards Ground water and law Judicial remedies and procedures Marine laws of India; Coastal zone regulations. Legal framework on Air pollution: Air Act,1981; EPA, 1986

Module IV: 6 Hours
Environment protection laws and large Projects Legal framework on environment protection-Environment Protection Act as the framework legislation–strength and weaknesses; EIA; National Green tribunal The courts infrastructure projects.

Module V: 3 Hours
Hazardous Substances and Activities Legal framework: EPA and rules made thereunder; PLI Act, 199 Principles of strict and absolute liability.

Module VI: 5 Hours
International Environmental law an introduction to International law; sources of international law; law of treaties; signature, ratification Evolution of international environmental law: Customary principles; Common but differentiated responsibility, Polluter pays principle.

Suggested Readings
1. Birnie P. (2009) et al., International Law and the Environment, 3rd ed., Oxford.
2. Desai A. (2002) Environmental Jurisprudence, 2nd ed., Modern Law House, Allahabad.
2. Gadgil M. and Guha R. (1995) Ecology and Equity, Oxford, New Delhi.
3. Gadgil M. and Guha R. (1997) This Fissured Land, Oxford, New Delhi.
2. Guha R. (2000) Environmentalism: A Global History, Oxford, New Delhi.
3. Kamala S. and Singh U.K. (eds.) (2008) Towards Legal Literacy: An Introduction to Law in India, Oxford, New Delhi.
4. Leelakrishnan P. (2006) Environmental Law Case Book, 2nd ed, Lexis Nexis, India.
5. Sands P. (2002) Principles of International Environmental Law, 2nd ed, Cambridge.
6. Singh C. (1986) Common Property and Common Poverty, Oxford, New Delhi.
7. Upadhyay S. and Upadhyay V. (2002) Hand Book on Environmental Law- Forest Laws, Wildlife Laws and the Environment; Vols. I, II and III, Lexis Nexis- Butterworths-India, New Delhi.

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3
Module I	H	M	
Module II		H	
Module III		H	
Module IV		H	
Module V		H	
Module VI	H		M

CVSE0102: SUSTAINABLE ENGINEERING & TECHNOLOGY
(3 credits) (L-T-P: 3-0-0)

Objectives
This course introduces concepts green chemistry and different techniques to achieve sustainability.

COURSE OUTCOMES
After learning this course, the students should be able to
1. Understand the different principles of sustainable development and design for various infrastructural applications.
2. Comprehend the concepts of Cleaner Technologies and waste management.

3. Outline the concepts and regulations related to Green Productivity and emerging technologies.

Module I: 15 Hours
Principles of sustainable developments, SDGs, Concepts of green technology/design/architecture, and its principles. Importance, history and evolution of Green Technology. Design Criteria and major elements for consideration - Green building. Green Building Technologies & Case Studies.

Module II: 10 Hours
Concept of Cleaner Production, Definition of Cleaner Production, Role of Industry, Government and Institutions in cleaner Production. Introduction to Life Cycle Assessment (LCA).

Module III: 10 Hours
Green Productivity concepts, methodology & techniques, Eco-efficiency vs. eco-effectiveness, Guidelines of APO on Green Productivity, CEPI Index.

Module IV: 5 Hours
Principles & Management of Municipal Waste Management. 3 R concepts in solid waste management

Module V: 5 Hours
Emerging technologies and their techno economic evaluation.

Suggested Readings

1. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
2. Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning
3. Green Productivity and Cleaner Production: A Guidebook for Sustainability Hardcover by Guttila Yugantha Jayasinghe, Shehani Sharadha Maheepala, 2020
4. Cleaner Production and its implementation in Industries, Dr Bharat Jain, GCPC3.
5. Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3
Module I	H		
Module II	M	H	
Module III		H	
Module IV			H
Module V			H

CVRG0103: REMOTE SENSING AND GIS

(3 credits) (L-T-P: 3-0-0)

Objective
This elective course is designed to familiarise the students with the modern tools of remote sensing and geographic information systems (GIS) which are useful for analysis and interpretation of occurrences on the earth's surface. Foundation of GIS will help the students to go ahead for using this tool in decision making and bio-physical modelling.

COURSE/LEARNING OUTCOMES
On completion of the course, the students will be able to:

1. Comprehend fundamental concepts and practices of Remote Sensing and Geographic Information Systems (GIS) and advances in Geospatial Information Science and Technology and define the different types of maps, coordinate systems and recognise the importance and ease of surveying using remote sensing.
2. Apply basic graphic and data visualization concepts.
3. Apply GIS analysis to address geospatial problems and/or research questions.
4. Demonstrate proficiency in the use of remote sensing tools to create maps that are fit-for-purpose and effectively convey the information they are intended to.

Module I: (15 Hours)
Introduction to Remote Sensing – Electromagnetic Spectrum, interaction of electromagnetic radiation with the atmosphere and earth surface, remote sensing data acquisition: platforms and sensors; visual image interpretation; digital image processing.

Module II: (10 Hours)
Investigation of geographic information systems (GIS) and science (GIScience) including theory and applications areas. Use of a current widely used GIS computer software system.

Module III (10 Hours)
Aspects of geographic data entry and editing, spatial analysis, and map development and display to be considered.

Module IV (10 Hours)
Relationship of GIS to the Global Positioning System (GPS) and satellite generated data.

Mapping of COs to Syllabus

	CO1	CO2	CO3	CO4
Module I	H		M	
Module II	L	H	M	
Module III		M	L	H
Module IV		M	H	

Suggested Readings

1. Satheesh Gopi, R. Sathikumar, N. Madhu, Advanced Surveying — Total Station, GIS and Remote Sensing, Pearson Education.
2. Paul Longely, M.F. Goodchild, et al., Geographic Information System, Volume I and II, John Wiley and Sons, Inc. 1999.
3. J.B. Cambell, Introduction to Remote Sensing, Taylor and Francis, London, 1996

CVMM0107: STRUCTURAL ANALYSIS BY MATRIX METHODS

(3 credits) (L-T-P: 3-0-0)

Objectives
The course is designed to understand the matrix methods of analysis of framed structures for external loads. Analysis of multistory frames for lateral loads is also discussed in the course.

COURSE/LEARNING OUTCOMES:

1. Students will be able to define and classify statically determinate and indeterminate structural members and bending moment shear force, strain energy principles, different methods of finding internal forces and deflections.
2. Apply principles of statics etc to determine the energy principles for analysing the frames and beams by classical, iterative and matrix methods
3. Students will be able to analyse structural members with different types of loadings and different types of fixity and interpret the assumptions and limitations inherent in the analysis methods.
4. Test the load carrying capacity of structural members and estimate the safety and determine response of structures by classical, iterative and matrix methods

Module I: 15 Hours
Review of basic concepts in structural analysis:
structure (structural elements, joints and supports, stability, rigidity and static indeterminacy, kinematic indeterminacy); loads (direct actions, indirect loading); response (equilibrium, compatibility, force-displacement relations); levels of analysis; analysis of statically determinate structures (trusses, beams, frames); applications of principle of virtual work and displacement-based and force-based energy principles; deriving stiffness and flexibility coefficients.
Review of analysis of indeterminate structures: Force methods: Statically indeterminate structures (method of consistent deformations; theorem of least work). Displacement Methods: Kinematically indeterminate structures (slope-deflection method; moment distribution method).

Module II: 6 Hours
Matrix concepts and Matrix analysis of structures: Matrix; vector; basic matrix operations; rank; solution of linear simultaneous equations; eigenvalues and eigenvectors. Introduction; coordinate systems; displacement and force transformation matrices; Contra-gradient principle; element and structure stiffness matrices; Element and structure flexibility matrices; equivalent joint loads; stiffness and flexibility approaches.

Module III: 10 Hours
Matrix analysis of structures with axial elements: Introduction: Axial stiffness and flexibility; stiffness matrices for an axial element (two dof), plane truss element (four dof) and space truss element (six dof); One-dimensional axial structures: Analysis by conventional stiffness method (two dof per element) and reduced element stiffness method (single dof);Analysis by flexibility method; Plane trusses: Analysis by conventional stiffness method (four dof per element) and reduced element stiffness method (single dof); Analysis by flexibility method; Space trusses: Analysis by conventional stiffness method (six dof per element) and reduced element stiffness method (single dof).

Module IV: 14 Hours

Matrix analysis of plane and space frames: Conventional stiffness method for plane frames: Element stiffness (six dof); generation of structure stiffness matrix and solution procedure; dealing with internal hinges and various end conditions; Reduced stiffness method for plane frames: Element stiffness (three DOF); ignoring axial deformations; dealing with moment releases, hinged and guided fixed end supports; Flexibility method for plane frames: Force transformation matrix; element flexibility matrix; solution procedure (including support movements); Ignoring axial deformations; Stiffness method for space frames: Introduction; element stiffness matrix of space frame element with 12 DOF and 6 DOF; coordinate transformations; analysis by reduced stiffness method (six DOF per element);

Suggested Readings

1. Devdas Menon, “Advanced Structural Analysis", Narosa Publishing House, 2009.
2. Asslam Kassimali, "Matrix Analysis of Structures", Brooks/Cole Publishing Co., USA, 1999.
4. Amin Ghali, Adam M Neville and Tom G Brown, "Structural Analysis: A Unified Classical and Matrix Approach", Sixth Edition, 2007, Chapman & Hall.
5. Devdas Menon, "Structural Analysis", Narosa Publishing House, 2008

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I	H			
Module II		H		
Module III		H	M	L
Module IV		H		

CVEG0108: ELEMENTS OF GEOINFORMATICS

(3 credits — 45 hours) (L-T-P:3-0-0)

Objectives: This elective course is designed to familiarize the students with the modern tools of Geoinformatics viz., remote sensing (RS) and geographical information system (GIS) which are useful for analysis and interpretation of occurrences on the earth̓s surface. Satellite remote sensing in optical bands has been introduced in more detail. Foundation of GIS will help the students to go ahead for using this tool in decision making and Bio-physical modelling.

COURSE /LEARNING OUTCOMES

At the end of the course students will be able to:

CO1: Define the different types of maps, coordinate systems and recognize the importance and ease of surveying using remote sensing.

CO2: Classify different types of remote sensing. Students are able to differentiate the various types of remote sensing data.

CO3: Demonstrate the various methods of digital analysis and interpretation of satellite image.

CO4: Identify the hardware and software requirements for GIS analysis. They will be able to organize the data obtained from various remote sensing sources to formulate the map of an area and utilize the same for various planning and other related works.

Module I: Basics of Geoinformatics (8 hours)

a) Map basics: Definition of map and fundamental characteristics, types of map, scale of a map and its representations, map projection – meaning, types and characteristics of each
b) Coordinates system: geoid and reference ellipsoid, geographic coordinate system - projected coordinate, DEM - meaning and use, geo-referencing of map and image - its meaning and necessity, global positioning system (GPS) - important features and use
c) Global Navigation Satellite System: Radio and Satellite Navigation, GNSS Position Location Principles, GNSS system architecture-Satellite constellation, Geo-positioning-Basic Concepts, GNSS Receiver Operation and Differential GPS. NAVSTAR, GLONASS, Indian Geodetic System, GNSS applications: Defense, civilian, Navigational and Geodetic applications; GPS-GIS integration, GNSS applications in surveying, mapping, GNSS in intelligent transportation, fleet management and tracking, Location Based Services, Vehicle- Geo-Locking.

Module II: Foundation of remote sensing (10 hours)

a) Remote sensing system, passive and active remote sensing, electromagnetic spectrum, atmospheric window, relevant radiation principles, interaction of EMR with atmosphere and earth surface features, spectral signature, atmospheric and geometric influence of spectral response patterns

b) Data acquisition and visual interpretation: types of satellites, characteristic differences of optical and microwave data, multi-spectral and hyper-spectral data, data acquisition in optical bands - along track and across track scanning, examples of

LANDSAT, SPOT and IRS, data acquisition in microwave bands, advantages and limitations - salient features of few satellites with microwave sensors such as RISAT, ERS etc., types of multi- spectral data products, hard copy and digital image (panchromatic, true colour and FCC etc.) visual interpretation of image - important keys, ground truth verification

Module III: Digital analysis and interpretation of satellite image (17 hours)

a) Introduction to the broad types of computer assisted operators
b) Image rectification and restoration - geometric correction, resampling using nearest neighbour, bilinear interpolation and cubic convolution, radiometric correction due to sun elevation and earth-sun distance, noise removal
c) Image enhancements – level slicing, contrast stretching, spatial filtering, convolution, edge enhancements, and spectral ratios, vegetation indices
d) Image classification - supervised, unsupervised and hybrid

Module IV: Introduction to geographic information system (GIS) (10 hours)

Definition of GIS, comparison of GIS with CAD, GIS architecture, components of a GIS – hardware, software, data, people, methods, GIS data type – spatial and attribute, spatial data types – point, line and polygon, raster and vector representation of data GIS workflow diagram with explanation, fundamental operation of GIS, application of GIS – few examples

Suggested Readings

1. T.M. Lillisand and R.W. Kiefer, Remote Sensing and Image Interpretation, John Wiley and Sons, New York
2. Satheesh Gopi, R. Sathikumar, N. Madhu, Advanced Surveying – Total Station, GIS and Remote Sensing, Pearson Education
3. Paul Longely, M.F. Goodchild, et al., Geographical Information System, Volume I and II, John Wiley and Sons, Inc. 1999
4. J. B. Cambell, Introduction to Remote Sensing, Taylor and Francis, London, 1996
5. F.F. Sabins, Remote Sensing: Principles and Interpretation, W.H. Freeman and Company, New York, 1997
6. Jensen, J.R., Remote Sensing of the Environment – An Earth Resources Perspective, Pearson Education, Inc. (Singapore) Pvt. Ltd., Indian edition, Delhi, 2000
7. George Joseph, Fundamentals of Remote Sensing, Universities press (India) Pte Ltd., Hyderabad, 2003

Mapping of COs to Syllabus

	CO 1	CO 2	CO 3	CO 4
Module I	H			L
Module II	L	H	L	
Module III		H	H	M
Module IV	H	L	M	H

MTPP0105: PROFESSIONAL PRACTICE LAW AND ETHICS (2 credits –30 hours) (L-T-P:2-0-0)

Objective: Basic elements of civil engineering professional practice are introduced in this course. Roles of all participants in the process-owners, developers, designers, consultants, architects, contractors, and suppliers are described. Basic concepts in professional practice, business management, public policy, leadership, and professional licensure are introduced. The course covers professional relations, civic responsibilities, and ethical obligations for engineering practice. The course will make the students understand contracts management and various legal aspects related to engineering. Further, the course familiarizes students with elementary knowledge of laws that would be of utility in their profession, including several new areas of law such as IPR, ADR.

COURSE/LEARNING OUTCOMES

At the end of the course students will be able to:

CO1: To familiarize the students to what constitutes professional practice, introduction of various stakeholders and their respective roles; understanding the fundamental ethics governing the profession (Remembering)

CO2: To give a good insight into contracts and contracts management in civil engineering, dispute resolution mechanisms; laws governing engagement of labour

CO3: To give an understanding of Intellectual Property Rights, Patents

CO4: To *inculcate in* students *a proper understanding of the legal and practical aspects of their profession*

Module I: Professional Practice (5 Hours)
Respective roles of various stakeholders: Government (constituting regulatory bodies and standardization organizations, prescribing norms to ensure safety of the citizens); Standardization Bodies (ex. BIS, IRC)(formulating standards of practice); professional bodies (ex. Institution of Engineers(India), Indian Roads Congress, IIA/ COA, ECI, Local Bodies/ Planning Authorities) (certifying professionals and offering platforms for interaction); Clients/ owners (role governed by contracts); Developers (role governed by regulations such as RERA); Consultants (role governed DEPARTMENT OF HUMANITIES 838 |ADBU| Regulations and Syllabus|2021-22 by bodies such as CEAI); Contractors (role governed by contracts and regulatory Acts and Standards); Manufacturers/ Vendors/ Service agencies (role governed by contracts and regulatory Acts and Standards)

Module II: Professional Ethics (4 Hours)
Definition of Ethics, Professional Ethics, Business Ethics, Corporate Ethics, Engineering Ethics, Personal Ethics; Code of Ethics as defined in the website of Institution of Engineers (India); Profession, Professionalism, Professional Responsibility, Professional Ethics; Conflict of Interest, Gift Vs Bribery, Environmental breaches, Negligence, Deficiencies in state-of-the-art; Vigil Mechanism, Whistleblowing, protected disclosures.

Module III: General Principles of Contracts Management (4 Hours)
Indian Contract Act, 1972 and amendments covering General principles of contracting; Contract Formation & Law; Privacy of contract; Various types of contract and their features; Valid & Voidable Contracts; Prime and subcontracts; Joint Ventures & Consortium; Complex contract terminology; Tenders, Request Proposals, Bids & Proposals; Bid Evaluation; Contract Conditions & Specifications; Critical /"Red Flag" conditions; Contract award & Notice To Proceed; Variations & Changes in Contracts; Differing site conditions; Cost escalation; Delays, Suspensions & Terminations; Time extensions & Force Majeure; Delay Analysis; Liquidated damages & Penalties; Insurance & Taxation; Performance and Excusable Non-performance; Contract documentation; Contract Notices; Wrong practices in contracting (Bid shopping, Bid fixing, Cartels); Reverse auction; Case Studies; Build- OwnOperate & variations; Public- Private Partnerships; International Commercial Terms.

Module IV: Arbitration, Conciliation and ADR (Alternative Dispute Resolution) system. (6 Hours)
Meaning, scope and types – distinction between laws of 1940 and 1996; UNCITRAL model law – Arbitration and expert determination; Extent of judicial intervention; International commercial arbitration; Arbitration agreements – essential and kinds, validity, reference and interim measures by court; Arbitration tribunal – appointment, challenge, jurisdiction of arbitral tribunal, powers, grounds of challenge, procedure and court assistance; Award including Form and content, Grounds for setting aside an award, Enforcement, Appeal and Revision; Enforcement of foreign awards – New York and Geneva Convention Awards; Distinction between conciliation, negotiation, mediation and arbitration, confidentiality, resort to judicial proceedings, costs; Dispute Resolution Boards; Lok Adalats.

Module V: Engagement of Labour and Labour & other construction-related Laws. (6 Hours) Role of Labour in Civil Engineering; Methods of engaging labour- on rolls, labour sub-contract, piece rate work; Industrial Disputes Act, 1947; Collective bargaining; Industrial Employment (Standing Orders) Act, 1946; Workmen's Compensation Act, 1923; Building & Other Construction Workers (regulation of employment and conditions of service) Act (1996) and Rules (1998); RERA Act 2017, NBC 2017

Module VI: Law relating to Intellectual property. (6 Hours)
Introduction – meaning of intellectual property, main forms of IP, Copyright, Trademarks, Patents and Designs, Secrets; Law relating to Copyright in India including Historical evolution of Copy Rights Act, 1957, Meaning of copyright – computer programs, Ownership of copyrights and assignment, Criteria of infringement, Piracy in Internet – Remedies and procedures in India; Law relating to Patents under Patents Act, 1970 including Concept and historical perspective of patents law in India, Patentable inventions with special reference to biotechnology products, Patent protection for computer programs, Process of obtaining patent – application, examination, opposition and sealing of patents, Patent cooperation treaty and grounds for opposition, Rights and obligations of patentee, Duration of patents – law and policy considerations, Infringement and related remedies

Suggested Readings:

1. B.S. Patil, Legal Aspects of Building and Engineering Contracts, 1974.
2. The National Building Code, BIS, 2017
3. RERA Act, 2017
4. Meena Rao (2006), Fundamental concepts in Law of Contract, 3rd Edn. Professional Offset 5. Neelima Chandiramani (2000), The Law of Contract: An Outline, 2nd Edn. Avinash Publications Mumbai
6. Avtar Singh (2002), Law of Contract, Eastern Book Co. DEPARTMENT OF HUMANITIES ADBU| Regulations and Syllabus|2021-22| 839
7. Dutt (1994), Indian Contract Act, Eastern Law House
8. Anson W.R. (1979), Law of Contract, Oxford University Press
9. Kwatra G.K. (2005), The Arbitration & Conciliation of Law in India with case law on UNCITRAL Model Law on Arbitration, Indian Council of Arbitration
10. Wadhera (2004), Intellectual Property Rights, Universal Law Publishing Co.
11. T. Ramappa (2010), Intellectual Property Rights Law in India, Asia Law House

12. Bare text (2005), Right to Information Act
13. O.P. Malhotra, Law of Industrial Disputes, N.M. Tripathi Publishers
14. K.M. Desai(1946), The Industrial Employment (Standing Orders) Act
15. Rustamji R.F., Introduction to the Law of Industrial Disputes, Asia Publishing House
16. Vee, Charles & Skitmore, Martin (2003) Professional Ethics in the Construction Industry, Engineering Construction and Architectural management, Vol.10, Iss2, pp 117-127, MCB UP Ltd 17. American Society of Civil Engineers (2011) ASCE Code of Ethics – Principles Study and Application
18. Ethics in Engineering- M.W.Martin & R.Schinzinger, McGraw-Hill
19. Engineering Ethics, National Institute for Engineering Ethics, USA
20. www.ieindia.org
21. Engineering ethics: concepts and cases – C. E. Harris, M.S. Pritchard, M.J.Rabins
22. CONSTRUCTION CONTRACTS, http://www.jnormanstark.com/contract.htm
23. Internet and Business Handbook, Chap 4, CONTRACTS LAW, http://www.laderapress.com/laderapress/contractslaw1.html
24. Contract & Agreements
http://www.tco.ac.ir/law/English/agreements/General/Contract%20Law/C.htm

25. Contracts, http://206.127.69.152/jgretch/crj/211/ch7.ppt
26. Business & Personal Law. Chapter 7. "How Contracts Arise", http://yucaipahigh.com/schristensen/lawweb/lawch7.ppt
27. Types of Contracts, http://cmsu2.cmsu.edu/public/classes/rahm**/meiners.con.ppt**

	CO1	CO2	CO3	CO4
Module I	H			
Module II		H		
Module III		H		
Module IV			H	
Module V		H		
Module VI			M	H

LABORATORY COURSES

CVED6024: ENGINEERING GRAPHICS AND DESIGN

(3 credits) (L-T-P: 1-0-4)

Objectives

This course is designed to teach the basics of engineering drawing and drafting utilizing free hand sketching as well as computer aided modeling. The fundamental principles of projections and dimensioning as well as the overview of computer graphics, customizations, annotations, layering and other functions of computer aided designs viz. geometric and topological designs of engineered components are taught.

COURSE/LEARNING OUTCOMES

After completing the course students will be able to:

1. Demonstrate drawing methodology of lettering with ISO specifications , concepts of representative factors for drawing various types of scales , the theory and methodology for different types of conic and cycloidal curves , the concept of orthographic projection for drawing projection of points , lines , planes and the concept of dimensioning , drawing complex solids , concept of isometric scale , projection and views , perspective projection of simple 1,2 and 3D figures.
2. Explain the application and functionalities of computer aided drafting software like QCAD and AUTOCAD.
3. Apply the theoretical knowledge of engineering drawing to draw precise , accurate , neat and unambiguous drawings following the proper dimensioning specifications and drawing methodology that would be required in design pertaining civil and mechanical engineering.
4. Judiciously evaluate the concept of drawing 1,2 and 3D figures in orthographic , isometric and perspective projections in line with BIS design and drawing specifications.

Module I: Introduction to Engineering Drawing (5 hours)

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only), Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales.

Module II: Orthographic Projections (5 hours)

Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes

Module III: Projection of Solids (5 hours)

a. Projections of Regular Solids: Solids inclined to both the Planes- Auxiliary Views, simple annotation, dimensioning and scale
b. Sections and Sectional Views of Right Angular Solids: Prism, Cylinder, Pyramid, Cone – Auxiliary Views, development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone, sectional orthographic views of geometrical solids

Module IV: Floor Plan Drawings (5 hours)

Industry and dwellings (foundation to slab only)

Module V: Isometric Projections (5 hours)

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions, Isometric Views of lines, Planes, Simple and compound Solids, Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions

Module VI: Overview of Computer Graphics (5 hours)

Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids]

Module VII: Customization and CAD Drawing (5 hours)

Consisting of set up of the drawing page and the printer, including scale settings, setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, Snap to objects manually and automatically, producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles

Module VIII: Annotations, layering and other functions (5 hours)

Application of dimensions to objects, application of annotations to drawings; Setting up and use of layers, layers to create drawings, create, edit and use customized layers; changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface, Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, Multiview, auxiliary, and section views, Spatial visualization exercises, dimensioning guidelines, tolerancing techniques; dimensioning and scale Multiview of dwelling

Module IX: Team design project demonstrating geometry and topology of engineered components (5 hours)
Creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids, meshed topologies for engineering analysis and tool-path generation for component manufacture, geometric dimensioning and tolerancing, Use of solid-modeling software for creating associative models at the component and assembly levels, floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling, Introduction to Building Information Modelling (BIM).

Suggested Readings

1. N. D. Bhatt, V. M. Panchal, P. R. Ingle (2014), Engineering Drawing, Charotar Publishing House
2. M. B. Shah and B. C. Rana (2008), Engineering Drawing and Computer Graphics, Pearson Education
3. B. Agrawal and C. M. Agrawal (2012), Engineering Graphics, TMH Publication
4. K. L. Narayana and P Kannaiah (2008), Text book on Engineering Drawing, SciTech Publishers
5. Corresponding set of CAD Software Theory and User Manuals

CVCA6025: COMPUTER-AIDED CIVIL ENGINEERING DRAWING (LAB)
(2 Credits) (L:T:P: 1-0-2)

COURSE /LEARNING OUTCOMES
At the end of the course students will be able to:
1. Do a detailed study of an engineering artefact.
2. Illustrate a design idea/concept graphically/visually.
3. Develop parametric design and the conventions of formal engineering drawing.
4. Construct and interpret 2D & 3D drawings and produce designs using a combination of 2D and 3D software.

Module I (2 Hours)
INTRODUCTION: Introduction to concept of drawings, Interpretation of typical drawings, Planning drawings to show information concisely and comprehensively; optimal layout of drawings and Scales; Introduction to computer aided drawing, coordinate systems, reference planes. Commands: Initial settings, Drawing aids, Drawing basic entities, Modify commands, Layers, Text and Dimensioning, Blocks. Drawing presentation norms and standards.

Module II (2 Hours)
SYMBOLS AND SIGN CONVENTIONS: Materials, Architectural, Structural, Electrical and Plumbing symbols. Rebar drawings and structural steel fabrication and connections drawing symbols, welding symbols; dimensioning standards.

Module III (1 Hour)
MASONRY BONDS: English Bond and Flemish Bond – Corner wall and Cross walls - One brick wall and one and half brick wall.

Module IV (7 Hours)
BUILDING DRAWING: Terms, Elements of planning building drawing, Methods of making line drawing and detailed drawing. Site plan, floor plan, elevation and section drawing of small residential buildings. Foundation plan. Roof drainage plans. Depicting joinery, standard fittings & fixtures, finishes. Use of Notes to improve clarity

Module V (3 Hours)
PICTORIAL VIEW: Principles of isometrics and perspective drawing. Perspective view of building. Fundamentals of Building Information Modelling (BIM)

Suggested Readings

1. Subhash C Sharma & Gurucharan Singh (2005), "Civil Engineering Drawing", Standard Publishers
2. Ajeet Singh (2002), "Working with AUTOCAD 2000 with updates on AUTOCAD 200I", Tata- Mc Graw-Hill Company Limited, New Delhi
3. Sham Tickoo Swapna D (2009), "AUTOCAD for Engineers and Designers", Pearson Education
4. Venugopal (2007), "Engineering Drawing and Graphics + AUTOCAD", New Age International Pvt. Ltd.

5. Balagopal and Prabhu (1987), “Building Drawing and Detailing”, Spades publishing KDR building, Calicut,
6. (Corresponding set of) CAD Software Theory and User Manuals.
7. Malik R.S., Meo, G.S. (2009) Civil Engineering Drawing, Computech Publication Ltd New Asian.
8. Sikka, V.B. (2013), A Course in Civil Engineering Drawing, S.K.Kataria& Sons

CVEG6026: ENGINEERING GEOLOGY LAB

(1 Credit)

COURSE OUTCOMES

On completion of the course the students will be able to:

1. CO1: Categorize rocks and minerals by their origin and engineering properties.
2. CO2: Apply geological principles to rock masses and discontinuities for use in engineering design e.g., rock slopes, foundation.

List of Experiments:

1. Study of physical properties of minerals.
2. Study of different groups of minerals.
3. Study of Crystal and Crystal system.
4. Identification of minerals: Silica group: Quartz, Amethyst, Opal; Feldspar group: Orthoclase, Plagioclase; Cryptocrystalline group: Jasper; Carbonate group: Calcite; Element group: Graphite; Pyroxene group: Talc; Mica group: Muscovite; Amphibole group: Asbestos, Olivine, Hornblende, Magnetite, Hematite, Corundum, Kyanite, Garnet,Galena, Gypsum.
5. Identification of rocks (Igneous Petrology): Acidic Igneous rock: Granite and its varieties, Syenite, Rhyolite, Pumice, Obsidian, Scoria, Pegmatite, Volcanic Tuff. Basic rock: Gabbro, Dolerite, Basalt and its varieties, Trachyte.
6. Identification of rocks (Sedimentary Petrology): Conglomerate, Breccia, Sandstone and its varieties, Laterite, Limestone and its varieties, Shales and its varieties.
7. Identification of rocks (Metamorphic Petrology): Marble, slate, Gneiss and its varieties, Schist and its varieties. Quartzite, Phyllite.
8. Study of topographical features from Geological maps. Identification of symbols in maps. https://swayam.gov.in/nd1_noc20_ce33/preview

CVFM6027: FLUID MECHANICS LAB

(1 Credit)

COURSE OUTCOMES

At the end of the course, the students will have the ability to:

1. CO1: Calculate coefficient of discharge for orifices and notches and determine the impact of jet on vanes
2. CO2: Verify Bernoulli’s theorem
3. CO3: Understand stability of floating bodies and calculate hydrostatic pressures
4. CO4: Visualize fluid flow and calculate Reynold’s number

List of Experiments:

1. Measurement of viscosity
2. Study of Pressure Measuring Devices
3. Stability of Floating Body
4. Hydrostatics Force on Flat Surfaces/Curved Surfaces
5. Verification of Bernoulli’s Theorem
6. Venturimeter
7. Orifice meter
8. Impacts of jets
9. Flow Visualisation -Ideal Flow
10. Length of establishment of flow
11. Velocity distribution in pipes
12. Laminar Flow

CVSM6028: SOLID MECHANICS (STRENGTH OF MATERIALS) LAB

(1 Credit)

COURSE OUTCOMES

At the end of the course, the students will have the ability to:

1. Analyse the behaviour of the solid bodies subjected to various types of loading.

2. Apply knowledge of materials and structural elements to the analysis of simple structures.
3. Undertake problem identification, formulation and solution using a range of analytical methods.
4. Analyse and interpret laboratory data relating to behavior of structures and the materials they are made of and undertake associated laboratory work individually and in teams.

List of Experiments:

1. Tension test
2. Bending tests on simply supported beam and Cantilever beam.
3. Compression test on concrete
4. Impact test (ME Lab)
5. Shear test
6. Investigation of Hooke's law that is the proportional relation between force and stretching in elastic deformation,
7. Determination of torsion and deflection,
8. Measurement of forces on supports in statically determinate beam,
9. Determination of shear forces in beams,
10. Determination of bending moments in beams,
11. Measurement of deflections in statically determinate beam,
12. Measurement of strain in a bar
13. Bend test steel bar;
14. Yield/tensile strength of steel bar.

CVSG6029: SURVEYING & GEOMATICS LAB

1 Credit

COURSE OUTCOMES

On completion of the course the students will be able to:

1. Identify different types of surveying instruments and their applicability.
2. Execute profile levelling; determine Reduced Level, latitudes, departures, and coordinates of control points and balancing errors in a traverse and Implement curve setting work using appropriate instruments.
3. Operate the techniques, skills, and applicable tools of the discipline for application in engineering and surveying activities.
4. Investigate horizontal, vertical, and zenith angles with a transit, theodolite, and total station or survey grade GNSS instruments.

List of experiments:

1. Ranging- direct and indirect
2. Chain triangulation
3. Compass traversing- open and closed traverse
4. Levelling- Profile, Cross section and Fly leveling
5. Plane table traversing
6. Contouring- direct and indirect
7. Theodolite surveying- open and closed traverse
8. Curve setting – circular and combined curve
9. Trigonometric leveling- accessible and inaccessible objects
10. Total station surveying

CVMT6030: MATERIALS, TESTING LAB

1 Credit

COURSE OUTCOMES

On completion of the course the students will be able to:

1. Determine the specific gravity of coarse aggregate and fine aggregate by sieve analysis.
2. Classify soil based on standard geotechnical engineering practice.
3. Identify the grade and properties of bitumen.

List of Experiments:

1. Gradation of coarse and fine aggregates
2. Different corresponding tests and need/application of these tests in design and quality control
3. Tensile Strength of materials & concrete composites
4. Compressive strength test on aggregates

5. Tension I - Elastic Behaviour of metals & materials
6. Tension II - Failure of Common Materials
7. Direct Shear - Frictional Behaviour
8. Concrete I - Early Age Properties
9. Concrete II - Compression and Indirect Tension
10. Compression – Directionality
11. Soil Classification
12. Consolidation and Strength Tests
13. Torsion test
14. Hardness tests (Brinnel's and Rockwell)
15. Tests on closely coiled and open coiled springs
16. Theories of Failure and Corroboration with Experiments
17. Tests on unmodified bitumen and modified binders with polymers
18. Bituminous Mix Design and Tests on bituminous mixes - Marshall method
19. Concrete Mix Design as per BIS

CVIS6031: INSTRUMENTATION & SENSOR TECHNOLOGIES FOR CIVIL ENGINEERING APPLICATIONS LAB (TO BE TAKEN BY EEE DEPARTMENT)

(2 Credits; L:T:P :0-0-2)

COURSE/LEARNING OUTCOMES

After successfully studying this course, students will be able to:

1. Differentiate between analog and digital signal processing.
2. Identify the different sensors and gauges for instrumentation.
3. Calibrate the sensors and detect the errors during measurement.

List of Experiments:

1. Instrumentation of typical civil engineering members/structures/structural elements
2. Use of different sensors, strain gauges, inclinometers,
3. Performance characteristics
4. Errors during the measurement process
5. Calibration of measuring sensors and instruments
6. Measurement, noise and signal processing
7. Analog Signal processing
8. Digital Signal Processing
9. Demonstration & use of sensor technologies

CVHE6031: HYDRAULIC ENGINEERING LAB

1 Credit

COURSE OUTCOMES

At the end of the course, the students will have the ability to:

1. Calculate flow parameters for venturi flume.
2. Verify boundary layer theorem.
3. Understand gradually varied flow and rapid varied flow.
4. Visualize flow through pipes and identify laminar flow and turbulent flow.
5. Determine the head losses for flow through pipes.

List of Experiments:

1. Flow Visualization
2. Studies in Wind Tunnel
3. Boundary Layer
4. Flow around an Aerofoil / circular cylinder
5. Uniform Flow
6. Velocity Distribution in Open channel flow
7. Venturi Flume
8. Standing Wave Flume
9. Gradually Varied Flow
10. Hydraulic Jump

11. Flow under Sluice Gate
12. Flow through pipes
13. Turbulent flow through pipes
15. Laminar flow through pipes
16. Major losses / Minor losses in pipe

CVGE6032: GEOTECHNICAL ENGINEERING LAB

1 Credit

COURSE/LEARNING OUTCOMES

After successfully studying this course, students will be able to:

1. Identify the index properties and engineering properties of soil.
2. Understand the laboratory tests used for determination of physical, index and Engineering properties of soil.
3. Calculate the values of different engineering properties of soil.

List of Experiments:

1. Field Density using Core Cutter method.
2. Field Density using Sand replacement method.
3. Natural moisture content using Oven Drying method.
4. Field identification of Fine Grained soils.
5. Specific gravity of Soils.
6. Grain size distribution by Sieve Analysis.
7. Grain size distribution by Hydrometer Analysis.
8. Consistency limits by Liquid limit
2. Consistency limits by Plastic limit
3. Consistency limits by Shrinkage limit.
4. Permeability test using Constant-head test method.
5. Permeability test using Falling-head method.
6. Compaction test: Standard Proctor test.
7. Compaction test: Modified Proctor test.
8. Relative density.
9. Consolidation Test.
10. Triaxial Test (UU)
11. Vane shear test
12. Direct Shear Test
13. Unconfined Compression Strength Test.
14. MOOCs Link: https://swayam.gov.in/nd1_noc20_ce48/preview

CVEE6033: ENVIRONMENTAL ENGINEERING LAB

1 Credit-(L-T-P:0-0-2)

COURSE/LEARNING OUTCOMES

After successfully studying this course, students will be able to:

1. Implement and demonstrate instructions regarding various parameters of water and sewage quality testing and air quality assessment.
2. Demonstrate experimental procedures for water and air quality analysis
3. Produce report on various parameters of water and sewage quality tests and air quality analysis.
4. Present and justify results of water and sewage quality tests air quality monitoring.

List of Experiments

1. Physical Characterization of water: Turbidity, Electrical Conductivity, pH
2. Analysis of solids content of water: Dissolved, Settleable, suspended, total, volatile, inorganic etc.
3. Alkalinity and acidity, Hardness: total hardness, calcium and magnesium hardness
4. Analysis of ions: copper, chloride and sulfate
5. Optimum coagulant dose
6. Chemical Oxygen Demand (COD)
7. Dissolved Oxygen (D.O) and Biochemical Oxygen Demand (BOD)
8. Break point Chlorination
2. Bacteriological quality measurement: MPN,
3. Ambient Air quality monitoring (TSP, RSPM, SOx, NOx)

4. Ambient noise measurement

CVTE6034: TRANSPORTATION ENGINEERING LAB

(1 credit)

COURSE/LEARNING OUTCOMES

After successfully studying this course, students will be able to:

1. Identify engineering properties of aggregates.
2. Calculate the engineering properties of soil.
3. Identify the grade & properties of bitumen.

List of Experiments

1. To determine the IMPACT VALUE of coarse aggregates by use of IMPACT MACHINE.
2. To determine the ABRASION VALUE of coarse aggregates by use of LOS ANGELES MACHINE.
4. To determine the Flakiness Index and Elongation Index of coarse aggregates.
5. To determine the MARSHALL STABILITY of Bitumen mix.
6. To determine the SOFTENING POINT of Bitumen.
7. To determine the DUCTILITY of Bitumen.
8. To determine the Specific Gravity of Bitumen.
9. To determine the Penetration of Bitumen.
10. To determine the CALIFORNIA BEARING RATIO of soil.

CVEC6035: ENGINEERING ECONOMICS, ESTIMATION AND COSTING PRACTICAL CLASS

2 Credits

COURSE/LEARNING OUTCOMES

On completion of the course, the students will be able to:

1. Explain how competitive bidding works and how to submit a competitive bid proposal.
2. Examine present worth, future worth and annual worth analysis on one of more economic alternatives.
3. Formulate the worth of a structure by evaluating quantities of constituents, derive their cost rates and build up the overall cost of the structure.
4. Develop a competitive bid proposal.

List of Group assignments:

1. Deriving an approximate estimate for a multi-storeyed building by approximate methods.
2. Detailed estimate for the following with the required material survey for the same.
    a. Ground plus three storied RCC Framed structure building with blockwork walls
    b. bridge with minimum 2 spans
    c. factory building
    d. road work
    e. cross drainage work
    f. Ground plus three storied building with load-bearing walls
    g. Cost of finishes, MEP works for (f) above
3. Preparation of valuation report in standard Government form.
4. Assignments on rate analysis, specifications and simple estimates.
5. Detailed estimate of minor structure.
6. Preparation of Bar bending schedule.

CVIT6041: INDUSTRIAL TRAINING

(3 credits)

Objectives

During the semester break at the end of the third year, the students are required to undergo an industrial training. The purpose of the industrial training is to expose students to real-life industry situations, so that they may be able to apply the engineering knowledge and skills that they have gained through classroom teaching and lab activities, in an on-the-job situation. After the period of training, students are required to present their experience in the form of reports and seminar presentations. Students will be evaluated on the seminar, viva-voce examination and written reports.

COURSE / LEARNING OUTCOMES:

On completion of the course the students will be able to:

1. Relate the lessons learned in a classroom into real world experience set in a professional practice-oriented environment.
2. Summarize the activities required for a complete project and develop professional skills such as team work, effective communication and social interaction.
3. Make use of the latest software to analyze problems related to Civil Engineering and adapt to software and equipment as per the industrial requirements.
4. Identify, formulate and model problems and find engineering solution based on a system.

CVPJ6043: PROJECT-II

(4 credits) (L-T-P: 0-0-8)

Objectives

Each student group consisting of not more than 5 members is expected to plan, analyze and design a multistoried building and verify the work with a design and analysis software package.Students will identify and plan a multistoried building, prepare the drawings and perform gravity analysis followed by seismic analysis. There will be three progress seminars - after the planning after the gravity and seismic analysis,after designing and detailing which will be evaluated by a panel of internal examiners. This will be followed by verification of the analysis and design using a software package. The project work will be concluded with quantity estimation and preparation of report. The internal assessment shall be evaluated by the DPEC and the external assessment shall be done by the external examiner(s) assisted by the DPEC and the supervisor. The modality and components of the internal assessment and their weightages shall be notified at the beginning of each semester.

COURSE/LEARNING OUTCOMES:

On completion of the course the students will be able to:

1. List different types of buildings and components, their analyses and design methods and demonstrate a sound technical knowledge on planning a civil Engineering project.
2. Identify the support conditions and types of members in a building frame.
3. Analyse the structural members to arrive at the design values.
4. Design the structural members of a project optimizing the cost and materials and Use design software for analyzing different types of structures.
5. Compile all the analysis results for the design of different members.

CVMP6049: PROJECT I-MINOR PROJECT

(1 credit) (L-T-P: 0-0-2)

Objectives

To develop the capacity of the students to convert theoretical knowledge base to practical systems for performing creative tasks and analysis and hence suggest solutions to problems pertaining to civil engineering. Each student group consisting of not more than 5 members is expected to plan, analyze and design a multistoried building and verify the work with a design and analysis software package.

During the first phase of the Project students will identify and plan a multistoried building, prepare the drawings and perform gravity analysis followed by seismic analysis. There will be two progress seminars - after the planning and after the seismic analysis, which will be evaluated by a panel of internal examiners.

COURSE/LEARNING OUTCOMES

On completion of the course the students will be able to:

1. Work in a team to select a problem for project work
2. Review and evaluate the available literature on the chosen problem
3. Formulate the methodology to solve the identified problem
4. Apply the principles, tools and techniques to solve the problem
5. Prepare and present project report

CVSL0200: SERVICE LEARNING

(2 credit)

Objective

Service Learning is an experience-based approach to education. It is a course-based service experience that produces the best outcomes when meaningful service activities are related to the course material through reflection and critical inquiry. It deepens and enriches the theoretical and conceptual side of learning. Service-Learning combines – Academic Instruction, Meaningful Service and Critical and Reflective thinking.

Module I

Introduction to service learning-Its philosophy, historical background, purpose, value & theoretical framework; Locating Service Learning within the University context, Basic elements of service learning, Historical context of University Community Partnership; Understanding Community &Community Partnership; Ethical understanding of partnership; Understanding the agency of the Community – as co-educators; Community barriers; Understanding of society & social issues; Culture and Power Dynamics; Power & Privilege; social responsibility and engagement with the community.

Module II

a. Disaster management: Basic concepts and definition – hazard , disaster , impacts of disaster , types of hazards , types of disaster ; vulnerability , types of vulnerability , risk , capacity ;
b. Pre-disaster phase activities – awareness campaign in the community , prevention , mitigation measures; Preparedness, participatory learning action with the community , identifying community shelters , protecting livestock , making use of available resources within the community , mock drills, skill training , self-made life jackets , community stock of granary , survival kits , first- aid drill , identify early signs , identify critical facilities and their location like school , shelters , police etc .
c. During and post-disaster disaster activities - Early warning dissemination, response action , evacuation of temporary shelters , use of relief camps , arrangement of safe drinking water and sanitation , assist in rescue and relief efforts , carcass disposal , search , rescue , relief , recovery – safe reconstruction , rehabilitation , identifying safe routes .
d. Field work : Students are required to help the community in designing safe playgrounds , in training them with mock drills and in identifying similar relief and community shelter during and post disaster phase .

Module III

Syllabus for CVE (Field Work): Identification, use and application of different materials used for construction of concrete structures; preparation of concrete, Brick masonry procedure; Types of bond – English and Flemish; temporary structures like formwork, scaffolding, shuttering etc ; Ties , stirrups , reinforcements used in building construction; Casting of slabs , columns , beams ; Types and methods of curing .

Suggested Readings

1. R. Subramanian , “ Disaster Management “ , Vikas Publishing house .
2. B.C. Punmia , “ Building Construction “ , Laxmi Publications .
3. M.S. Shetty , “ Concrete Technology Theory and Practice “ , S Chand Publishing .
4. R.K. Rajput , “ Engineering materials “ , S Chand & Company.
5. Varghese P.C , “Limit State Design of Reinforced Concrete” , Prentice Hall India Learning Private Limited.

VALUE ADDED COURSES

CVAD6046: TRAINING ON COMPUTER AIDED DRAFTING

(2 Credits - L: T: P :0-0-4) (30 Hrs)

Objectives

The objective of this value-added training course is to teach the student about the usage of Auto CAD and basic drawing fundamentals in various civil engineering applications, especially in building drawing.

Module I (5 Hours)

Introduction to AutoCAD: File menu of AutoCAD with New, Open, Save, Save as and Close; Basic 2D commands like Line, Circle, Ellipse, Multi Line, Construction Line, Polyline, Point, Donut, Ellipse, Polygon, Rectangle, Arc; Erase, Snap, Redraw, Regenerate, Zoom, Pan. Introduction to concept of drawings, Interpretation of typical drawings, Planning drawings to show information concisely and comprehensively; optimal layout of drawings and Scales.

Module II (5 Hours)

Symbols and Sign Conventions: Materials, Architectural, Structural, Electrical and Plumbing symbols. Rebar drawings and structural steel fabrication and connections drawing symbols, welding symbols; dimensioning standards.

Module III (5 Hours)

Editing of AutoCAD Drawing: Modify Properties of Drawing Entity: Copy, Move, Rotate, Mirror, Offset; Array, Scale, Stretch, Lengthen, Trim, Extend, Break, Chamfer, Fillet; Block, WBlock, Insert and Explode; Area, Volume and associated commands with Civil Engineering application.

Module IV (5 Hours)

Advanced 2D Commands: Application of LAYER command in Civil Engineering: Layer command with its all its sub commands, Line type, Color & Dimension command – linear, aligned, arc length, radius, Diameter, Centre, Leader, Baseline and Continuous Dimensioning, tolerance, override and Dimension updates Text and DTEXT commands with Text Style Hatch command.

Module V (5 Hours)

Building Drawing: Terms, Elements of planning building drawing, Methods of making line drawing and detailed drawing. Site plan, floor plan, elevation and section drawing of small residential buildings. Foundation plan. Roof drainage plans. Depicting joinery, standard fittings & fixtures, finishes. Use of Notes to improve clarity.

Module 6 (5 Hours)

Plotting of 2D & 3D Drawings: Introduction to basic 3D commands. PLAN, ELEVATION, and 3D Views of Residential and Commercial Building. PLOT and its Sub Command for Plotting Drawing on A1, A2 and A3 Size Paper using Printer and / or Plotter.

COURSE /LEARNING OUTCOMES

At the end of the course students will be able to:

1. Demonstrate basic concepts and functions of the AutoCAD software.
2. Infer drawings through editing/modifying techniques in AutoCAD.
3. Design and interpret 2D & 3D Civil Engineering drawings.

Suggested Readings

1. Subhash C Sharma & Gurucharan Singh (2005), "Civil Engineering Drawing", Standard Publishers
2. Sham Tickoo Swapna D (2009), "AUTOCAD for Engineers and Designers", Pearson Education,
3. Venugopal (2007), "Engineering Drawing and Graphics + AUTOCAD", New Age International Pvt. Ltd.,
4. Balagopal and Prabhu (1987), "Building Drawing and Detailing", Spades publishing KDR building, Calicut, (Corresponding set of) CAD Software Theory and User Manuals.
5. Malik R.S., Meo, G.S. (2009) Civil Engineering Drawing, Computech Publication Ltd New Asian.

CVBA6047: TRAINING ON BUILDING MODELING AND ANALYSIS USING STAAD-PRO

Course Outcomes

After successfully completing the course students will be able to:

1. Model a building structure
2. Analyse and design a building structure for various loadings like Dead Load, Live Load and Earthquake Load.
3. Model steel truss and water tank
4. Analyse and design a steel truss and water tank for various loadings like Dead Load, Live Load and Earthquake Load.

Module I: 6 Hours
Creating Models, Structures, Graphical Interface, Steel Designing, Design of Concrete Structures

Module II: 7 Hours
Specification of Member Properties, Material Constants, Specify Supports, Specify Loads and Analysis Type, Annotating the Displacements

Module III:7 Hours
Creating Models of a Reinforced Concrete Framed Structure, Modelling and Analysis of a Slab, Interoperability Feature, Interactive Design Information, Creating Models Using Graphical Interface

Module IV: 6 Hours
Performing Analysis and Designing for Dead Loads, Live Loads, Earthquake Loads and Wind Loads, Viewing Results Using the Output File, Viewing Post Post –Processing, Stress Contours, Specifying Post-Analysis Print Commands.

Module V: 4 Hours
Producing on Onscreen Report, Viewing Supports Reaction. Assessment

Mapping of COs to Syllabus

Course Outcomes	CO1	CO2	CO3	CO4
Module I	H			
Module II		M		
Module III	H		H	
Module IV		H		H

CVMA6048: TRAINING ON MODELING AND ANALYSIS USING ABACUS

COURSE OUTCOMES
1. Students will be able to solve linear and nonlinear problems
2. Students will be able to submit and monitor analysis jobs
3. Students will be able to view simulation results using the interactive interface of Abaqus

Day 1: Linear and nonlinear structural analysis.
Day 2: Static, dynamic and heat transfer analysis.
Day 3: Material models: linear elasticity, hyper elasticity and metal plasticity.
Day 4: Loads and constraints. Modeling contact. Selecting the appropriate elements for your problem.
Day 5: Feature-based modeling, parts and assemblies.
Day 6: Working with CAD geometry and imported meshes.
Day 7: Mesh generation techniques. Creating, submitting and monitoring analysis jobs. Viewing simulation results. Restarting an analysis

CVCR6050: DETAILING AND DRAFTING OF CONCRETE REINFORCEMENT

Objective
This value-added course will provide knowledge on drafting features and the reinforcement details of different structural members like slabs, beams, columns, and foundations.

Course/learning outcomes:
After successful completion of the course, students will be able to
1. Understand layout, graphics, scales, reinforcement drawing, drafting principles and features.
2. Perform analysis and design civil engineering structure using SAP 2000.
3. Understand various reinforcement details of the beam, column, slab, foundations, beam-to-beam connection, beam-column joint, and corbels.

Module I (5 Hours):
Drafting principles for layout and reinforcement drawings: Technical drawings of concrete structures, scales, basic line types, types of drawing, layout drawing, principles of drafting, reinforcement drawing, drafting principles, elevation and longitudinal sections, cross-sections, typical notes in reinforcement drawing.

Module II (8 Hours):
Detailing of beams: Anchorage of longitudinal reinforcement, detailing of flexural reinforcement and pretension tendons, types of anchorage, sliding shear failure, mechanical anchorages, arch action, closely spaced transverse stirrups, anchorage of

Stirrups, types of Stirrups, reinforcement details in beam, crack control provided by shear reinforcement, support and loading points, slab supported by upturned beam, beam-to-beam connection, half-Joint or dapped-end joint.

Module III (8 Hours):
Detailing of slab: Detailing for crack control, flexural cracking, restrained shrinkage cracking in slabs, types of reinforcement provided in slab, placing of reinforcement.
Detailing of column: Lapped compressive splices, typical tie arrangements in columns, details of bar diameter, detailing of beam-column connections, knee connections, reinforcement detail of three member connections and four-member connections, reinforcement detail of corbels.

Module IV (9 Hours):
Reinforcement detailing of foundation: Isolated footing, combined footing, strip footing, raft footing and pile foundations, reinforcement cover, reinforcement distribution in footing.
Complete knowledge of SAP2000: Learn structural analysis and design of a residential building using SAP2000, analyze and design any kind of civil engineering structure, export the designed data to excel for further calculations, calculate lumped mass, base shear and storey shear.

Mapping of COs to syllabus:

Course Outcomes	CO1	CO2	CO3
Module I	H		
Module II		M	H
Module III		M	H
Module IV	M	H	M

SCHOOL OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION

To be a centre of technological excellence for outstanding education and research in electrical and electronics engineering, contributing to the world socially committed engineers capable of accepting the continuous challenges of technological advancements.

MISSION

The department of Electrical and Electronics Engineering of Don Bosco College of Engineering and Technology, School of Technology, Assam Don Bosco University seeks to:

- Achieve excellence in teaching, research, practice and extension activities in the fields of Engineering in general and Electrical and Electronics Engineering in particular.
- Provide a strong foundation for the students to make them professionally competent for industry and research.
- Create an environment for the holistic development of individuals, encouraging them to serve the society with commitment and integrity.
- Offer necessary support and guidance to individuals to shape their ideas into reality.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

- To create an environment, give opportunity and also encourage the individuals to build a strong foundation of Electrical and Electronics Engineering as well as in related interdisciplinary fields of study, to be able to contribute to the need of the industry and the society at large.
- To make students capable of generating ideas, apply their knowledge and analyse the situations for executing live projects in Electrical and Electronics Engineering, with modern tools, equipment and software.
- To inculcate the habit of teamwork and infuse management skills in the students for their future professional life.
- To guide students to become ethical professionals in their own fields of work and be conscious about the effect of technology on the environment.

PROGRAMME OUTCOMES (POs) OF B. TECH IN ELECTRICAL AND ELECTRONICS ENGINEERING

PO 1: **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6: **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11: **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM-SPECIFIC OUTCOMES (PSO) OF B.TECH. IN ELECTRICAL AND ELECTRONICS ENGINEERING

PSO 1: Ability to apply and communicate the knowledge gained during the course of the program from all engineering as well as mathematics, basic sciences, social sciences courses and to identify, formulate and solve real-life problems faced in industries and/or research work.

PSO 2: Ability to solve ethically and professionally various electrical and electronics engineering problems to meet desired needs within realistic constraints.

PSO 3: Ability to demonstrate a systematic and procedural knowledge in electrical and electronics engineering for research and development, teaching and service in relevant industry.

PSO 4: Ability to work professionally in the areas of power systems, control systems, manufacturing, software etc. and recognize the need to engage in life-long learning.

PROGRAMME-SPECIFIC OUTCOMES (PSO) OF M.TECH. IN ELECTRICAL AND ELECTRONICS ENGINEERING (SPECIALIZATION- POWER SYSTEMS)

PSO 1: Ability to apply the enhanced knowledge in advanced technologies for modeling, analyzing and solving contemporary issues in the power sector with a global perspective and to carry out detailed and independent investigation on multifaceted complex problems in the area of power systems and to envisage advanced research in allied thrust areas.

PSO 2: Ability to express ideas clearly and communicate orally as well as in writing with others in an effective manner, adhering to various national and international standards and practices for the documentation and presentation of the contents.

PSO 3: Ability to critically analyze and identify real-life engineering problems in the area of power systems; and professionally and ethically provide strategic solutions satisfying the safety, societal, cultural, financial and environmental aspects/ needs with an eagerness for continued pursuance of research to design, develop or propose theoretical and practical methodologies towards the research and development support for the power system infrastructure.

PSO 4: Ability to utilize and develop modern tools for modeling, analyzing and solving various scientific problems related to power systems and to take up technical/administrative challenges including the management of various projects of interdisciplinary nature, working in a team with mutual understandings to take unsophisticated challenges leading and motivating the group to inculcate multidisciplinary and collaborative approach.

PROGRAMME-SPECIFIC OUTCOMES (PSO) OF M.TECH. IN ELECTRICAL AND ELECTRONICS ENGINEERING (SPECIALIZATION- CONTROL SYSTEMS)

PSO 1: Ability to apply the enhanced knowledge in advanced technologies for modeling, analyzing and solving contemporary issues in system and control engineering with a global perspective and to carry out detailed and independent investigation on multifaceted complex problems in the area of system engineering and control and to envisage advanced research in allied thrust areas.

PSO 2: Ability to express ideas clearly and communicate orally as well as in writing with others in an effective manner, adhering to various national and international standards and practices for the documentation and presentation of the contents.

PSO 3: Ability to critically analyze and identify real-life engineering problems in the area of control systems; and professionally as well as ethically provide strategic solutions satisfying the safety, societal, cultural, financial and environmental aspects/ needs with an eagerness for continued pursuance of research to design, develop or propose methodologies, both of academic and applied nature, in the area of mathematical and applied control systems.

PSO 4: Ability to use the techniques, skills and modern control engineering tools necessary for engineering practices and to take up technical/administrative challenges including the management of various projects of interdisciplinary nature, while working in a team with mutual understandings to take unsophisticated challenges leading and motivating the group to inculcate multidisciplinary and collaborative approach.

LIST OF COURSES- BTECH (EEE)

Course code	Course Name
EEBE0038	Basic Electrical Engineering
EEBL6027	Basic Electrical Engineering Laboratory

EECA0041	Electrical Circuit Analysis
EECA0042	Analog Electronics
EEMC0044	Electrical Machines – I
EEDE0045	Digital Electronics
EEAE6028	Analog Electronics Lab
EEMC6029	Electrical Machines-I Lab
EEDE6030	Digital Electronics Lab
EEEF0043	Electromagnetic Fields
EEMS0046	Electrical Machines – II
EEPE0047	Power Electronics
EEMS6031	Electrical Machines-II Lab
EEPE6032	Power Electronics Laboratory
EEEF0043	Electromagnetic Fields
EEEU0092	Energy Efficiency in Electrical Utilities (Honors)
EEPS0072	Power Systems -I
EECS0073	Control Systems
EECS6044	Control Systems Laboratory
EEMM0074	Microprocessors and Microcontrollers
EESS0075	Signals and Systems
EEED0076	Electrical Machine Design
EEEW0077	Electromagnetic Waves
EEED0078	Electronic Devices
EEMI6045	Mini Project-I
EEMM6042	Microprocessors and Microcontrollers Laboratory
EERS6043	Power Systems-I Laboratory
EEPS0079	Power Systems - II
EEMI0080	Measurements and Instrumentation
EEED0082	Electrical Drives
EEHV0083	High Voltage Engineering
EEDS0084	Digital Control Systems
EEDP0085	Digital Signal Processing
EEES0086	Embedded Systems
EEOD0099	Optoelectronic Devices
EEPS6046	Power Systems-II Laboratory
EEMI6047	Measurements and Instrumentation Lab
EEED6048	Electronic Design Laboratory
EEMI6049	Mini Project-II
EEAD0093	Analog and Digital Communication
EESP0094	Power System Protection
EERE0095	Renewable Energy Systems
EEOT0101	Optimization Techniques
7.5	Electrical Materials
7.6	Wind and Solar Energy Systems
EEIT6052	Industrial Internship Seminar
EEMP6053	Major Project Phase-I
8.1	Power Quality and FACTS
8.2	Power System Dynamics and Control
8.3	Electrical Energy Conservation and Auditing
8.4	Industrial Electrical Systems
8.5	Power Plant Engineering
8.6	Major Project Phase-II

Mapping of Courses to PO/PSO

Course code	PO	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4

	1															
EEBE0038	M	M											M		L	
EEBL6027	M	M											M		L	
BTIA8			M			H		L	H	M		H		H		
EECA0041	H	H	M										H	L	L	
EECA0042	H	M		M	M								H	M	M	
EEEF0043	H	M	L										H		M	
EEMC0044	M	H	L	L									H	M	H	M
EEAE6028	L	L		L	H								M	L	L	H
EEMC6029	M	H	L	L									H	M	H	M
EEDE6030	H	L	M		H								H	L	L	L
EEDE0045	H	L	M										H	L	L	L
EEMS0046	M	H	L	L									H	M	H	M
EEPE0047	L	M	L	M	M								M	L	M	
EEMS6031	M	H	L	L									H	M	H	M
EEPE6032	L	M	L	M	H								M	L	M	
EEEU0092	M	M	H	L	H	H	H	M	L		M	M	H	M	L	M
EEPS0072	M	H	L	M	M	M							L	L	H	H
EECS0073	M	M	M	H	L								M	H	M	H
EESS0075	L	H		M	M		L						H	L	M	L
EEED0078	L	M	L	H	M								M	L	M	L
EEED0076	M	H		M	H								M	L	M	H
EEMM6042	H	L	H	L	H								M	L	M	L
EERS6043	M	H	L	M	M	M							L	L	H	H
EEMI6045	H	M	L	H	M				M	M	M	M	M	M	L	H
BTIP12			M			H		L	H	M		H		H		
EEEW0077	M	H				L							M	L	L	
EEMM0074	H	L	H	L	H								M	L	M	L
EECS6044				L	H								L	L	L	H
EEPS0079	M	H	L	M	M	M							L	L	H	H
EEMI0080	M	L	H	L	H								H	L	M	L
EEED0081	H	M		L	H								M	M	L	M
EEED0082	M	H		L	H								M	L	M	H
EEHV0083			M			H	L	M					M		M	H
EEDS0084	L	M	M	H	M								M	H	M	H
EEDP0085	L	H		M	H		L						H	L	M	L
EEES0086	H	L	H	L	H								M	L	M	L
EEOD0099	H	H	L	M	H	M							M	H	M	H
EEPS6046	M	H	L	M	M	M							L	L	H	H
EEMI6047	M	L	H	L	H								H	L	M	L
EEED6048	H	M		L	H								M	M	L	M
EEMI6049	H	M	L	H	M				M	M	M	M	M	M	L	H
7.1	L		M	L	H	L							L	L	M	M
EESP0094	L	M	H	L	L								M	L	L	H
7.3	L	L	M	L	M	L	H						M			H
7.4	M	M	L	L	H								H			M
7.5			M	L		M	H						L		M	L
7.6	L	L	M	L	M	L	H						M			H
7.7	L		M	M	H	M	M	M	H	M	L	H	H	M	M	H
7.8	H	M	L	H	H				M	M	M	M	M	M	L	H
8.1	M	H	L	M	M	M							L	L	H	H
8.2	M	H	L	M	M	M							L	L	H	H
8.3	M	L	H		L	M	H	M				M	H	L	L	H
8.4	M	L	H	L	H								H	L	M	L
8.5	H	H	M	L			M						L	L	M	H
8.6	H	M	L	H	H				M	M	M	M	M	M	L	H

DETAILED SYLLABUS

THEORY COURSES

EECE0022/ EEED0078: ELECTRONIC DEVICES

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Distinguish between the various types of transistors. (Understanding)
2. Outline the principles of semiconductor Physics. (Understanding)
3. Describe the mathematical models of semiconductor junctions and MOS transistors for circuits and Systems. (Applying)
4. Categorize general specifications and deploy abilities of the electronic devices, and assemblies. (Analyzing)

Module I (8 Lectures)

Semiconductor materials, crystal lattices, bulk crystal growth, epitaxial growth.

Bonding forces and energy bands in solids, charge carriers in semiconductors- electrons and holes, intrinsic and extrinsic materials; Carrier concentrations- Fermi level, temperature dependence; Drift of carriers- conductivity and mobility.

Excess carriers in semiconductors- optical absorption, luminescence, carrier lifetime, photoconductivity; Diffusion of carriers- diffusion and recombination.

Module II (8 lectures)

PN junction formation, open circuit condition; forward bias- diffusion current, recombination and total current; Depletion layer capacitance, diffusion capacitance and dynamic resistance; I-V characteristics, and small signal switching models; Avalanche breakdown, Zener diode, Schottky diode.

Module III (8 lectures)

BJT, Construction, Operation, Amplifying Action, Common base (CB) dc characteristics, common base amplifier, common emitter (CE) characteristics, Ebers-Moll Model, Biasing, low frequency small signal model, Coupling and bypass capacitors.

Module IV (8 lectures)

Junction Field Effect Transistor (JFET), JFET amplifier; Metal Oxide Field Effect Transistor (MOSFET) - Field effect and inversion, Enhancement MOSFET, threshold voltage.

Module V (7 lectures)

a. Light Emitting Diodes (LED), Hetero-junction high intensity LEDs, LED characteristics.
b. Solar Cells- Principles of photovoltaic devices, series and shunt resistance, solar cell materials, devices and efficiencies.
c. PIN diodes, photodiodes, semiconductor optical amplifiers and lasers.

Module VI (6 lectures)

Integrated circuit fabrication process: oxidation, diffusion, ion implantation, photolithography, etching, chemical vapor deposition, sputtering, twin-tub CMOS process, Ion implanted MOS transistors and Poly-Si Gates.

Suggested Readings

1. D. Neamen, D. Biswas, "Semiconductor Physics and Devices," McGraw-Hill Education.
2. NPTEL Lectures
3. G. Streetman, and S. K. Banerjee, “Solid State Electronic Devices,” 7th edition, Pearson, 20
4. S. M. Sze and K. N. Kwok, “Physics of Semiconductor Devices,” 3rd edition, John Wiley & Sons, 2006.
5. Y. Tsividis and M. Colin, “Operation and Modeling of the MOS Transistor,” Oxford Univ. Press, 2011.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					
CO 2		H	M			
CO 3					H	H
CO 4		H		H		

EEBE0038: BASIC ELECTRICAL ENGINEERING

(4 Credits – 60 hours) (L-T-P: 3-1-0)

Objectives:
- To understand and Analyse basic electric and magnetic circuits.
- To study the working principles of electrical machines and power converters.
- To introduce the components of low voltage electrical installations.

Course Outcomes
2. Define basic terminologies related to electrical circuits and machines. (Remembering)
3. Explain the working principle, construction, applications of dc machines and ac machines. (Understanding)
4. Explain basics of converters, domestic wiring and Electrical Installations. (Understanding)
5. Implement network theorems to simplify and solve a complex circuit. (Applying)
6. Interrogate basic DC as well as AC circuits. (Analyzing)

Module I (18 lectures)
Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.

Module II (16 lectures)
Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, R-L, R-C, R-L-C combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.

Module III (14 lectures)
DC Machines: Principle of operation of generators and motors, construction of DC machine, EMF and Torque Equations, Classification and applications of DC machines.
Transformer: Construction and principle of operation of a single-phase transformer, EMF equation, introduction of auto-transformer.
Induction Motor: Classification and applications, Construction and principle of operation of single phase and three-phase induction motor

Module IV (6 lectures)
DC-DC buck and boost converters, duty ratio control. Single-phase and three-phase voltage source inverters; sinusoidal modulation.

Module V (6 lectures)
Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Suggested Readings
1. J.B. Gupta, "Basic Electrical Engineering", S.K Kataria and Sons.
2. P.V. Prasad, S. Sivanagaraju, K.R. Varmah, Chikku Abraham, "Basic Electrical Engineering, Cengage Learning India.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H		M		M
CO 2		H	H		
CO 3				H	H
CO 4	H				
CO 5	M			M	

EECA0041: ELECTRICAL CIRCUIT ANALYSIS
(4 Credits - 60 hours) (L-T-P: 3-1-0)

Objective
To understand the physical laws that governs the response of electrical circuits and networks. The students obtain equations to solve circuits in steady and in transitory state through the application of mathematical tools

Course Outcomes
1. Define and relate the various network theorems used for circuit analysis. (Remembering)
2. Analyze circuits in the sinusoidal steady-state and two-port circuit behaviour. (Understanding)

3. Determine the transient and steady-state response of electrical circuits. (Applying)
4. Evaluate graph of a network, tie-set matrix, loop currents, cut-set matrix and their node-pair potentials. (Analysing)

Module I (16 lectures)
Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Reciprocity Theorem, Compensation Theorem, Tellegen's Theorem, Substitution Theorem, Voltage and current divider rule. Analysis with dependent current and voltage sources. Node and Mesh analysis, Source transformation, Concept of Duality and Dual Networks.

Module II (10 lectures)
Solution of first and second order differential equations for series and parallel R-L, R-C, R-L-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient response.

Module III (9 lectures)
Representation of sine function as rotating phasor, phasor diagrams, impedances and admittances, AC circuit analysis, Effective and RMS values, Average power and complex power. Three phase circuits. Mutually coupled circuits, Dot Convention in coupled circuits, Ideal Transformer.

Module IV (11 lectures)
Review of Laplace Transforms, Analysis of Electrical Circuits using Laplace Transform for standard inputs, convolution integral, Inverse Laplace transform, transformed network with initial conditions, Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots), Series and Parallel Resonances.

Module V (8 lectures)
Two port networks, terminal pairs, relationship of two-port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, Interconnections of two- port networks.

Module VI (6 lectures)
Graph of network, concept of tree branch, tree link. Incidence matrix, Tie-set matrix and loop currents, Cut set matrix and node pair potentials

Suggested Readings

1. D Roy Choudhury, Networks and Systems, New Age International
2. Abhijit Chakrabarti, Circuit Theory (Analysis and Synthesis), Dhanpat Rai and Co., New Delhi
3. ME Van Valkenburg, Network Analysis, Prentice Hall
4. Joseph Administer, Electric Circuits, Schaum's Outline Series
5. David A Bell, Electric Circuits, 6th ed., PHI
6. MS Shukhija and TK Nagsarkar, Circuits and Networks, Oxford University Press, 2010
7. William H. Hayt Jr., Jack E. Kemmerly, Steven M. Durbin, Engineering Circuit Analysis, 6/e, TMH.
8. Ravish R Singh, Network Analysis and Synthesis, Mc Graw Hll Education.
9. K.M. Soni, Circuits &Systems, S.K. Kataria & Sons.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H					
CO 2		L	H		H	
CO 3			L	H		
CO 4						H

EEAE0042: ANALOG ELECTRONICS

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Objective
This course aims to familiarize the student with the concept of diode circuits, BJT circuits, MOSFET circuits etc. Also, the course introduces OpAmp and its different applications in electronic circuits.

Course Outcomes
1. Explain the characteristics of transistors. (Understanding)
2. Classify various modes of transistors working. (Understanding)
3. Compare different OP-AMP circuits. (Evaluating)
4. Design various rectifier, amplifier circuits and oscillators. (Creating)

Module I (4 lectures)
P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits.

Module II (10 lectures)
Structure and I-V characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits, current mirror; common-emitter, common-base and common- collector amplifiers; Small signal equivalent circuits, high-frequency equivalent circuit.

Module III (8 lectures)
MOSFET structure and I-V characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, transconductance, high-frequency equivalent circuit.

Module IV (7 lectures)
Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product).

Module V (10 lectures)
Idealized analysis of op-amp circuits. Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, P, PI and PID controllers and lead/lag compensator using an op-amp, voltage regulator, oscillators (Wein bridge and phase shift). Analog to Digital Conversion.

Module VI (6 lectures)
Hysteresis Comparator, Zero Crossing Detector, Square-wave and triangular-wave generators.Precision rectifier, peak detector. Monoshot.

Suggested Readings

1. A.S. Sedra and K.C. Smith, “Microelectronic Circuits”, New York, Oxford University Press, 1998.
2. J.V. Wait, L.P. Huelsman and G.A. Korn, “Introduction to Operational Amplifier theory and applications”, McGraw Hill U. S., 1992.
3. J. Millman and A. Grabel, “Microelectronics”, McGraw Hill Education, 1988.
4. P. Horowitz and W. Hill, “The Art of Electronics”, Cambridge University Press, 1989.
5. P.R. Gray, R.G. Meyer and S. Lewis, “Analysis and Design of Analog Integrated Circuits”, John Wiley & Sons, 2001.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1		H		L		
CO 2		H				
CO 3				H	H	H
CO 4	H	H	H			

EEEF0043: ELECTROMAGNETIC FIELDS
(3 Credits-45 hours) (L-T-P: 3-0-0)

Objective
The objective of the course is to introduce the students to various electromagnetic field related quantities including vector differential and integral operators, electrostatics, magnetostatics and related applications.

Course Outcomes
1. Relate the concepts of electromagnetism with the operations of Electrical Machines and Power Transmission Systems. (Understanding)
2. Identify the laws involved in Generating and Motoring Actions of different Machines. (Applying)
3. Distinguish between guided and free space propagation of Electromagnetic Waves. (Analysing)
4. Estimate forces on the objects due to various Electromagnetic Fields. (Evaluating)

Module I (8 lectures)
a. Vector algebra- addition, subtraction, components of vectors, scalar and vector multiplications, triple products.
b. Three orthogonal coordinate systems (rectangular, cylindrical and spherical).

c. Vector calculus differentiation, Partial differentiation, integration, vector operator del, gradient, divergence and curl; integral theorems of vectors.
d. Conversion of a vector from one coordinate system to another.

Module II (6 Lectures)
a. Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications.
b. Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density.

Module III (7 lectures)
a. Current and current density, Ohms Law in Point form, Continuity of current.
b. Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two-wire line.
c. Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations.

Module IV (6 lectures)
Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors.

Module V (6 lectures)
Force on a moving charge, Force on a differential current element, Force between differential current elements, Nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Magnetic circuits, inductances and mutual inductances.

Module VI (6 lectures)
Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Motional Electromotive forces. Boundary Conditions.

Module VII (6 lectures)
Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in Phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors, Skin effect. Poynting theorem.

Suggested Readings
1. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014.
2. Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2009.
3. Pramanik, "Electromagnetism-Problems with solution", Prentice Hall India, 2012.
4. G. W. Carter, "The electromagnetic field in its engineering aspects", Longmans, 1954.
5. W. J. Duffin, "Electricity and Magnetism", McGraw Hill Publication, 1980.
6. W. J. Duffin, "Advanced Electricity and Magnetism", McGraw Hill, 1968.
7. E. G. Cullwick, "The Fundamentals of Electromagnetism", Cambridge University Press, 1966.
8. D. Popovic, "Introductory Engineering Electromagnetics", Addison-Wesley Educational Publishers, International Edition, 1971.
9. W. Hayt, "Engineering Electromagnetics", McGraw Hill Education, 2012.
10. U.A. Bakshi, A.V. Bakshi, "Electromagnetic Fields", Technical Publications, 2013.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI	Module VII
CO 1			L		H		
CO 2					H		
CO 3						L	H
CO 4	M	H		H	M		

EEMC0044: ELECTRICAL MACHINES-I
(3 Credits-45 hours) (L-T-P: 3-0-0)

Objective

The objective of this course is to equip the students with a basic understanding of DC machines and transformer fundamentals, different parts of these machines and help to gain the skills for operating DC machines and transformers. The course also equips students with the ability to understand and analyse the different circuits of DC machines and transformers.

Course Outcomes

1. List different types of dc machines. (Remembering)
2. Explain principle of operation of dc motor and dc generator, transformers (Understanding)
3. Differentiate different circuits used in dc motors and generators and transformers (Analyzing)
4. Solve problems related to the performances in terms of losses, efficiency, and regulation of different types of dc machines and transformers. (Applying)

Module I: Magnetic circuits, Electromagnetic force and torque (12 hours)

Review of magnetic circuits ohm's law of magnetic circuit, series and parallel magnetic circuit, B-H curve of magnetic materials; flux-linkage vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to position of a moving element; torque as a partial derivative of stored energy with respect to angular position of a rotating element. Examples -galvanometer coil, relay contact, lifting magnet, rotating element with eccentricity or saliency.

Module II: DC machines (6 hours)

Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation, flux per pole, induced EMF in an armature coil, commutation, lap and wave windings, Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction.

Module III: DC machine - motoring and generation (8 hours)

Armature circuit equation for motoring and generation, Types of field excitations – separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. DC motor starters. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines

Module IV: Single phase Transformers (8 hours)

Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses

Module V: Three phase Transformers (11 hours)

Three-phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers.

Suggested Readings

1. A.E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Education, 2013.
2. J.B. Gupta, "Theory and performance of Electrical machines" S.K. Kataria and sons. 2017
3. A.E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
4. M.G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
5. P.S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
6. I.J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1			H		
CO 2		H		H	
CO 3			H	H	H
CO 4			H	H	H

EEDE0045: DIGITAL ELECTRONICS

(3 Credits-45 hours) (L-T-P: 3-0-0)

Objective

The objectives of this course are to introduce the concept of digital and binary systems and give students the concept of digital electronics. The course also provides fundamental concepts used in the design of digital systems, the basic tools for the design and implementation of digital circuits, modules and subsystems.

Course Outcomes

1. Define the basic terminologies related to digital electronics and logic design. (Remembering)
2. Explain the fundamentals of basic logic gates, combinational and sequential circuits, digital converters and memories. (Understanding)
3. Apply simplification methods for minimizing logic expressions. (Applying)
4. Design and implement combinational and sequential circuit. (Creating)

Module I (9 Lectures)

Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems-binary, signed binary, octal, hexadecimal number, binary, arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital lCs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic.

Module II (10 Lectures)

Standard representation for logic functions, K-map representation, simplification of logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices, Q-M method of function realization.

Module III (10 Lectures)

A 1-bit memory, the circuit properties of bistable latch, the clocked SR flip flop, J- K-T and D types flip-flops, applications of flip-flops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of counters.

Module IV (8 Lectures)

Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs.

Module V (8 Lectures)

Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory(RAM), content addressable memory (CAM), charge decoupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).

Suggested Readings

1. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.
2. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.
3. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.
4. William H. Gothmann, "Digital Electronics: An Introduction to Theory and Practice", PHI.
5. B. Somanathan Nair, "Digital Electronics and Logic Design", PHI
6. G. K Kharate, "Digital Electronics", Oxford.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M			
CO 2	M	H	M	M	M
CO 3		H	M		
CO 4			H	H	M

EEMS0046: ELECTRICAL MACHINES-II

(3 Credits-45 hours) (L-T-P: 3-0-0)

Objective

This course provides a basic understanding of AC machinery fundamentals, machine parts and helps to gain the skills for operating AC machines. The course also equips students with the ability to understand and analyse the phasor diagrams and equivalent circuits of AC Induction and Synchronous Machines.

Course Outcomes

1. List various parts of all important ac machines (Remembering)
2. Explain the basic principle of operation of ac machines. (Understanding)
3. Analyze performance characteristics of ac machines. (Analysing)
4. Develop equivalent circuits and phasor diagram of different ac motors and generators. (Creating

Module I (8 Lectures)

Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, 3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding - concentrated and distributed, Sinusoidally distributed winding, winding distribution factor

Module II (4 Lectures)

Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Addition of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field.

Module III (13 Lectures)

Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque-speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines.

Module IV (8Lectures)

Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications

Module V (12 Lectures)

Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine – two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.

Suggested Readings

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery”, McGraw Hill Education, 2013.
2. M. G. Say, “Performance and design of AC machines”, CBS Publishers, 2002.
3. P. S. Bimbhra, “Electrical Machinery”, Khanna Publishers, 2011.
4. I. J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 2010.
5. A. S. Langsdorf, “Alternating current machines”, McGraw Hill Education, 1984.
6. P. C. Sen, “Principles of Electric Machines and Power Electronics”, John Wiley & Sons, 2007

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H		H	H	H
CO 2		H	H	H	H
CO 3			H	H	H
CO 4			H	M	H

EEPE0047: POWER ELECTRONICS

(3 Credits-45 hours) (L-T-P: 3-0-0)

Objective

The course helps to develop an in-depth understanding of the power electronics devices and circuits for current and voltage control and protection. The course helps in the learning of switching characteristics and various arrangement of power switching devices for realizing rectifier, inverter and choppers and triggering methods of SCRs.

Course Outcomes
1. Explain the working of different power converters such as rectifiers, choppers and inverters. (Understanding)
2. Identify different power electronic devices and their characteristics. (Applying)
3. Compare the various types of power electronics converters and application. (Evaluating)
4. Choose a suitable type of converter for electrical application and construct. (Creating)

Module I (8 lectures)
Diode, Thyristor, MOSFET, IGBT: I-V Characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT.

Module II (9 lectures)
Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor.

Module III (5 lectures)
Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.

Module IV (5 lectures)
Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

Module V (10 lectures)
Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage.

Module VI (8 lectures)
Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, three-phase sinusoidal modulation.

Suggested Readings

1. M. H. Rashid, “Power electronics: circuits, devices, and applications”, Pearson Education India, 2009.
2. N. Mohan and T. M. Undeland, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, 2007.
3. R. W. Erickson and D. Maksimovic, “Fundamentals of Power Electronics”, Springer Science & Business Media, 2007.
4. L. Umanand, “Power Electronics: Essentials and Applications”, Wiley India, 2009.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	M			
CO 2	H	M	M	M
CO 3		H	M	H
CO 4				M

EESA0048: POWER SYSTEM ANALYSIS
(3 Credits - 45 hours) (L-T-P: 3-0-0)

Objective
The objective of this course is to give the knowledge of various methods of load flow, analysis of various types of faults in power systems, concept of security & contingency analysis of power systems and their needs for maintaining security of the system. It also introduces the concept of state estimation and the phenomenon of voltage instability in power systems.

Course Outcomes
1. Find different parameters for the analysis of power system. (Remembering)
2. Explain methods of state estimation in power system. (Understanding)
3. Organize various contingencies according to their severity. (Applying)
4. Analyse simultaneous fault using generalized method. (Analysing)

5. Determine voltage magnitude and phase-angles at all buses for the given data using various methods of load flow. (Evaluating)

Module I: Load Flow (10 hours)
Overview of Newton-Raphson, Gauss-Seidel, fast-decoupled methods, convergence properties, sparsity techniques, handling Q-max violations in constant matrix, inclusion in frequency effects, AVR in load flow, handling of discrete variables in load flow.

Module II: Fault Analysis (7 hours)
Simultaneous faults, short circuit and open conductor faults, generalized method of analysis of simultaneous faults in power systems.

Module III: Security Analysis (7 hours)
Security state diagram, contingency analysis, generator shift distribution factors, line outage distribution factor, multiple line outages, overload index ranking.

Module IV: Power System Equivalents (5 hours)
WARD equivalents (Kron reduction), WARD equivalent circuits for power flow studies, REI equivalents for power systems.

Module V: State Estimation (8 hours)
Sources of errors in measurement, Virtual and Pseudo, Measurement, Observability, Tracking state estimation, WSL method, bad data correction.

Module VI: Voltage Stability (8 hours)
Introduction to voltage instability scenario in a single machine infinite bus system, Voltage collapse, P-V curve, multiple power flow solution, continuation power flow, optimal multiplies load flow.

Suggested Readings
1. J. J. Grainger and W. D. Stevenson, “Power system analysis”, McGraw Hill, 2003.
2. A. R. Bergen and Vijay Vittal, “Power System Analysis”, Pearson, 2000.
3. L. P. Singh, “Advanced Power System Analysis and Dynamics”, New Age International, 2006.
4. G. L. Kusic, “Computer aided power system analysis”, Prentice Hall India, 1986.
5. A. J. Wood, “Power generation, operation and control”, John Wiley, 1994.
6. P. M. Anderson, “Faulted power system analysis”, IEEE Press, 1995.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	M		H			H
CO 2		M		M	H	
CO 3			H	H		
CO 4		H	M			
CO 5	H					H

EESD0049: POWER SYSTEM DYNAMICS-I
(3 Credits - 45 hours) (L-T-P: 3-0-0)

Objective
The objective of this course is to give the concept of power system dynamics and its physical interpretation, development of mathematical models for synchronous machine and modeling of induction motor, prime mover controller, load modeling in power systems and stability analysis with and without power system stabilizer.

Course Outcomes
1. List the various stability problems in power systems. (Remembering)
2. Describe the modeling of electrical machines and excitation systems. (Understanding)
3. Solve problems related to various electrical machines and excitation systems. (Applying)
4. Find different parameters of Electrical machines. (Alalyzing)
5. Experiments to observe power system dynamics using simulation. (Evaluating)

Module I: Synchronous Machine (8 hours)
a. Basic concepts of stability, types of stability, stability phenomena Armature and field structure, MMF waveforms, equations, Direct and quadrature axes, Mathematical description of a synchronous machine, Basic equations of synchronous machine.

b. Park's Transformation (modified), Flux-linkage equations.

Module II: Synchronous Machine Equations (8 hours)
Voltage and current equations, Stator self and mutual inductances, mutual inductances between stator and rotor, Electrical power and torque equations
per unit stator and rotor voltage, flux, inductance, power and torque, phasor representation, dq-0 transformations of stator and rotor Current and Voltage, rotor angle, Formulation of State-space equations, Equivalent

Module III: Modeling and Analysis of Synchronous Machine (6 hours)
Sub-transient and transient inductance and Time constants, Simplified models of synchronous machines

Module IV: Small Signal Model (8 hours)
Introduction to frequency model. Models of governor, turbine, power system stabilizer and FACTS devices.

Module V: Excitation System and Load (8 hours)
Excitation systems requirements, Elements of an excitation system, types of excitation systems: dc excitation systems, ac excitation systems, static excitation systems, Recent developments and future trends, Philips-Heffron model, PSS Load modeling.

Module VI: Induction Motors (7 hours)
Modeling of Induction Motors, equation of induction machines, steady state characteristics modeling of Prime mover, Prime mover controllers.

Suggested Readings

1. P. M. Anderson & A. A. Fouad "Power System Control and Stability", Galgotia, New Delhi, 1981.
2. J. Machowski, J. Bialek & J. R. W. Bumby, "Power System Dynamics and Stability", John Wiley & Sons, 1997.
3. P. Kundur, "Power System Stability and Control", McGraw Hill Inc., 1994.
4. E. W. Kimbark, "Power system stability", Vol. I & III, John Wiley & Sons, New York 2002.
5. D. Mondal, A. Chakrabarti & A. Sengupta, "Power System Small Signal Stability Analysis and Control", Academic Press, 2014.
6. J Machowski, J Bialek& J. R W. Bumby, "Power System Dynamics and Stability", John Wiley & Sons, 1997.
7. E.W. Kimbark, "Power system stability", Vol. I & III, John Wiley & Sons, New York 2002.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H					
CO 2	H	H	L		M	M
CO 3	H	H				M
CO 4		H	M	M	M	
CO 5	L					

EEHP0050: HIGH POWER CONVERTERS

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Objective
Students will be able to understand the need of high power rated converters and analyze the different topologies involved for these converters. It will provide a holistic approach to comprehend the design of protection circuits for these converters.

Course Outcomes

1. Define the characteristics of PSDs such as SCRs, GTOs, IGBTs and use them in practical systems. (Remembering)
2. Explain the working of multi-level VSIs, DC-DC switched mode converters, Cyclo-converters and PWM techniques. (Understanding)
3. Analyze performance of converters based on output characteristics. (Analyzing)
4. Compare various types of Power Inverters. (Evaluating)

Module I: Power Switching Devices (10 hours)
Power electronic systems: an overview of PSDs, multi-pulse diode rectifier, multi-pulse SCR rectifier .

Module II: Power Inverters (15 hours)
Phase shifting transformers, multilevel voltage source inverters: two level voltage source inverter, Cascaded, H bridge multilevel inverter. Diode clamped multilevel inverters, flying capacitor multilevel inverter, PWM current source inverters.

Module III: Power Inverters (13 hours)
DC to DC switch mode converters, AC voltage controllers: Cyclo-converters, matrix converter.

Module IV: Power Inverters (7 hours)
Power conditioners and UPS, design aspects of converters, protection of devices and circuits.

Suggested Readings
1. N. Mohan, T. M. Undel & W. P. Robbins, "Power Electronics: Converter, Applications and Design", John Wiley and Sons, 1989.
2. M. H. Rashid, "Power Electronics", Prentice Hall of India, 1994.
3. B. K. Bose, "Power Electronics and A.C. Drives", Prentice Hall, 1986.
4. Bin Wu, "High power converters and drives", IEEE press, Wiley Enter science.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	H		
CO 2			M	
CO 3			M	M
CO 4				M

EEWS0051: WIND AND SOLAR SYSTEMS)
(3 Credits - 45 hours) (L-T-P: 3-0-0)

Objective:
The objectives of this course are-
To expose the students to wind and solar energy systems.To make the students understand the factors involved in installation and commissioning of a Solar or Wind plant and to facilitate the students learn the dynamics involved when solar and wind energy systems are interconnected with power system grid.

Course Outcomes
1. Distinguish the various renewable energy sources. (Understanding)
2. Identify various advantages and disadvantages of wind and solar energy systems. (Applying)
3. Identify the possibility of solar power generation in India and across the globe. (Applying)
4. Develop new renewable energy generation system. (Creating)

Module I (8 hours)
Historical development and current status of wind and solar systems. Characteristics of wind and solar power generation. Network integration issues of renewable energy systems.

Module II (8 hours)
Generators and power electronics for wind turbines, Use of DFIG for wind energy, power quality standards for wind turbines, Technical regulations for interconnections of wind farms with power systems.

Module III (8 hours)
Isolated wind systems, reactive power and voltage control, economic aspects.

Module IV (8 hours)
Impact of wind energy systems on power system dynamics and stability, Wind energy systems grid connection and power system interconnection issues.

Module V (6 hours)
Introduction of solar systems, merits and demerits of solar energy conversion systems, solar concentrators, various applications of solar energy conversion systems.

Module VI (7 hours)
Solar thermal power generation, PV power generation, Energy Storage device. Designing the solar system for small installations.

Suggested Readings
1. Thomas Ackermann (Editor), "Wind Power in Power Systems", John Wiley & Sons. Ltd., 2005.
2. Siegfried Heier, "Grid Integration of Wind Energy Conversion Systems", 2nd Edition, John Wiley and Sons Ltd, 2006.
3. K. Sukhatme & S. P. Sukhatme, "Solar Energy", 3rd Edition, Tata McGraw Hill, 1996.

4. NPTEL Lectures

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H					
CO 2		H	M			
CO 3					H	H
CO 4				H	H	

EEPD0052: ELECTRICAL POWER DISTRIBUTION SYSTEM

(3 Credits – 45 hours) (L-T-P: 3-0-0)

Objective

The objective of this course is to make the students familiar with topics on electrical distribution system planning, load characteristics, application of distribution transformers, design of sub-transmission lines, distribution substations, primary systems, and secondary systems, voltage drop and power-loss calculations, application of capacitors, harmonics on distribution systems, voltage regulation, and smart grid concepts.

Course Outcomes

1. Demonstrate the knowledge of various distribution transformers, load characteristics, and associated factors. (Understanding)
2. Illustrate primary and secondary distribution networks. (Understanding)
3. Analyze voltage drops in distribution systems and choose proper measures to counteract voltage drops. (Analyzing)
4. Explain the integration of smart grid with the distribution management system. (Evaluating)

Module I: Distribution System Planning and Automation (8 hours)

Introduction, Distribution System Planning, Factors Affecting System Planning, Present Distribution System Planning Techniques, Central Role of the Computer in Distribution Planning, Distribution System Automation, load characteristics, Diversified demand, Non-coincident demand, Coincidence factor, Contribution factor problems, Relationship between the Load and Loss Factors, Load Forecasting, Rate structure, Customer billing.

Module II: Application of Distribution Transformers (8 hours)

Types of Distribution transformers, Regulation, Efficiency, single-phase transformer connections, Three-phase transformer connections, Auto-transformer, Booster transformer, phasor diagrams, Grounding Transformers.

Module III: Design of Sub-transmission Lines and Distribution Substations (8 hours)

Sub-station bus schemes, Rating of distribution substation, Service area with multiple feeders, Sub-station application curves, Percent voltage drop calculations, Substation Grounding, Types of Ground Faults.

Module IV: Design Considerations of Primary and Secondary Systems (8 hours)

Radial type, Loop type primary feeder, primary feeder loading, Radial Feeders with Uniformly Distributed Load, Introduction to Secondary Systems, secondary Banking, Secondary networks, Network transformers, Economic Design of Secondaries - General Total Annual cost (TAC), equation with and without constraints, Unbalanced loads and voltages.

Module V: Voltage-Drop and Application of capacitors (8 hours)

3-phase and Non 3-phase primary lines, Single-phase two-wire laterals with ungrounded neutral, Single-phase two-wire ungrounded laterals, Application of capacitors to distribution systems, Effect of series and shunt capacitors, power factor correction, Economic justification for capacitors, Optimum location for capacitor bank.

Module VI: Concept of Smart Grid (5 hours)

Need for Establishment of Smart Grid, Distributed Automation, SCADA, Integration of Smart Grid with the Distribution Management System, Evolution of Smart Grid, Smart Microgrids, Topology of a Microgrid, Consumer Information Service (CIS), Automatic Meter Reading (AMR).

Suggested Readings

1. Turan Gönen, “Electric Power Distribution Engineering”, CRC Press, 2014.
2. A. S. Pabla, “Electric Power Distribution”, McGraw Hill Education (India) Private Limited, 2011.
3. T. A. Short, “Electric Power Distribution Equipment And Systems”, CRC Press, 2004.
4. Kamalesh Das, “Electrical power Systems for Industrial Plants”, Jaico Publishing House, 2007.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H	H		M		L
CO 2			H	H		
CO 3			M		H	
CO 4	M					H

EEMM0053: MATHEMATICAL METHODS OF POWER ENGINEERING

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Objective

The objective of this course is to make the students understand the relevance of mathematical methods to solve engineering problems and to facilitate the students to learn how to apply the mathematical methods for a given engineering problem.

Course Outcomes

1. Demonstrate an understanding about vector sources, linear transformation, Eigen values and eigenvectors of linear operators. (Understanding).
2. Apply the knowledge of linear programming problems in various fields of power engineering. (Applying).
3. Utilize various techniques of nonlinear programming for solving constrained and unconstrained nonlinear programming problems. (Applying)
4. Justify the use of stochastic processes in the field of power engineering. (Evaluating)

Module I: Vectors and Linear Transformation (6 hours)

Definition of group and field, Vectors and vector spaces, Characterization of vector spaces, Linear transformation, Singular and Non-singular transformation, Matrix representation of linear transformation.

Module II: Eigen Vectors of Linear Operator (6 hours)

Eigen values and Eigen vectors of linear operator, Eigen spaces, Eigen basis for matrices, Eigen decomposition.

Module III: Introduction to Linear Programming (9 hours)

Linear programming problems, Graphical method, Simplex method, Dual-Simplex method, Duality, Non Linear programming problems.

Module IV: Introduction to Non-Linear Programming (8 hours)

Unconstrained problems, Newton's method, Hessian matrix, Search methods, Constrained problems.

Module V: Constrained Optimization (8 hours)

Lagrange method, Interpretation of Lagrange multipliers, Quadratic Programming problem, Kuhn-Tucker conditions, Random variables, Distributions.

Module VI: Stochastic Model/ Process (8 hours)

Definition, Independent random variables, Marginal and Conditional distributions, Elements of Stochastic process, State space, Index set.

Suggested Readings

1. Kenneth Hoffman & Ray Kunze, "Linear Algebra", 2nd Edition, PHI, 1992.
2. Erwin Kreyszig, "Introductory Functional Analysis with Applications", John Wiley & Sons, 2004.
3. Irwin Miller and Marylees Miller, "John E. Freund's Mathematical Statistics", 6th Edition, PHI, 2002.
4. J. Medhi, "Stochastic Processes", New Age International, New Delhi, 1994.
5. Papoulis and S. Pillai, "Probability, Random Variables and Stochastic Processes", 3rd Edition, McGraw Hill, 2002.
6. John B. Thomas, "An Introduction to Applied Probability and Random Processes", John Wiley, 2000.
7. Hillier F. S. and Liebermann G. J., "Introduction to Operations Research", 7th Edition, McGraw Hill, 2001.
8. Simmons D. M., "Non Linear Programming for Operations Research", PHI, 1975.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	H				
CO 2			H			
CO 3				H	H	
CO 4						H

EEMC0054: MATHEMATICAL METHODS IN CONTROL

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Objective

This course aims to give the students an understanding of foundational concepts in linear algebra and random processes for use in control systems. Students will understand Probability and Random variables.

Course Outcomes

1. Define vector space vector space axioms, vector space properties. (Remembering)
2. Explain responses of linear systems to any given input signal. (Understanding)
3. Apply matrix properties and functions to a given problem. (Applying)
4. Solve problems of control system Engineering using probability theory. (Creating)

Module I (10 hours)

Linear Spaces – Vectors and Matrices, Transformations, Norms, Matrix Factorization.

Module II (10 hours)

Eigen value, Eigenvectors and Applications, SVD and Applications, Projections and Least Square Solutions.

Module III (10 hours)

Probability, Random variables, Probability distribution and density functions, Joint density and conditional distribution, Functions of random variables and random vectors.

Module IV (5 hours)

Characteristic functions and correlation matrices, Random Processes and properties.

Module V (5 hours)

Response of Linear systems to stochastic inputs, PSD theorem.

Suggested Readings

1. G. Strang, “Introduction to Linear Algebra”, 4th Edition, Wellesley-Cambridge Press, 2009.
2. Papoulis and S. Pillai, “Probability, random variable and stochastic processes”, Mcgraw Hill, 2002.
3. H. Stark and J. W. Woods, “Probability and random processes with application to signal processing”, Pearson Education Asia, 2002.
4. J. A. Gubner, “Probability and Random processes for Electrical and Computer engineers”, Cambridge Univ. Press. 2006.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	L			
CO 2			H		
CO 3				H	
CO 4					H

EENS0055: NON-LINEAR SYSTEMS

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Objective

This course aims at introducing fundamental concepts of nonlinear dynamical systems and understanding basic tools for mathematical analysis as well as applications.

Course Outcomes

1. Choose tools for stability analysis and response evaluation of control problems with significant nonlinearities. (Remembering)
2. Identify the design problem and distinguish between the controls strategies. (Applying)
3. Analyse non linear systems using describing function methods. (Analysing)
4. Interpret stability of nonlinear systems from Lyapunav stability analysis. (Understanding)

Module I (10 hours)

Introduction to nonlinear systems: Examples of phenomena, models & derivation of system equations.

Module II (15 hours)

Fundamental properties: Existence & uniqueness, Dependence on initial conditions & parameters. Phase plane analysis. Limit cycles & oscillations. Describing function method and applications. Circle criterion.

Module III (12 hours)
Lyapunov stability of autonomous systems. Perturbation theory & Averaging. Singular perturbation model and stability analysis.

Module IV (8 hours)
Basic results on Lie algebra. Controllability and Observability of nonlinear systems. Bifurcations. Chaos. Synchronization.

Suggested Readings

1. H. K. Khalil, “Nonlinear systems”, 3 rd edition, Prentice Hall, 2001.
2. J. J. E. Slotine and W. Li, “Applied nonlinear systems”, Prentice Hall, 1991.
3. A. Nijemjer and A. van der schaft, “Nonlinear dynamical control systems”, Springer, 1989.
4. M. Vidyasagar, “Nonlinear Systems Analysis, Society for Industrial and Applied Mathematics”, 2002.
5. S. Strogatz, “Nonlinear Dynamics and Chaos”, West view Press, 2001.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1		H	H	
CO 2	H	L	L	
CO 3		H		
CO 4			H	

EECL0056: DIGITAL CONTROL

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Objective
This course aims to familiarize the student with the concept of discretization. The objective is to introduce the students to discrete-time system representations and digital control and make the learn to design controllers for digital systems.

Course Outcomes

1. Define a discrete time system. (Remembering)
2. Explain sampled data system. (Understanding)
3. Model control system on differential samping. (Applying)
4. Analyse digital systems in time domain and frequency domain. (Analysing)

Module I (15 hours)
Introduction to discrete-time systems, Frequency domain approach – Analysis and discretization, Time domain approach, analysis and discretization, State space formulation for discretized systems.

Module II (15 hours)
Engineering aspects of computer controlled systems, Sampled data systems, Control of Sampled data systems.

Module III (15 hours)
Concept of differential sampling, Closed loop analysis of differentially sampled systems, Control design based on differential sampling, Recent applications of Digital Control.

Suggested Readings

1. K. Ogata, “Discrete-time Control Systems”, 2nd Ed., Prentice-Hall, 1995.
2. Benjamin C. Kuo, “Digital Control Systems”, 2nd Ed., Oxford University Press, 1999.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H		
CO 2		H	
CO 3			H
CO 4	H		

EENC0057: NONLINEAR CONTROL

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Objective

This course aims to study concepts and techniques for stability analysis and learning control design of nonlinear systems.

Course Outcomes

1. Define tangent vectors, vector fields. (Remembering)
2. Explain Passivity analysis and applications to control design. (Understanding)
3. Apply deeper ideas from mathematics and specifically from geometry to engineering problems. (Applying)
4. Design control system using disturbance decoupling.(creating)

Module I (8 hours)

Overview of nonlinear Control-Introduction to Advanced Calculus, Elementary notions of Topology, Smooth Manifolds, Sub-manifolds, Tangent Vectors, Vector Fields.

Module II (7 hours)

Lyapunov stability for autonomous and non-autonomous systems, Input-Output Stability and Input-to-State Stability Absolute Stability.

Module III (8 hours)

Passivity analysis and applications to control design, Lyapunov-based feedback control design. Feedback linearization and back stepping.

Module IV (7 hours)

Sussmann's Theorem and global Decompositions, The Control Lie Algebra, the observation space.

Module V (8 hours)

Local Co-ordinates, Transformations, Exact Linearization via Feedback, The Zero dynamics, Local Asymptotic Stabilization, Asymptotic Output Tracking.

Module VI (7 hours)

Disturbance Decoupling, High Gain Feedback, Additional Results on Exact Linearization, Observers with Linear Error Dynamics.

Suggested Readings

1. H. K. Khalil, "Nonlinear Systems", 3rd edition, Prentice Hall, 2001.
2. H. K. Khalil, "Nonlinear Control", Pearson, 2015.
3. J. J. E. Slotine and W. Li, "Applied nonlinear systems", Prentice Hall, 1991.
4. A. Nijemjer and A. van der schaft, "Nonlinear dynamical control systems", Springer, 1989.
5. M. Vidyasagar, "Nonlinear Systems Analysis", Society for Industrial and Applied Mathematics, 2002.
6. Alberto Isidori, "Nonlinear Control Systems", Third Edition, Springer, 1995.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H					
CO 2			H			
CO 3				L	H	
CO 4						H

EESC0058: SCADA SYSTEM AND APPLICATIONS

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Objective

This course aims to familiarize the student with the concept of SCADA and its functions, to know SCADA communication and to get an insight into its application.

Course Outcomes

1. Explain the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications. (Understanding)
2. Make use of knowledge about SCADA architecture, various advantages and disadvantages of each system. (Applying)
3. Analyse the single unified standard architecture IEC 61850. (Analysing)
4. Select suitable SCADA system components: remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADA server. (Evaluating)

Module I (15 hours)

Introduction to SCADA: Data acquisition system, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA applications in Utility Automation and Industries SCADA.

Module II (15 hours)
Industries SCADA System Components: Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices(IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems, SCADA Architecture: Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture -IEC 61850.

Module III (15 hours)
SCADA Communication: various industrial communication technologies - wired and wireless methods and fiber optics, Industries - oil, gas and water. Case studies, Implementation, Simulation Exercises.

Suggested Readings

1. Stuart A. Boyer, "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, 2004.
2. Gordon Clarke and Deon Reynders, "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK, 2004.
3. William T. Shaw, "Cybersecurity for SCADA systems", Penn Well Books, 2006.
4. David Bailey and Edwin Wright, "Practical SCADA for industry", Newnes, 2003.
5. Michael Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power", Penn Well, 1999.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H	M	L			L
CO 2				H		
CO 3				H	M	
CO4			H			

EDA0059: DESIGN ASPECTS IN CONTROL

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Objective
This course aims to familiarize the student to the tools and techniques of control system design. Introduction to various aspects of controller design philosophy, learning PID Controller are incorporated into the course.

Course Outcomes
1. Tell about FOPDT and SOPDT systems. (Remembering)
2. Explain zero dynamics in servo control. (Understanding)
3. Model a control system given its parameters. (Applying)
4. Design observer. controllers like PI, PID in a given control system. (Evaluating)

Module I (15 hours)
System Modelling, review of concepts, FOPDT and SOPDT systems and identification of Smith Predictor and its variations.

Module II (15 hours)
PID Controllers – review PID Tuning – Ziegler Nichols, Cohen-Coon techniques. State feedback review – pole placement, Eigen structure assignment, Eigen structure – time response relation, Controller gain selection, controller robustness, disturbance rejection.

Module III (15 hours)
Frequency Domain Loop Shaping, Lag, Lead and Lag-lead compensators, Zero dynamics in servo control, Unstable zero dynamics – control design, Observer – concept and design, Case studies – Applications.

Suggested Readings

1. Karl J. Astrom and Richard M. Murray, "Feedback Systems: An Introduction for Scientists and Engineers", Princeton University Press, 2010.
2. Thomas Kailath, "Linear Systems", Prentice-Hall.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III

CO 1	H		
CO 2			H
CO 3		H	
CO4	M		H

EEDP0060: DIGITAL PROTECTION OF POWER SYSTEM

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Illustrate the use of mathematical methods for relaying purposes. (Understanding)
2. Apply the digital relaying techniques in power system protection. (Applying)
3. Assess effectiveness of digital relays over the electromechanical ones for power system protection requirements. (Evaluating)
4. Design digital protection systems for power system applications. (Creating)

Objective

The objectives of this course are-

- To provide an overview of the numerical relays and their working
- Introduce a mathematical approach towards protection
- To provide a detailed treatment of algorithms for numerical protection

Module I (6 hours)

Evolution of digital relays from electromechanical relays, Types of digital relays, Performance and operational characteristics of digital protection.

Module II (6 hours)

Mathematical background to protection algorithms, Finite difference techniques.

Module III (8 hours)

Interpolation formulae, forward, backward and central difference interpolation, Numerical differentiation, Curve fitting and smoothing, Least squares method, Fourier analysis, Fourier series and Fourier transform, Walsh function analysis.

Module IV (8 hours)

Basic elements of digital protection, Signal conditioning: transducers, surge protection, analog filtering, analog multiplexers, Conversion subsystem: the sampling theorem, signal aliasing. Error, sample and hold circuits, multiplexers, analog to digital conversion, digital filtering concepts, digital relay as a unit consisting of hardware and software, Integration of Digital Relays into SCADA systems.

Module V (8 hours)

Mathematical basis of numerical techniques and relay algorithms, Sinusoidal wave based algorithms, Sample and first derivative (Mann and Morrison) algorithm. Fourier and Walsh based algorithms.

Module VI (8 hours)

Fourier Algorithm: Full cycle window algorithm, fractional cycle window algorithm, Walsh function based algorithm. Least Squares based algorithms. Differential equation based algorithms. Traveling Wave based Techniques. Digital Differential Protection of Transformers.Digital Line Differential Protection. Recent Advances in Digital Protection of Power Systems.

Suggested Readings

1. A. G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, Wiley/Research studies Press, 2009.
2. A. T. Johns and S. K. Salman, “Digital Protection of Power Systems”, IEEE Press, 1999.
3. Gerhard Zeigler, “Numerical Distance Protection”, Siemens Publicis Corporate Publishing, 2006.
4. S. R. Bhide, “Digital Power System Protection” PHI Learning Pvt. Ltd., 2014.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1		H		M	
CO 2	M		H		L
CO 3	H		L		
CO 4			M		H

EEPD0061: POWER SYSTEM DYNAMICS-II

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Recall the basic concepts of dynamic systems and stability definition. (Remembering)
2. Explain the different stability problems arise in power system. (Understanding)
3. Identify different stability problems faced by modern power systems, e.g., multi-machine stability, large signal stability, etc. (Applying)
4. Analyze the stability problems and implement modern control strategies, e.g., damper, AGC etc. (Analyzing)
5. Assess voltage and frequency stability in power systems. (Evaluating)

Objective

The objective of this course is to give the concept of power system dynamics, interpretation of power system dynamic phenomena and various forms of stability problems in power systems & their mitigation technique.

Module I: Power System Stability (8 hours)

Basic Concepts of Dynamic Systems and Stability Definition, Small Signal Stability (Low Frequency Oscillations) of Unregulated and Regulated System, Analysis of stability.

Module II: Damper (8 hours)

Effect of Damper, Flux Linkage Variation and AVR.

Module III: Large Signal Stability (8 hours)

Large Signal Rotor Angle Stability, Dynamic Equivalents and Coherency, Direct Method of Stability Assessment, Stability Enhancing Techniques, Mitigation Using Power System Stabilizer.

Module IV: Multi-Machine Stability (6 hours)

Asynchronous Operation and Resynchronization, concept of multi-Machine Stability.

Module V: Voltage Stability (6 hours)

Dynamic Analysis of Voltage Stability, Voltage Collapse and classification, typical scenario of voltage collapse, Prevention of voltage collapse.

Module VI: Frequency Stability (6 hours)

Introduction to Frequency Stability, Automatic Generation Control, Primary and Secondary Control, Sub-Synchronous Resonance and Counter Measures.

Suggested Readings

1. P. Kundur, “Power System Stability and Control”, McGraw Hill Inc, 1994.
2. J. Machowski, J. Bialek and J. Bumby, “Power System Dynamics and Stability”, John Wiley & Sons, 1997.
3. L. Leonard Grigsby (Ed.), “Power System Stability and Control”, Second edition, CRC Press, 2007.
4. V. Ajjarapu, “Computational Techniques for voltage stability assessment & control”, Springer, 2006.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H		M		M	M
CO 2		H	H	M	L	L
CO 3			H	H	M	
CO 4		H		H		
CO 5					H	H

EERP0062: RESTRUCTURED POWER SYSTEMS

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Explain the various types of regulations in power systems. (Understanding).
2. Illustrate the Technical and Non-technical issues in Deregulated Power Industry.(Understanding).
3. Identify the need of regulation and deregulation. (Applying)
4. Interpret different market mechanisms and various entities in the market. (Applying)

Objective

The objective of this course is to introduce the concepts of restructuring and deregulation of electricity market. This will enable the students to understand the need behind the requirement for deregulation of the electricity market. This course focuses on the understanding of the money, power & information flow in a deregulated power system.

Module I: Introduction to Electricity Market (10 hours)
Fundamentals of electricity market deregulation and restructured system, Market power, Market models and architecture, Independent System Operator (ISO), Power Exchange (PX), Market Clearing Price (MCP), Day-Ahead and Hour-Ahead Markets, Elastic and Inelastic Markets, Social welfare maximization.

Module II: Optimal Power Flow (11 hours)
OPF: Role in vertically integrated systems and in restructured markets, Transmission Open Access, Power Wheeling, Congestion management, Transfer Capability: Definitions and calculations- Available Transfer Capability (ATC).

Module III: Hedging Tools for Managing Risks in Electricity Markets (8 hours)
Optimal bidding; Risk assessment, Hedging; Transmission Pricing; Electricity Pricing: Volatility, Risk and Forecasting.

Module IV: Ancillary Services & Distributed Generations (6 hours)
Ancillary Services, Distributed generation in restructured markets, IT applications in restructured markets.

Module V: Indian sector and Global Electric Utility Markets (10 hours)
Developments in India, Working of restructured power systems in various countries, Standard Market Design (SMD), PJM, Recent trends in Restructuring.

Suggested Readings

1. Mohammad Shahidehpour and Muwaffaq Alomoush, "Restructured electrical power systems: operation, trading and volatility", Marcel Dekker.
2. Kankar Bhattacharya, Jaap E. Daadler and Math H. J. Boolen, "Operation of restructured power systems", Kluwer Academic Pub., 2001.
3. Lorrin Philipson and H. Lee Willis, "Understanding electric utilities and de-regulation", Marcel Dekker Pub., 1998.
4. L. L. Lai, "Power System Restructuring and Deregulation: Trading, Performance and Information Technology", Wiley, 2001.
5. Steven Stoft, "Power system economics: designing markets for electricity", John Wiley and Sons, 2002.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	L			
CO 2		H	H		
CO 3			M	H	
CO 4				M	H

EEAS0063: ADVANCED DIGITAL SIGNAL PROCESSING

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Demonstrate knowledge about the time domain and frequency domain representations as well analysis of discrete time. (Understanding)
2. Apply the design techniques for IIR and FIR filters and their realization structures. (Applying)
3. Utilize knowledge about the finite word length effects in implementation of digital filters. (Applying)
4. Make use of the knowledge about the various linear signal models and estimation of the power spectrum of stationary random signals. (Applying)

Objective
The course helps to develop an in-depth understanding of the digital signal processing techniques. The course helps in learning of the methods used to structure and design various filters and understand their characteristics.

Module I: Fundamentals of Discrete-Time Signal and System (8 hours)
Discrete time signals, Linear shift invariant systems, Stability and causality, Sampling of continuous time signals, discrete time Fourier transform- Discrete Fourier series- Discrete Fourier transform, Z transform-Properties of different transforms.

Module II: Discrete-Time Signals in the Transfer Domain (8 hours)

Linear convolution using DFT, Computation of DFT Design of IIR digital filters from analog filters, Impulse invariance method, Bi-linear transformation method.

Module III: Digital Filter Structures and Design (8 hours)
FIR filter design using window functions, Comparison of IIR and FIR digital filters, Basic IIR and FIR filter realization structures, Signal flow graph representations Quantization process and errors, Coefficient quantization effects in IIR and FIR filters.

Module IV: Analysis of Finite Word length Effects (8 hours)
A/D conversion noise- Arithmetic round-off errors, Dynamic range scaling, Overflow oscillations and zero Input limit cycles in IIR filters, Linear Signal Models.

Module V: Linear Signal Models and Power Spectrum Estimation (7 hours)
All pole, All zero and Pole-zero models, Power spectrum estimation- Spectral analysis of deterministic signals, Estimation of power spectrum of stationary random signals.

Module VI: Optimum Linear Filters (6 hours)
Optimum linear filters, Optimum signal estimation, Mean square error estimation, Optimum FIR and IIR Filters.

Suggested Readings

1. Sanjit K. Mitra, “Digital Signal Processing: A computer-based approach”, Tata McGraw-Hill Edition, 1998.
2. Dimitris G. Manolakis, Vinay K. Ingle & Stephen M. Kogon, “Statistical and Adaptive Signal Processing”, McGraw Hill international edition 2000.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H	H				L
CO 2			H	M	L	H
CO 3	M		M	H		
CO 4		M			H	M

EEAS0064: POWER SYSTEM TRANSIENTS

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Explain the reasons for occurrence of transients in a power system. (Understanding)
2. Utilize the knowledge of various transients that could occur in power systems and their mathematical formulation. (Applying)
3. Illustrate the use of insulation in various equipment in power systems. (Applying)
4. Analyze the power system for transient analysis. (Analyzing)
5. Design various protective devices in power systems for protecting equipment and personnel. (Creating)

Objective
The objective of this course is to introduce the concepts of power system transients. Students will be able to learn the reasons for occurrence of transients in a power system. This will enable the students to understand the change in parameters like voltage & frequency during transient. This course also focuses on the lightning phenomenon and its effect on the power system.

Module I: (8 hours)
Fundamental circuit analysis of electrical transients; Laplace Transform method of solving simple Switching transients; Damping circuits-Abnormal switching transients; Three-phase circuits and transients; Computation of power system transients.

Module II (7 hours)
Principle of digital computation-Matrix method of solution; Modal analysis- Z transform; Computation using EMTP; Lightning, switching and temporary over voltage; Physical phenomena of lightning.

Module III (6 hours)
Interaction between lightning and power system; Influence of tower footing resistance and Earth Resistance; Switching: Short line or kilometric fault; Energizing transients - closing and re-closing of lines; line dropping, load rejection - over voltages induced by faults.

Module IV (8 hours)

Switching HVDC line; Travelling waves on transmission line, Circuits with distributed Parameters; Wave Equation; Reflection, Refraction, Behaviour of Travelling waves at the line terminations; Lattice Diagrams - Attenuation and Distortion; Multi-conductor system and Velocity wave.

Module V (8 hours)
Insulation co-ordination: Principle of insulation co-ordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS); Coordination between insulation and protection level; Statistical approach.

Module VI (8 hours)
Protective devices; Protection of system against over voltages, lightning arresters, substation earthing.

Suggested Readings

1. Allan Greenwood, “Electrical Transients in Power System”, Wiley & Sons Inc. New York, 1991.
2. Y. G. Paithankar, “Fundamentals of Power System Protection”, Prentice Hall India Learning Private Limited, 2010.
3. Akihiro Ametani, Naoto Nagaoka, Yoshihiro Baba, Teruo Ohno and Koichi Yamabuki, “Power System Transients: Theory and Applications”, CRC Press, 2016.
4. Prabha Kundur, “Power System Stability and Control”, McGraw Hill Education, 2006.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					
CO 2		H	H	L		
CO 3					H	
CO 4			M	H		
CO 5						H

EEFC0065: FACTS AND CUSTOM POWER DEVICES

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. List various FACTS devices. (Remembering)
2. Describe fundamental principles of Passive and Active Reactive Power Compensation Schemes. (Understanding)
3. Identify suitable FACTS devices for specific applications. (Applying)
4. Experiments with various FACTS devices to improve Power quality. (Evaluating)

Objective
This course gives an introduction to the of flexible ac transmission systems to enhance controllability and power transfer capability in ac systems, involves applications of power electronics in power systems in the range of a few tens to hundred megawatts to improve reliability of power supply and opens up new opportunities for controlling power and enhancing the usable capacity of present, as well as new and upgraded lines.

Module I: Power flow control (6 hours)
Reactive power flow control in Power Systems, Control of dynamic power unbalances in Power System - Power flow control, Constraints of maximum transmission line loading, Benefits of FACTS Transmission line compensation, Uncompensated line - Shunt compensation, Series compensation Phase angle control, Reactive power compensation Shunt and Series compensation principles, Reactive compensation at transmission and distribution level.

Module II: Shunt compensator (10 hours)
Static versus passive VAR compensator, Static shunt compensators: SVC and STATCOM, Operation and control of TSC, TCR and STATCOM -Compensator control, Comparison between SVC and STATCOM.

Module III: Series compensator and regulators (15hours)
Static series compensation: TSSC, SSSC -Static voltage and phase angle regulators, TCVR and TCPAR Operation and Control, Applications, Static series compensation, GCSC, TSSC, TCSC and Static synchronous series compensators and their Control.

Module IV: Combined compensator (8 hours)
SSR and its damping Unified Power Flow Controller, Circuit Arrangement, Operation, and control of UPFC, Basic Principle of P and Q control, Independent real and reactive power flow control-Applications, Introduction to interline power flow controller.

Module V: Power quality (6hours)

Modeling and analysis of FACTS, Controllers, Simulation of FACTS controllers, Power quality problems in distribution systems, harmonics, loads that create harmonics, modeling, harmonic propagation, series and parallel resonances mitigation of harmonics, passive filters, active filtering – shunt, series and hybrid and their control, Voltage swells, sags, flicker, unbalance and mitigation of these problems by power line conditioners, IEEE standards on power quality.

Suggested Readings

1. K. R. Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age International Publishers, 2007.
2. X. P. Zhang, C Rehtanz and B. Pal, “Flexible AC Transmission Systems- Modelling and Control”, Springer, Verlag, Berlin, 2006.
3. N. G. Hingorani, L. Gyugyi, “Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems”, IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.
4. K. S. Suresh Kumar and S. Ashok, “FACTS Controllers & Applications”, E-book edition, Nalanda Digital Library, NIT Calicut, 2003.
5. G. T. Heydt, “Power Quality”, McGraw-Hill Professional, 2007.
6. T. J. E. Miller, “Static Reactive Power Compensation”, John Wiley and Sons, New York, 1982.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2	L	H	H	H	
CO 3		H	H	H	M
CO 4		M	M		

EEOC0066: OPTIMAL CONTROL THEORY

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Relate the mathematical methods used in optimal control to derive the solution to variations of the problems studied in the course. (Remembering)
2. Explain dynamic programming and its use in control system engineering. (Understanding)
3. Apply principle of optimality to decision making. (Applying)
4. Utilize the standard algorithms for numerical solution of optimal control problems and use MATLAB to solve fairly simple but realistic problems. (Applying)

Objective

This course aims at introducing the basic and fundamental concepts of optimal control theory, controller design. The course also introduces computational aspects of optimal control.

Module I (15 hours)

Review of Matrix Computations. Maximization of functional of a single and several functions using calculus of variations, Constrained externals, Euler-Lagrange Equation, Necessary conditions for optimal control, Pontryagin’s minimum principle and state inequality constraints, Minimum time problems, Minimum control effort problems.

Module II (15 hours)

Linear quadratic regulator problems, Riccati Equation, Singular intervals in optimal control problems, The principle of optimality, Application of the principle of optimality to decision making, Dynamic programming applied to routing problems.

Module III (15 hours)

Solving optimal control problems using dynamic programming, Discrete linear regulator problem, Hamilton-Jacobi-Bellman Equation, Numerical Techniques to determine optimal trajectories, Numerical Aspects of Optimization.

Suggested Readings

1. M. Athans and P. L. Falb, “Optimal Control: An Introduction to the Theory and Its Applications”, Dover Books on Engineering, 2006.
2. D. S. Naidu, “Optimal Control Systems”, CRC Press, 2002.
3. D. Liberzon, "Calculus Of Variations and Optimal Control Theory: A Concise Introduction", Princeton University Press, Dec 2011.
4. Frank L. Lewis, Draguna Vrabie and Vassilis L. Syrmos, “Optimal Control”, 3rd Edition, Wiley, 2012.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H	H	
CO 2		M	H
CO 3		H	
CO 4	M		H

EESF0067: STOCHASTIC FILTERING AND IDENTIFICATION

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Tell about different filtering and prediction methods for system design. (Remembering)
2. Take part in convergence analysis of Recursive Identification methods. (Analyzing)
3. Elaborate essential stochastic modeling tools including Markov chains and queuing theory. (Creating)
4. Design control system based on adaptive control. (Creating)

Objective

This course aims at introducing fundamental concepts of stochastic filtering, prediction, control. The course introduces non-linear system identification.

Module I (15 hours)

Introduction to Parameter Estimation and System Identification, MMSE estimation including LMS, Gaussian case, Wiener filtering & prediction, Kalman filtering & prediction, Extended Kalman filtering and its variations, Predictors for difference equation based models including ARMA, Box Jenkins & others.

Module II (15 hours)

Statistical properties of Least Squares estimation and its relationship with Bayes estimation (ML, MAP), convergence analysis, CR bound, Recursive Least Squares, Iterative methods for nonlinear Least Squares Identification problem: Different approaches for linear dynamical system, Offline identification methods including Least Squares, Prediction error framework, Pseudo-linear regression (PLR) & Instrument variable methods. Recursive Identification of linear dynamical system: RLS, PLR, Prediction error framework & its application to ARMA & Innovations representation, Convergence Analysis of Recursive Identification methods: Associated ODE, Martingale.

Module III (15 hours)

Nonlinear system identification, Subspace based method of system identification, Applications including LQG and adaptive control.

Suggested Readings

1. A. Papoulis and S. Pillai, “Probability, random variable and stochastic processes”, McGraw Hill, 2002.
2. T. Soderstrom and P. Stoica, “System Identification”, Prentice-Hall, 1989.
3. Lennart Ljung, “System Identification”, Prentice-Hall, 2nd edition, 1999.
4. S. Thomas Alexander: “Adaptive Signal processing, Theory and applications”, Springer-Verlag, 1986.
5. R. Isermann and M. Munchhof, “Identification of Dynamic Systems”, Springer-Verlag, 2011.
6. B. D. O. Anderson and J. B. Moore, “Optimal Filtering”, Dover Books on Electrical Engineering, 2005.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H		
CO 2		H	H
CO 3		H	
CO 4			H

EECS0068: ADVANCE CONTROL SYSTEM

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Define different approaches for modeling of dynamic systems. (Remembering)
2. Explain philosophy of optimal control system. (Understanding)
3. Apply the concepts of linear algebra and their applications to control systems. (Applying)

4. Design linear quadratic controller, reduced order observer,compensator (Creating)

Objective
The course provides glimpses into the advanced methods of modelling and analysis of the dynamical systems. The course is a strong step in inculcating the research aptitude in the students.

Module I (15 hours)
Math Modelling of Dynamical Systems: Newtonian and Lagrangian approaches, Concept of dynamical state of a system, Concept of equilibrium point, linearization of nonlinear model. Review of Linear Algebra concepts: Field, Vector space, linear combination, linear independence, bases of a vector space, representation of any vector on different basis, matrix representation of a linear operator, change of basis, rank, nullity, range space and null space of a matrix, Eigen value and Eigen vector of a matrix, similarity transform, Diagonalisation

Module II (15 hours)
Modern Control Analysis: Concept and computation of systems modes, controllability theorem and its proof, Observability theorem and its proof, Controllable and observable subspaces. Stability Analysis: Stability of linear systems, stability types and their definitions for any general system, Stability of an equilibrium point, Lyapunov stability theory for LTI systems, Quadratic forms and Lyapunov functions.

Module III (15 hours)
Modern Control Design: Converting the math model to controllable canonical form and its use for pole placement, Concept of linear observer and its design, Design of reduced order observer, Compensator design using separation principle, Poles of compensator, Open-loop and close-loop systems. Optimal Control Theory: Introduction to the philosophy of optimal control, formulation of optimal control problem, different performance criterion, Linear quadratic regulator (LQR) and optimum gain matrix, Riccati equations, conceptual models and statistical models for random processes, Kalman filter.

Suggested Readings
1. Bernard Friedland, “Control System Design: An Introduction to State-Space Methods”, Dover Publications, Inc. Mineola, New York, 2012.
2. Thomas Kailath, “Linear Systems”, Prentice-Hall Inc., New Jersey, 1986.
3. M. Gopal, “Modern Control System Theory”, New Age International (P) Limited, New Delhi, 2000.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H		
CO 2		H	
CO 3	H		
CO4	L		H

EEAL0069: ADAPTIVE LEARNING AND CONTROL
(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes
1. Recall detailed knowledge of classical system identification and the development and properties of various methods. (Remembering)
2. Utilize detailed knowledge of robust adaptive control, neural network based control (Applying)
3. Apply adaptive and learning techniques for control design for uncertain dynamical systems. (Applying)
4. Design control system based on predictive control. (Creating)

Objective
The course introduces adaptive and learning techniques for control design for uncertain dynamical systems. The course also introduces learning based control.

Module I (15 hours)
Introduction to adaptive control, Direct and indirect adaptive control, Model reference adaptive control, Parameter convergence, Persistence of excitation, Review of Lyapunov stability theory.

Module II (15 hours)
Adaptive backstepping, Adaptive control of nonlinear systems, Composite adaptation, Robust adaptive control, Neural Network-based control.

Module III (15 hours)
Reinforcement learning-based control, Repetitive learning control, Predictive control,

Suggested Readings
1. Bernard Friedland, “Control System Design: An Introduction to State-Space Methods”, Dover Publications, Inc. Mineola, New York, 2012.
2. Thomas Kailath, “Linear Systems”, Prentice-Hall Inc., New Jersey, 1986.
3. M. Gopal, “Modern Control System Theory”, New Age International (P) Limited, New Delhi, 2000.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H		
CO 2		H	
CO 3		H	
CO4		M	H

EEMR0070: MODEL REDUCTION IN CONTROL
(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes
1. Identify Source of Large Models. (Remembering)
2. Explain sliding mode control for control system design. (Understanding)
3. Make use of Pade approximation for control system design. (Applying)
4. Apply model reduction techniques for a given control design problem. (Applying)

Objective
The course introduces the concept of model reduction of large scale dynamics models from various engineering disciplines. The course also introduces model reduction in control.

Module I (15 hours)
Introduction to Model Reduction, Source of Large Models – Circuits, EM systems, Mechanical Systems. Classical Model Reduction Methods – Modal reduction.

Module II (15 hours)
Pade approximation and moment matching, Routh Approximants, Modern Methods - SVD (Grammian) based methods, Krylov based methods, SVD-Krylov based methods, MOR for Nonlinear Systems – SVD & POD Methods.

Module III (15 hours)
Model Reduction in Control, Sliding Mode Control – Review, SMC as model reducing control, Higher Order Sliding Mode.

Suggested Readings
1. A. C. Antoulas, “Approximation of Large Scale Dynamical Systems”, SIAM, 2005.
2. Ed. Alfio Quarteroni and Gianluigi Rozza, “Reduced Order Methods for Modeling and Computational Reduction”, Springer, 2014.
3. M. Jamshidi, “Large-scale systems: modelling & control”, North Holland, New York, 1983.
4. C. Edwards and S. Spurgeon, “Sliding Mode Control: Theory and Applications”, CRC Press, 1998.
5. B. Bandyopadhyay, S. Janardhanan and S. Spurgeon, “Advances in Sliding Mode”, Springer, 2013.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H		
CO 2		H	
CO 3		H	
CO4	M		H

EERC0071: ROBUST CONTROL
(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes
1. Define LTI systems and its applications. (Remembering)

2. Explain Passive system for frequency domain and time domain. (Understanding)
3. Assess stability and performance of passive systems. (Evaluating)
4. Design robust control system based on Riccatti equation (Creating)

Objective
This course introduces the concept of to control techniques with greater emphasis on robustness to modelling uncertainty. The course introduces how to handle parameter variations, and presence of disturbances and noise.

Module I (15 hours)
Modelling of uncertain systems, Signals and Norms, Lyapunov theory for LTI systems.

Module II (15 hours)
Passive systems- frequency domain, Passive systems- time domain, Robust Stability and performance, Stabilizing controllers - Co prime factorization.

Module III (15 hours)
LQR, LQG problems, Ricatti equations and solutions, Ricatti equation solution through LMI, H-infinity control and mu-synthesis, Linear matrix inequalities for robust control.

Suggested Readings

1. L. Fortuna, M. Frasca (Eds.), “Optimal and Robust Control”, CRC Press, 2012.
2. K. Zhou, J. C. Doyle and K. Glover, “Robust and Optimal Control”, Prentice Hall, 1996.
3. J. C. Doyle, B. A. Francis and A. R. Tannenbaum, “Feedback Control Theory”, Macmillan, 1992.
4. Benefits of FACTS Transmission line compensation, Uncompensated line –

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H		
CO 2		H	
CO 3		H	
CO4		M	H

EEPS0072: POWER SYSTEM- I
(3 Credits-45 hours) (L-T-P: 3-0-0)

Course Outcomes
1. List the various components used in a power system. (Remembering)
2. different protection schemes used to prevent faults in power system. (Understanding)
3. Identify suitable protection scheme used for a particular type of fault. (Applying)
4. Find various performance parameters of a power system by using given data. (Analyzing)
5. Experiments with Solar PV cell and formulate the I-V and P-V characteristics of PV panels. (Evaluating)

Objective
This is the basic course, which aims to make students aware of the basic concepts of electrical power systems and spells out the various components of an electrical power system. This course is the stepping-stone to make students understand how to model and analyze the power system under steady state operating conditions, under faulted conditions and the transient behavior of power systems whenever it is subjected to a fault.

Module I: Basic Concepts (8 lectures)
Evolution of Power Systems and Present-Day Scenario. Structure of a power system: Bulk Power Grids and Micro-grids. Synchronous Grids and Asynchronous (DC) interconnections. Generation: Conventional and Renewable Energy Sources. Distributed Energy Resources. Energy Storage. Transmission and Distribution Systems: Line diagrams, transmission and distribution voltage levels and topologies (meshed and radial systems). Review of Three-phase systems. Analysis of simple three-phase circuits. Power Transfer in AC circuits and Reactive Power.

Module II: Power System Components (15 lectures)
Overhead Transmission Lines and Cables: Electrical and Magnetic Fields around conductors, Corona. Parameters of lines and cables. Capacitance and Inductance calculations for simple configurations. Travelling-wave Equations. Sinusoidal Steady state representation of Lines: Short, medium and long lines. Power Transfer, Voltage profile and Reactive Power. Characteristics of transmission lines. Surge Impedance Loading. Series and Shunt Compensation of transmission lines.

Transformers: Three-phase connections and Phase-shifts. Neutral Grounding transformers. Transformer Parameters. Single phase equivalent of three-phase transformers.
Synchronous Machines: Steady-state performance characteristics. Real and Reactive Power Capability Curve of generators. Loads: Types, Voltage and Frequency Dependence of Loads. Per-unit System and per-unit calculations.

Module III: Over-Voltages and Insulation Requirements (4 lectures)
Generation of Over-voltages: Lightning and Switching Surges. Protection against Over-voltages, Insulation Coordination. Propagation of Surges.

Module IV: Fault Analysis (6 lectures)
Method of Symmetrical Components (positive, negative and zero sequences). Balanced and Unbalanced Faults. Representation of generators, lines and transformers in sequence networks. Computation of Fault Currents. Neutral Grounding.

Module V: Introduction to Protection Systems (6 lectures)
Switchgear: Types of Circuit Breakers. Attributes of Protection schemes, Back-up Protection. Protection schemes (Over-current, directional, distance protection, differential protection) and their application.

Module VI: Introduction to DC Transmission & Renewable Energy Systems (6 lectures)
DC Transmission Systems: Line-Commutated Converters (LCC) and Voltage Source Converters (VSC). Solar PV systems: I-V and P-V characteristics of PV panels. Wind Energy Systems: Power curve of wind turbine. Fixed and variable speed turbines

Suggested Readings

1. C.L. Wadhwa, “Electrical Power systems”, (5^{th} Edition) New Age International Publishers.
2. D.P. Kothari, I.J. Nagrath, “Power System Engineering”, Second edition, Tata McGraw Hill.
3. W.D. Stevenson Jr., Elements of Power System Analysis, Mc Graw Hill.
4. V.K Mehta, Rohit Mehta, “Principles of Power Systems”, S. Chand.
5. Leon Freris, David Infi eld, “Renewable Energy in Power Systems”, Wiley, A John Wiley & Sons, Ltd, Publication.
6. Ashfaq Husain, “Electrical Power systems”, (5^{th} Edition) CBS Publishers.
7. R. Gupta, “Generation of Electrical Energy”, S. Chand & Co. Ltd. N. Delhi
8. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 1995.
9. R. Bergen and V. Vittal, “Power System Analysis”, Pearson Education Inc., 1999.
10. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “Electric Power Systems”, Wiley, 2012.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				
CO 2			M		H	
CO 3				L	H	
CO 4		H		M		
CO 5						H

EECS0073: CONTROL SYSTEMS

(3 Credits - 45 hours) (L-T-P : 3-0-0)

Course Outcomes
1. Define feedback and feed-forward control architecture. (Remembering)
2. Illustrate the concepts related to the operation analysis and stabilization of closed loop and open loop control systems using various control techniques. (Understanding)
3. Apply block diagram representations for simplifying complex control systems. (Applying)
4. Examine different controllers based on empirical tuning rules. (Analysing)

Objective
This course aims to familiarize the student with the concept mathematical modelling and analysis of Linear Time-Invariant (LTI) systems. Also, the course enables one to understand the concept of stability and its assessment for linear-time invariant systems. Design of simple feedback controllers is introduced. Mathematical modelling techniques like transfer function and state-space representations are introduced.

Module I: Introduction to Control Problem (5 lecture)

Industrial Control examples. Mathematical models of physical systems. Control hardware and their models. Transfer function models of linear time-invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback. Block diagram algebra.

Module II: Time Response Analysis (10 lecture)
Standard test signals. Time response of first and second order systems for standard test inputs. Application of initial and final value theorem. Design specifications for second-order systems based on the time-response. Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci.

Module III: Frequency-Response Analysis (10 lecture)
Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.

Module IV: Introduction to Controller Design (10 lecture)
Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems. Root-loci method of feedback controller design. Design specifications in frequency-domain. Frequency-domain methods of design. Application of Proportional, Integral and Derivative Controllers, Lead and Lag compensation in designs. Analog and Digital implementation of controllers.

Module V: State Variable Analysis (10 lecture)
Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability. Pole-placement by state feedback. Discrete-time systems. Difference Equations. State-space models of linear discrete-time systems. Stability of linear discrete-time systems.

Suggested Readings
1. M. Gopal, “Control Systems: Principles and Design”, McGraw Hill Education, 1997.
2. B. C. Kuo, “Automatic Control System”, Prentice Hall, 1995.
3. K. Ogata, “Modern Control Engineering”, Prentice Hall, 1991.
4. I. J. Nagrath and M. Gopal, “Control Systems Engineering”, New Age International, 2009.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	H		
CO 2	H	M		
CO 3			H	M
CO 4			H	

EEMM0074: MICROPROCESSORS AND MICROCONTROLLERS
(3 Credits - 45 hours) (L-T-P : 3-0-0)

Course Outcomes
1. List the various functional blocks of microprocessors and microcontrollers. (Remembering)
2. Explain the operation and configuration of the various functional blocks and pins of 8051 microcontroller. (Understanding)
3. Explain the functions of the assembly language instructions of 8051 microcontroller. (Understanding)
4. Make use of 8051 assembly language instructions to write programs for a given application. (Applying)
5. Design microcontroller based system for simple applications. (Creating)

Objective
This course provides an in-depth understanding of the architecture and operation of microprocessors and microcontroller, assembly language programming and microcontroller interfacing techniques. The students will be able to design and implement microcontroller-based systems in both hardware and software and can apply this knowledge to more advanced structures.

Module I: Fundamentals of Microprocessors (6 lecture)
Fundamentals of microprocessor architecture. 8-bit microprocessor and microcontroller architecture, Comparison of 8-bit microcontrollers, 16-bit and 32-bit microcontrollers. Definition of embedded system and its characteristics, Role of microcontrollers in embedded Systems. Overview of the 8051 family.

Module II: The 8051 Architecture (9 lecture)

Internal Block Diagram, CPU, ALU, address, data and control bus, Working registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Data and Program Memory, Timing diagrams and Execution Cycles.

Module III: Instruction Set and Programming (8 lecture)
Addressing modes: Introduction, Instruction syntax, Data types, Subroutines Immediate addressing, Register addressing, Direct addressing, Indirect addressing, Relative addressing, Indexed addressing, Bit inherent addressing, bit direct addressing. 8051 Instruction set, Instruction timings. Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instruction. Assembly language programs, C language programs. Assemblers and compilers. Programming and debugging tools.

Module IV: Timer, Serial Port and Interrupt Programming (10 lecture)
SFRs of Timers, Timer programming in assembly language and C, RS232 basics, Synchronous and asynchronous communication, SFRs for Serial Communication, Serial Port programming in assembly language and C, Interrupts of 8051, Interrupt programming in assembly language and C.

Module V: External Interfacing and Applications (12 lecture)
External memory interfacing, LED, LCD and keyboard interfacing. Stepper motor interfacing, DC Motor interfacing, ADC and DAC interfacing, sensors interfacing.

Suggested Readings
1. M. A. Mazidi, J. G. Mazidi and R. D. McKinlay, “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”, Pearson Education, 2007.
2. K. J. Ayala, “8051 Microcontroller”, Delmar Cengage Learning, 2004.
3. R. Kamal, “Embedded System”, McGraw Hill Education, 2009.
4. R. S. Gaonkar, “Microprocessor Architecture: Programming and Applications with the 8085”, Penram International Publishing, 1996.
5. D. A. Patterson and J. H. Hennessy, “Computer Organization and Design: The Hardware/Software interface”, Morgan Kaufman Publishers, 2013.
6. D. V. Hall, “Microprocessors & Interfacing”, McGraw Hill Higher Education, 1991.
7. Relevant datasheets.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M			
CO 2	H	H	M		
CO 3		H		H	M
CO 4			M	H	
CO 5				H	H

EESS0075: SIGNALS AND SYSTEMS
(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes
At the end of this course, students will be able to:
1. Define the basic terms related to continuous and discrete time LTI systems. (Remembering)
2. Classify the signals and systems into continuous-discrete, time varying-time invariant and linear-nonlinear types. (Understanding)
3. Make use of Fourier, Laplace and z-Transforms techniques in analysis of signals and systems. (Applying)
4. Examine the signals and systems by using the results of the transform techniques. (Analysing)
5. Estimate the continuous time equivalence of a discrete signal by applying reconstruction techniques. (Evaluating)

Objective
The Objective of the course is to acquaint the students with the various types of signals, which form the basis of electronic communication. The course also is intended to provide the theoretical background necessary to understand the working of any signal processing system and apply the techniques.

Module I: Introduction to Signals and Systems (10 hours)
a. Signals and systems as seen in everyday life and in various branches of engineering and science.

b. Signal properties: periodicity, absolute integrability, determinism and stochastic character.
c. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals;
d. Continuous and discrete time signals, continuous and discrete amplitude signals.
e. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability. Examples.

Module II: Behaviour of Continuous and Discrete-Time LTI Systems (12 hours)

a. Impulse response and step response, convolution, input-output behaviour with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations.
b. State-space Representation of systems. State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role.
c. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.

Module III: Fourier, Laplace and Z-Transforms (17 hours)

a. Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete- Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem.
b. Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behaviour.
c. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.

Module IV: Sampling and Reconstruction (6 hours)

a. The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems.

Suggested Readings

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, “Signals and systems”, Prentice Hall India, 1997.
2. J. G. Proakis and D. G. Manolakis, “Digital Signal Processing: Principles, Algorithms, and Applications”, Pearson, 2006.
3. H. P. Hsu, “Signals and systems”, Schaum’s series, McGraw Hill Education, 2010.
4. S. Haykin and B. V. Veen, “Signals and Systems”, John Wiley and Sons, 2007.
5. A. V. Oppenheim and R. W. Schafer, “Discrete-Time Signal Processing”, Prentice Hall, 2009.
6. M. J. Robert “Fundamentals of Signals and Systems”, McGraw Hill Education, 2007.
7. B. P. Lathi, “Linear Systems and Signals”, Oxford University Press, 2009.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H		M	
CO 2	M	H		
CO 3			H	M
CO 4			H	L
CO 5			L	H

EEED0076: ELECTRICAL MACHINE DESIGN

(2 Credits - 30 hours) (L-T-P: 2-0-0)

Course Outcomes

1. Select proper materials for the design of electrical machines. (Remembering)
2. Design transformer, induction motor and synchronous machine. (Creating)
3. Execute software programs for designing electrical machines. (Applying)

Module I: Introduction (6 Lectures)

Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines.

Module II: Transformers (6 Lectures)

Sizing of a transformer, main dimensions, kVA output for single and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no-load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers.

Module III: Induction Motors (6 Lectures)
Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of poly-phase machines, magnetizing current, short circuit current, circle diagram, operating characteristics.

Module IV: Synchronous Machines (6 Lectures)
Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of air gap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design.

Module V: Computer Aided Design (CAD) (6 Lectures)
Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design. Introduction to complex structures of modern machines-PMSMs, BLDCs, SRM and claw-pole machines.

Suggested Readings

1. K. Sawhney, “A Course in Electrical Machine Design”, Dhanpat Rai and Sons, 1970.
2. S. K. Sen, “Principles of Electrical Machine Design with computer programmes”, Oxford and IBH Publishing, 2006.
3. M.G. Say, “Theory & Performance & Design of A.C. Machines”, ELBS London.
4. R.K.Agarwal, “Electrical Machine Design
5. Rajini, V.S. Nagarajan “Electrical machine design”, Pearson Education,2018

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	L	L	L	
CO 2		H	H	H	
CO 3					H

EEEW0077: ELECTROMAGNETIC WAVES

(2 Credits – 30 hours) (L-T-P: 2-0-0)

Course Outcomes

1. Relate the Electromagnetic Field quantities with the behaviour of Electromagnetic Waves. (Understanding)
2. Model Electromagnetic Wave propagating media for guided and free space propagation. (Applying)
3. Examine the working conditions of Transmission Lines, Waveguides and Antennae. (Analysing)

Objective
The objective of the course is to introduce the students with the study of the behaviour of electromagnetic waves, which have a one-dimensional spatial dependence (plane waves). The course will also provide a basis for fundamental theoretical as well as practical concepts related to plane waves.

Module I: Transmission Lines (6 lectures)
Introduction, Concept of distributed elements, Equations of voltage and current, Standing waves and impedance transformation, Lossless and low-loss transmission lines, Power transfer on a transmission line, Analysis of transmission line in terms of admittances, Transmission line calculations with the help of Smith chart, Applications of transmission line, Impedance matching using transmission lines.

Module II: Maxwell’s Equations (5 lectures)
Basic quantities of Electromagnetics, Basic laws of Electromagnetics: Gauss’s law, Ampere’s Circuital law, Faraday’s law of Electromagnetic induction. Maxwell’s equations, Surface charge and surface current, Boundary conditions at media interface.

Module III: Uniform Plane Wave (4 lectures)
Homogeneous unbound medium, Wave equation for time harmonic fields, Solution of the wave equation, Uniform plane wave, Wave polarization, Wave propagation in conducting medium, Phase velocity of a wave, Power flow and Poynting vector.

Module IV: Plane Waves at Media Interface (5 lectures)

Plane wave in arbitrary direction, Plane wave at dielectric interface, Reflection and refraction of waves at dielectric interface, Total internal reflection, Wave polarization at media interface, Brewster angle, Fields and power flow at media interface, Lossy media interface, Reflection from conducting boundary.

Module V: Waveguides (5 lectures)
Parallel plane waveguide: Transverse Electric (TE) mode, transverse Magnetic (TM) mode, Cut-off frequency, Phase velocity and dispersion. Transverse Electromagnetic (TEM) mode, Analysis of waveguide- general approach, Rectangular waveguides.

Module VI: Antennas (5 lectures)
Radiation parameters of antenna, Potential functions, Solution for potential functions, Radiations from Hertz dipole, Near field, Far field, Total power radiated by a dipole, Radiation resistance and radiation pattern of Hertz dipole, Hertz dipole in receiving mode.

Suggested Readings

1. R. K. Shevgaonkar, “Electromagnetic Waves”, Tata McGraw Hill, 2005.
2. D. K. Cheng, “Field and Wave Electromagnetics”, Addison-Wesley, 1989.
3. M. N.O. Sadiku, “Elements of Electromagnetics”, Oxford University Press, 2007.
4. A. Balanis, “Advanced Engineering Electromagnetics”, John Wiley & Sons, 2012.
5. A. Balanis, “Antenna Theory: Analysis and Design”, John Wiley & Sons, 2005.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1		H	L	L		
CO 2			M	M	H	
CO 3	H				H	M

EEPS0079: POWER SYSTEM II
(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes
1. Describe the concept of power System economics and management. (Remembering)
2. Explain the method of power system planning, operation and control. (Understanding)
3. Carry out numerical analysis for solving power system problems. (Applying)
4. Experiments with various load flow method, power quality issues and control of power systems. (Evaluating)

Objective
This course introduces the numerical methods for analyzing the power system in steady state and gives an understanding of the methods to control the voltage, frequency and various stability constraints in a synchronous grid also the monitoring and control and basics of economics of a power system.

Module I: Power Flow Analysis (7 hours)
Review of the structure of a Power System and its components. Analysis of Power Flows: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Load and Generator Specifications. Application of numerical methods for solution of non- linear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations. Computational Issues in Large-scale Power Systems.

Module II: Stability Constraints in Synchronous Grids (9 hours)
Swing Equations of a synchronous machine connected to an infinite bus. Power angle curve. Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three--phase fault. Analysis using numerical integration of swing equations (using methods like Forward Euler, Runge-Kutta 4th order methods), as well as the Equal Area Criterion. Impact of stability constraints on Power System Operation. Effect of generation rescheduling and series compensation of transmission lines on stability.

Module III: Control of Frequency and Voltage (9 hours)
Turbines and Speed-Governors, Frequency dependence of loads, Droop Control and Power Sharing. Automatic Generation Control. Generation and absorption of reactive power by various components of a Power System. Excitation System Control in synchronous generators, Automatic Voltage Regulators. Shunt Compensators, Static VAR compensators and STATCOMs. Tap-Changing Transformers. Power flow control using embedded dc links, phase shifters.

Module IV: Monitoring and Control (10 hours)

Overview of Energy Control Centre Functions: SCADA systems. Phasor Measurement Units and Wide-Area Measurement Systems. State-estimation. System Security Assessment. Normal, Alert, Emergency, Extremis states of a Power System. Contingency Analysis. Preventive Control and Emergency Control.

Module V: Power System Economics and Management (10 hours)
Basic Pricing Principles: Generator Cost Curves, Utility Functions, Power Exchanges, Spot Pricing. Electricity Market Models (Vertically Integrated, Purchasing Agency, Wholesale competition, Retail Competition), Demand Side-management, Transmission and Distributions charges, Ancillary Services. Regulatory framework.

Suggested Readings
1. Grainger and W. D. Stevenson, "Power System Analysis", McGraw Hill Education, 1994.
2. O.I.Elgerd, "Electric Energy Systems Theory", McGraw Hill Education, 1995.
3. R. Bergen and V.Vittal, "Power System Analysis", Pearson Education Inc., 1999.
4. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", McGraw Hill Education, 2003.
5. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, "Electric Power Systems", Wiley, 2012.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1					H
CO 2	H	M	H	M	
CO 3	L	H			
CO 4	H	L	H		

EEMI0080: MEASUREMENTS AND INSTRUMENTATION
(2 Credits – 30 hours) (L-T-P: 2-0-0)

Objective
This subject is aimed at familiarizing the students with the principle, construction and uses of instruments utilized for the measurement of Current, Voltage, Resistance, Inductance, beside the measurement of passive elements.

Course Outcomes
1. Define various static characteristics of measurement systems. (Remembering)
2. Utilize the concepts of various instruments for measuring different electrical and non-electrical quantities (Applying)
3. Explain instrumentation systems using different sensors and transducers. (Evaluating)

Module I: Concepts Relating to Measurements and Errors (10 hours)
a. Concepts relating to Measurements: True value, Accuracy, Precision, Resolution, Drift, Hysteresis, Dead-band, Sensitivity.
b. Errors in Measurements. Basic statistical analysis applied to measurements: Mean, Standard Deviation, Six-sigma estimation, Cp, Cpk.

Module II: Sensors and Transducers (10 hours)
a. a)Sensors and Transducers for physical parameters: temperature, pressure, torque, flow. Speed and Position Sensors.
b. b)Current and Voltage Measurements. Shunts, Potential Dividers. Instrument Transformers, Hall Sensors. Measurements of R, L and C.

Module III: Measuring Instruments (10 hours)
Digital Multimeter, True RMS meters, Clamp-on meters, Meggers. Digital Storage Oscilloscope.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H		M
CO 2		H	H
CO 3		H	M

EEED0082: ELECTRICAL DRIVES
(3 credits-45 hours) (L-T-P: 3-0-0)

Course Outcomes
1. Describe the characteristics of D.C motor and relate the armature voltage control. (Remembering)
2. Explain the characteristics of the induction motor and recount the torque speed characteristics. (Understanding)

3. Implement knowledge of working of chopper fed DC drive and identify the quadrant of operation. (Applying)
4. Interrogate the impact of rotor resistance and assume the slip-ring induction motor for speed control. (Analyzing)
5. Check the ability to design a three-phase voltage source inverter and define the scalar control of the induction motor. (Evaluating)

Objective
Students will be able to understand and analyze the characteristics of various a.c and d.c motors and demonstrate the speed control using the power electronics converter.

Module I: DC motor characteristics (6 hours)
Review of emf and torque equations of DC machine, evaluation of torque-speed characteristics of separately excited dc motor, change in torque-speed curve with armature voltage, armature voltage control for varying motor speed.

Module II: Chopper fed DC drive and Multi-quadrant DC drive (10 hours)
Review of dc chopper and duty ratio control, chopper fed dc motor for speed control, steady state operation of a chopper fed drive, armature current waveform and ripple, calculation of losses in dc motor and chopper. Review of motoring and generating modes operation of a separately excited dc machine, four-quadrant operation of dc machine.

Module III: Closed-loop control of DC Drive (9 hours)
Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor – dynamic equations and transfer functions.

Module IV: Induction motor characteristics (8 hours)
Review of induction motor equivalent circuit and torque-speed characteristic, variation of torque-speed curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage and frequency.

Module V: Scalar control and Control of slip ring induction motor (12 hours)
Review of three-phase voltage source inverter, generation of three-phase PWM signals, sinusoidal modulation, space vector theory, conventional space vector modulation; constant V/f control of induction motor, steady-state performance analysis based on equivalent circuit, slip regulation. Impact of rotor resistance of the induction motor torque-speed curve, operation of slip-ring induction motor with external rotor resistance, starting torque, slip power recovery.

Suggested Readings
1. G. K. Dubey, “Power Semiconductor Controlled Drives”, Prentice Hall, 1989.
2. R. Krishnan, “Electric Motor Drives: Modelling, Analysis and Control”, Prentice Hall, 2001.
3. G. K. Dubey, “Fundamentals of Electrical Drives”, CRC Press, 2002.
4. W. Leonhard, “Control of Electric Drives”, Springer Science & Business Media, 2001.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M			
CO 2				H	M
CO 3		H	M		
CO 4				H	M
CO 5		M	H		

EEHV0083: HIGH VOLTAGE ENGINEERING
(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes
1. Recall the concept of generation and measurement of D. C., A.C., & Impulse voltages. (Remembering)
2. Understand the basic physics related to various breakdown processes in solid, liquid and gaseous insulating materials. (Understanding)
3. Analyze the various tests on H. V. equipment and on insulating materials, as per the standards. (Analyzing)
4. Evaluate the various high voltage transmission system such as HVAC, HVDC etc. (Evaluating)

Objective
The subject helps in the detailed analysis of breakdown that occurs in gaseous, liquids and solid dielectrics and information about generation and measurement of high voltage and current along with high voltage testing methods.

Module I: Breakdown in Gases (8 hours)
Ionization processes and de-ionization processes, Types of Discharge, Gases as insulating materials, Breakdown in Uniform gap, non-uniform gaps, Townsend's theory, Streamer mechanism, Corona discharge.

Module II: Breakdown in liquid and solid Insulating materials (7 hours)
Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, electromechanical breakdown and thermal breakdown, Partial discharge, applications of insulating materials.

Module III: Generation of High Voltages (7 hours)
Generation of high voltages, generation of high D. C. and A.C. voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators.

Module IV: Measurements of High Voltages and Currents (7 hours)
Peak voltage, impulse voltage and high direct current measurement method, cathode ray oscillographs for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements.

Module V: Lightning and Switching Over-voltages (7 hours)
Charge formation in clouds, Stepped leader, Dart leader, Lightning Surges. Switching over voltages, Protection against over-voltages, Surge diverters, Surge modifiers.

Module VI: High Voltage Testing of Electrical Apparatus and High Voltage Laboratories (7 hours)
Various standards for HV Testing of electrical apparatus, IS, IEC standards, Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers and some high voltage equipment, High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, safety precautions in H. V. Labs.

Suggested Readings

1. M. S. Naidu and V. Kamaraju, "High Voltage Engineering", McGraw Hill Education, 2013.
2. C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers, 2007.
3. D. V. Razevig (Translated by Dr. M. P. Chourasia), "High Voltage Engineering Fundamentals", Khanna Publishers, 1993.
4. E. Kuffel, W. S. Zaengl and J. Kuffel, "High Voltage Engineering Fundamentals", Newnes Publication, 2000.
5. R. Arora and W. Mosch "High Voltage and Electrical Insulation Engineering", John Wiley & Sons, 2011.
6. Various IS standards for HV Laboratory Techniques and Testing.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H		H	M		
CO 2		H				H
CO 3				H	H	
CO 4				H		H

EEDS0084: DIGITAL CONTROL SYSTEMS

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Name different methods available for stability analysis of a system in the digital domain. (Remembering)
2. Classify various stability states of a system. (Understanding)
3. Model a system in a discrete domain. (Applying)
4. Analyse performance of digital controllers and systems. (Analysing).

Objective
This course aims to familiarize the student with the concept of system analysis and design in discrete-domain. Also, the course enables one to understand the concept of discrete representation of LTI systems, design and analyse digital controllers. Design of state feedback and output feedback controllers are introduced.

Module I: Discrete Representation of Continuous Systems (6 hours)
Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modelling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent.

Module II: Discrete System Analysis (6 hours)

Z-Transform and Inverse Z Transform for analysing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Solution of Discrete time systems. Time-response of discrete time system.

Module III: Stability of Discrete Time System (5 hours)
Stability analysis by Jury test. Stability analysis using bilinear transformation. Design of digital control system with dead beat response. Practical issues with dead beat response design.

Module IV: State Space Approach for Discrete Time Systems (10 hours)
State space models of discrete systems, State space analysis. Lyapunov Stability. Controllability, reach-ability, Reconstructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability.

Module V: Design of Digital Control System(10 hours)
Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator.

Module VI: Discrete Output Feedback Control (8 hours)
Design of discrete output feedback control. Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.

Suggested Readings

1. K. Ogata, “Digital Control Engineering”, Prentice Hall, Englewood Cliffs, 1995.
2. M. Gopal, “Digital Control Engineering”, Wiley Eastern, 1988.
3. G. F. Franklin, J. D. Powell and M. L. Workman, “Digital Control of Dynamic Systems”, Addison-Wesley, 1998.
4. C. Kuo, “Digital Control System”, Holt, Rinehart and Winston, 1980.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1		M	H	H	L	
CO 2			H	H		
CO 3				M	H	M
CO 4	H	H	H			

EEDP0085: DIGITAL SIGNAL PROCESSING

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Describe signals mathematically in continuous and discrete-time, and in the frequency domain. (Remembering).
2. Understanding the analytical tools such as Discrete Fourier Transforms, Fast Fourier Transforms and Z-Transforms essential for digital signal processing. (Understanding)
3. Implement digital signal processing for analysis of real-life signals. (Applying)
4. Check digital filters for various applications. (Evaluating)

Objective
This course aims to familiarize the student with the concept of signals and systems in discrete domain. Also, the course enables one to represent signals mathematically in continuous and discrete-time, and in the frequency domain. Analysis in Z-domain along with discrete Fourier transform is introduced. Design of digital filters and application of digital signal processing is introduced.

Module I: Discrete-Time Signals and Systems (6 hours)
Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.

Module II: Z-Transform (6 hours)
Z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using Z-Transform, Properties of Z-Transform for causal signals, Interpretation of stability in Z-domain, Inverse Z- transforms.

Module III: Discrete Fourier Transform (10 hours)
Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval’s Identity, Implementation of Discrete Time Systems.

Module IV: Design of Digital Filters (15 hours)
Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Band-stop and High-pass filters. Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing.

Module V: Applications of Digital Signal Processing (8 hours)
Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

Suggested Readings

1. S. K. Mitra, "Digital Signal Processing: A computer-based approach", McGraw Hill, 2011.
2. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.
3. J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Prentice Hall, 1997.
4. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992
5. J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.
6. D. J. DeFatta, J. G. Lucas and W. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H		H		
CO 2	H	H	H	M	
CO 3				M	H
CO 4			M	H	

EEMC0087: ADVANCED MICROCONTROLLER BASED SYSTEMS
(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes
1. List the various functional blocks of a basic computer. (Remembering)
2. Recall the architecture of PIC microcontrollers. (Remembering)
3. Summarize the architecture of Intel 8051 and 8086 microcontrollers and microprocessors. (Understanding)
4. Summarize the architecture of DSP processors and FPGA. (Understanding)
5. Develop Intel and PIC microcontroller based systems. (Applying)

Objective
The course will help to develop an in-depth understanding of the basic computer architecture and organizations. Students will be able to understand the architecture and application of advanced microcontrollers, DSP processors and FPGA.

Module I: Basic Computer Organization (7 hours)
Basic computer organization. Accumulator based processes, Architecture, Memory Organization, I/O organization.

Module II: Intel 8051 Microcontroller and 8086 Microprocessor (14 hours)
Intel 8051, Intel 8086- Registers, Memories. I/O Ports, Serial communication. Timers, Interrupts, Programming. Intel 8051- Assembly language programming, Addressing operations, Stack & Subroutines, Interrupts-DMA.

Module III: PIC Microcontrollers (8 hours)
PIC 16F877- Architecture Programming, Interfacing Memory/ I/O Devices, Serial I/O and data communication.

Module IV: Digital Signal Processors (8 hours)
Digital Signal Proc Processor (DSP) – Architecture, Programming, Introduction to FPGA.

Module V: Applications (8 hours)
Microcontroller development for motor control applications. Stepper motor control using microcontroller.

Suggested Readings

1. John. F. Wakerly, "Microcomputer Architecture and Programming", John Wiley and Sons 1981.
2. Ramesh S. Gaonker, "Microprocessor Architecture, Programming and Applications with the 8085", Penram International Publishing (India), 1994.
3. Raj Kamal, "The Concepts and Features of Microcontrollers", Wheeler Publishing, 2005.
4. Kenneth J. Ayala, "The 8051 microcontroller", Cengage Learning, 2004.
5. John Morton, "The PIC microcontroller: your personal introductory course", Elsevier, 2005.

6. Dogan Ibrahim, "Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F Series", Elsevier, 2008.
7. Microchip datasheets for PIC16F877.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	L	L	L	
CO 2			H		H
CO 3		H			H
CO 4				H	L
CO 5		L	L	L	H

EEPQ0088: POWER QUALITY

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Explain about the harmonics, harmonic introducing devices and effect of harmonics on system equipment and loads. (Understanding)
2. Explain the series and shunt active power filtering techniques for harmonics. (Understanding)
3. Classify different power quality issues. (Analyzing)
4. Develop analytical modeling skills needed for modeling and analysis of harmonics in networks and components. (Creating)
5. Improve power factor based on static VAR compensators. (Creating)

Objective

The objective of this course is to introduce the different power quality issues faced by the power system and understand the recommended practices by various standard bodies like IEEE, IEC, etc. on voltage & frequency, harmonics and understanding the concept of STATIC VAR Compensators in power systems.

Module I: Power quality issues (8 hours)

Introduction-power quality-voltage quality-overview of power, Quality phenomena classification of power quality issues, Power quality measures and standards-THD-TIF-DIN-C-message weights, Flicker factor transient phenomena-occurrence of power quality problems, Power acceptability curves-IEEE guides, Standards and recommended practices.

Module II: Harmonics (8 hours)

Harmonics-individual and total harmonic distortion, RMS value of a harmonic waveform, Triplex harmonics. Important harmonic introducing devices, SMPS, Three-phase power converters-arcing devices, saturable devices, Harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.

Module III: Modeling of systems (6 hours)

Modeling of networks and components under non-sinusoidal conditions, Transmission and distribution systems, Shunt capacitors-transformers, Electric machines, Ground systems loads that cause power quality problems, Power quality problems created by drives and its impact on drive.

Module IV: Improvement and control in power system (6 hours)

Power factor improvement- Passive Compensation, Passive Filtering, Harmonic, Resonance, Impedance Scan Analysis, Active Power Factor Corrected Single Phase Front End, Control Methods for Single Phase APFC, Three-Phase APFC and Control Techniques, PFC based on Bilateral Single Phase and Three Phase Converter.

Module V: Hamilton-Jacobi-Bellman model (8 hours)

Introduction to Hamilton-Jacobi-Bellman equation - model reference adaptive systems (MRAS) - Design hypothesis.

Module VI: Control methods (8 hours)

Introduction to design method based on the use of Liapunov function, Design and simulation of variable structure adaptive model following control.

Suggested Readings

1. G. T. Heydt, "Electric power quality", McGraw-Hill Professional, 2007.
2. Math H. Bollen, "Understanding Power Quality Problems", IEEE Press, 2000.
3. J. Arrillaga, "Power System Quality Assessment", John Wiley, 2000.
4. J. Arrillaga, B. C. Smith, N. R. Watson and A. R. Wood, "Power system Harmonic Analysis", Wiley, 1997.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1		H		L	
CO 2			H		H
CO 3		H		H	
CO 4		H			
CO 5			L	H	

EEWE0092: WASTE TO ENERGY

(3 Credits – 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Select the appropriate method for Biomass pyrolysis, biomass gasification and biomass combustion for waste to energy conversion. (Remembering)
2. Explain waste management systems with respect to its physical properties, and associated critical considerations in view of emerging technologies. (Understanding)
3. Implement energy conversion system for conversion of waste to electrical energy. (Applying)
4. Design cooking stoves, digester, gasifier. (Creating)

Objective

The objective of this course is to introduce different sources, processes to carry on waste to energy conversion. The students will be able to design different systems and devices for converting waste materials to useful energy.

Module I: Introduction to Energy from waste (9 hours)

Classification of waste as fuel, Agro based, Forest residue, Industrial waste, MSW, Conversion devices, Incinerators, gasifiers, digestors.

Module II: Biomass Pyrolysis (9 hours)

Pyrolysis, Types, slow, fast, Manufacture of charcoal, Methods, Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Module III: Biomass Gasification (9 hours)

FiFixed bed system, Downdraft and updraft gasifiers, Fluidized bed gasifiers, Design, construction and operation, Gasifier burner arrangement for thermal heating, Gasifier engine arrangement and electrical power, Equilibrium and kinetic consideration in gasifier operation.

Module IV: Biomass Combustion (9 hours)

Biomass stoves, Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation, Operation of all the above biomass combustors.

Module V: Biogas (9 hours)

Properties of biogas (Calorific value and composition), Biogas plant technology and status, Bio energy system, Design and constructional features, Biomass resources and their classification, Biomass conversion processes, Thermo chemical conversion, Direct combustion, Types of biogas Plants, Applications, Alcohol production from biomass, Bio-diesel production, Urban waste to energy conversion, Biomass energy programme in India.

Suggested Readings:

1. Ashok V. Desai, “Non Conventional Energy”, Wiley Eastern Ltd., 1990.
2. K. C. Khandelwal and S. S. Mahdi, “Biogas Technology - A Practical Hand Book - Vol. I & II”, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. D. S. Challal, “Food, Feed and Fuel from Biomass”, IBH Publishing Co. Pvt. Ltd., 1991.
4. C. Y. WereKo-Brobby and E. B. Hagan, “Biomass Conversion and Technology”, John Wiley & Sons, 1996.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	H	H	H	
CO 2	H	M	M	M	M
CO 3			H	H	
CO 4				H	M

EEAD0093: ANALOG AND DIGITAL COMMUNICATIONS

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Define different modulation techniques. (Remembering)
2. Apply probability and random process principles for noise analysis in communication channels. (Applying)
3. Analyze and compare different analog modulation schemes for their efficiency and bandwidth. (Analysing)
4. Estimate the inter symbol interference in digital modulation schemes. (Evaluating)

Objective

This course aims to familiarize the students with the concepts of communication systems. The course enables one to understand different modulation techniques both in analog and digital domains. Also, the course enables one to understand the behaviour of a communication channel and errors associated.

Module I: Review of Signals and Systems and Analog Modulation (10 hours)

Review of signals and systems, Frequency domain representation of signals, Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations. Angle Modulation, Representation of FM and PM signals, Spectral characteristics of angle modulated signals.

Module II: Review of Probability and Random Process and Noise in Different Modulation Schemes (6 hours)

Review of probability and random process. Gaussian and white noise characteristics, Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and De-emphasis, Threshold effect in angle modulation.

Module III: Pulse Data Communication (8 hours)

Pulse modulation. Sampling process. Pulse Amplitude and Pulse code modulation (PCM), Differential pulse code modulation. Delta modulation, Noise considerations in PCM, Time Division multiplexing, Digital Multiplexers.

Module IV: Signal Detection (6 hours)

Elements of Detection Theory, Optimum detection of signals in noise,Coherent communication with waveforms- Probability of Error evaluations.

Module V: Digital Modulation (15 hours)

Baseband Pulse Transmission- Inter symbol Interference and Nyquist criterion. Pass band Digital Modulation schemes- Phase Shift Keying, Frequency Shift Keying,Quadrature Amplitude Modulation, Continuous Phase Modulation and Minimum Shift Keying.Digital Modulation trade-offs. Optimum demodulation of digital signals over band-limited channels- Maximum likelihood sequence detection (Viterbi receiver). Equalization Techniques. Synchronization and Carrier Recovery for Digital modulation.

Suggested Readings

1. Haykin S., “Communications Systems”, John Wiley and Sons, 2001.
2. Proakis J. G. and Salehi M., “Communication Systems Engineering”, Pearson Education, 2002.
3. Taub H. and Schilling D.L., "Principles of Communication Systems”, Tata McGraw Hill, 2001.
4. Wozencraft J. M. and Jacobs I. M., “Principles of Communication Engineering”, John Wiley, 1965.
5. Barry J. R., Lee E. A. and Messerschmitt D. G., “Digital Communication”, Kluwer Academic Publishers, 2004.
6. Proakis J.G., “Digital Communications”, 4th Edition, McGraw Hill, 2000.
7. H P Hsu, “Analog and Digital Communications”, Special Indian Edition 2006, Tata McGraw Hill

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M	M		M
CO 2		H	M	M	
CO 3	H				
CO 4	M				H

EESP0094: POWER SYSTEM PROTECTION

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Recall the basic concepts of CT, PT, relays, CB and power system protection attributes. (Remembering)
2. Summarize the different components of a protection system. (Understanding)
3. Develop the understanding of digital protection basic principles. (Applying)

4. Analyse the various protection schemes for different power system components. (Analysing)
5. Evaluate fault current due to different types of fault in a network. (Evaluating)

Objective

The objective of this course is to introduce the students to power system protection problems and the basic concepts of its modeling and analysis. This course introduces the basic theory, construction, usage of current and voltage transformers, relays and circuit breakers. It covers the protection systems used for electric machines, transformers, bus-bars, overhead and underground lines, over- voltages, and digital protection.

Module I: Introduction and Components of a Protection System (8 hours)

Principles of Power System Protection, Relays, Instrument transformers, Circuit Breakers.

Module II: Faults and Over-Current Protection (8 hours)

Review of Fault Analysis, Sequence Networks. Introduction to Over-current Protection and over-current relay coordination.

Module III: Equipment Protection Schemes (12 hours)

Directional, Distance, Differential protection. Transformer and Generator protection. Bus-bar Protection, Bus Bar arrangement schemes. Feeder Protection. Earth fault relays.

Module IV: Digital Protection (8 hours)

Comparators, Introduction and block diagram of numerical relay, Computer-aided protection, Sampling Theorem.

Module V: System Protection and Simulation of Protection Schemes (9 hours)

Effect of Power Swings on Distance Relaying. System Protection Schemes. Under-frequency, Under-voltage and df/dt relays, Out-of-step protection, Synchro-phasors, Simulation of transients.

Suggested Readings

1. J. L. Blackburn, “Protective Relaying: Principles and Applications”, Marcel Dekker, New York, 1987.
2. Y. G. Paithankar and S. R. Bhide, “Fundamentals of power system protection”, Prentice Hall, India, 2010.
3. G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, John Wiley & Sons, 1988.
4. G. Phadke and J. S. Thorp, “Synchronized Phasor Measurements and their Applications”, Springer, 2008.
5. D. Reimert, “Protective Relaying for Power Generation Systems”, Taylor and Francis, 2006.
6. P. M. Anderson, “Power System Protection”, Wiley-IEEE Press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M			
CO 2	H	H	M		
CO 3		H		H	M
CO 4			M	H	
CO 5				H	H

EERE0095: RENEWABLE ENERGY SYSTEMS

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Choose the most suited energy generation systems for potential locations of applications. (Remembering)
2. Understand the basic physics of wind and solar power system.(understanding)
3. Identify the potential fields of renewable energy applications. (Applying)
4. Examine the power electronic interfaces for renewable energy systems. (Analyzing)

Objective:

The objective of this course is to understand and analyze the importance and potential of renewable energy, study the working principle and mechanism of the different renewable energy sources and to introduce the different renewable energy sources and its application in the current context

Module I: Physics of Wind Power (6 hours)

History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.

Module II: Wind generator topologies (6 hours)

Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Power electronic converters. Generator-Converter configurations, Converter Control.

Module III: The Solar Resource (5 hours)
Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.

Module IV: Solar Photovoltaic (10 hours)
Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control.

Module V: Network Integration Issues (10 hours)
Overview of grid code technical requirements. Voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems, Integration in Smart Grid System.

Module VI: Solar Thermal Power Generation (2 hours)
Technologies, Fresnel reflector, solar pond, elementary analysis.

Module VII: Micro Hydel Generation (3 hours)
Operating principles. Power and Efficiency of Micro Hydel plant. Control, Automation and Monitoring in a Small Hydro Plant. Components of a microhydel power plant, Load balancing.

Module VIII: Bioconversion (3 hours)
Biomass, physical and biological thermal methods of bioconversion. Solid fuels, ethanol, methanol, vegetable oils. Biomass fuels in IC engines. Alcohol fuels, vegetable oils, producer gas.

Suggested Readings

1. T. Ackermann, “Wind Power in Power Systems”, John Wiley and Sons Ltd., 2005.
2. G. M. Masters, “Renewable and Efficient Electric Power Systems”, John Wiley and Sons, 2004.
3. G.D. Rai, Non-conventional energy sources, Khanna publishers.
4. S. P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, McGraw Hill, 1984.
5. H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems”, John Wiley and Sons Ltd., 2006.
6. G. N. Tiwari and M. K. Ghosal, “Renewable Energy Applications”, Narosa Publications, 2004.
7. J.A. Duffie and W. A. Beckman, “Solar Engineering of Thermal Processes”, John Wiley & Sons, 1991.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6	Module 7	Module 8
CO 1	M	M						
CO 2			M			H		
CO 3				L	H			
CO 4				H	M			

EEPQ0096: POWER QUALITY AND FACTS
(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes
1. List the effect of shunt and series reactive compensation. (Remembering)
2. Explain the working principles of FACTS devices. (Understanding)
3. Compare performance of various FACTS devices. (Analyzing)
4. Experiment with various FACTS devices to mitigate power quality issues. (Evaluating)

Objective
This course gives an introduction to the power quality and application of Flexible Ac Transmission Systems to enhance controllability and power transfer capability in ac systems and involves applications of power electronics devices in power systems to improve reliability of power supply and opens up new opportunities for controlling power and enhancing the usable capacity of present, as well as new and upgraded lines.

Module I: Series/Shunt Reactive Power Compensation (4 hours)
Basics of AC Transmission. Analysis of uncompensated AC transmission lines. Passive Reactive Power Compensation. Shunt and series compensation at the mid-point of an AC line. Comparison of Series and Shunt Compensation.

Module II: Thyristor-based Flexible AC Transmission Controllers (8 hours)
Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor and Single Pole Single Throw (SPST) Switch, Configurations/Modes of Operation, Harmonics and control of SVC and TCSC, Fault Current Limiter.

Module III: Voltage Source Converter based FACTS controllers (12 hours)

a. Voltage Source Converters (VSC): Six Pulse VSC, Multi-pulse and Multi-level Converters, Pulse-Width Modulation for VSCs, Selective Harmonic Elimination, Sinusoidal PWM and Space Vector Modulation.
b. FACTS controller: Principle of Operation, operation of STATCOM ,Reactive Power Control: Type I and Type II controllers, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller, Principle of Operation and Control. Working principle of Interphase Power Flow Controller, Other Devices: GTO Controlled Series Compensator.

Module IV: Application of FACTS (8 hours)
Application of FACTS devices for power-flow control and stability improvement, Simulation example of power swing damping in a single-machine infinite bus system using a TCSC, Simulation example of voltage regulation of transmission mid-point voltage using a STATCOM.

Module V: Power Quality Problems in Distribution Systems (8 hours)
Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement. Tolerance of Equipment: CBEMA curve. Reactive Power Compensation, Harmonics and Unbalance mitigation in Distribution Systems using DSTATCOM and Shunt Active Filters. Synchronous Reference Frame Extraction of Reference Currents. Current Control Techniques in for DSTATCOM.

Module VI: Dynamic Voltage Restorer and Unified Power Quality Conditioner (6 hours)
Voltage Sag/Swell mitigation: Dynamic Voltage Restorer – Working Principle and Control Strategies, Series Active Filtering, Unified Power Quality Conditioner (UPQC): Working Principle. Capabilities and Control Strategies.

Suggested Readings

1. N. G. Hingorani and L. Gyugyi, “Understanding FACTS: Concepts and Technology of FACTS Systems”, Wiley-IEEE Press, 1999.
2. K. R. Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age International (P) Ltd. 2007.
3. T. J. E. Miller, “Reactive Power Control in Electric Systems”, John Wiley and Sons, New York, 1983.
4. R. C. Dugan, “Electrical Power Systems Quality”, McGrawHillEducation, 2012.
5. G. T. Heydt, “Electric Power Quality”, Stars in a Circle Publications, 1991

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H	H	M	M		
CO 2		M	M	M		M
CO 3		M	M	L		L
CO 4		L	M	L	H	M

EEIS0097: INDUSTRIAL ELECTRICAL SYSTEMS

(3 Credits – 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. List the various components and define the various terminologies used in residential, commercial and industrial electrical systems. (Remembering)
2. Explain the construction, operations and application of various electrical components used and different methods employed in design of residential, commercial and industrial electrical systems. (Understanding)
3. Determine the ratings of various components used in residential, commercial and industrial electrical systems. (Applying)
4. Design residential, commercial and industrial electrical systems for a given problem. (Creating)

Objective
The objective of this course is to introduce the students to electrical wiring systems for residential, commercial and industrial consumers. The various concepts related to illumination systems for residential and commercial premises will be studied. Industrial Electrical System Automation is covered in detail.

Module I: Electrical System Components (8 hours)

LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays,MPCB, Electric shock and Electrical safety practices

Module II: Residential and Commercial Electrical Systems (8 hours)
Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices,earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

Module III: Illumination Systems (8 hours)
Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.

Module IV: Industrial Electrical Systems I (8 hours)
HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.

Module V: Industrial Electrical Systems II (6 hours)
DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

Module VI: Industrial Electrical System Automation (7 hours)
Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.

Suggested Readings

1. S. L. Uppal and G.C. Garg, “Electrical Wiring, Estimating & Costing”, Khanna publishers, 2008.
2. K. B. Raina, “Electrical Design, Estimating & Costing”, New age International, 2007.
3. S. Singh and R. D. Singh, “Electrical estimating and costing”, Dhanpat Rai and Co., 1997.
4. Web site for IS Standards.
5. H. Joshi, “Residential Commercial and Industrial Systems”, McGraw Hill Education, 2008.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO1	H	M	H	M	M	M
CO2	L	H	H	H	H	H
CO3	M	H	H	M	M	L
CO4	L	H	H	H	M	L

EECA0098: ELECTRICAL ENERGY CONSERVATION AND AUDITING
(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes
1. Apply the concept of energy management to improve energy efficiency in different electrical systems. (Applying)
2. Analyze the concepts of different energy efficient devices. (Analyzing)
3. Choose the appropriate energy conservation methodology for a particular energy source. (Evaluating)
4. Adapt new and efficient methodology to auditing. (Creating)

Objective
The objective of the course is to introduce energy conservation methodologies and importance of energy audit, measurement, energy performance diagnosis and analysis and carryout financial analysis and cost prediction for energy saving. The course also addresses the energy management issues in various sectors.

Module I: Energy Scenario (6 hours)
Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment,

energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.

Module II: Basics of Energy and its various forms (7 hours)
Electricity tariff, load management and maximum demand control, power factor improvement, election & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

Module III: Energy Management & Audit (6 hours)
Definition, energy audit, need, types of energy audit. Energy management (audit) approach understanding energy costs, benchmarking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

Module IV: Energy Efficiency in Electrical Systems (7 hours)
Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

Module V: Energy Efficiency in Industrial Systems (8 hours)
Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers.

Module VI: Energy Efficient Technologies in Electrical Systems (8 hours)
Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

Suggested Readings

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online).
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online).
3. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.
4. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org).

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	L		H			
CO 2					H	H
CO 3		L		M	L	M
CO 4	L		H	L		

EEOD0099: OPTOELECTRONIC DEVICES

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Describe and show the working of basic optoelectronics devices such as optical sources, detectors, optical amplifiers and connectors, etc. (Remembering)
2. Explain the nature and performances of various types of optical sources, photodetectors, connectors and couplers (Understanding)
3. Implement mathematical models to compute the efficiencies and other parameters related to optoelectronic sources, detectors and amplifiers. (Applying)

4. Check the performance characteristics of optical sources, detectors, optical amplifiers and other optoelectronics components. (Evaluating)

Objective
The course is intended to give the students an exposure to the design criteria for semiconductor optical sources including light emitting diodes and laser diodes, optical detectors, amplifiers and connectors for a variety of applications.

Module I: Sources (15 hours)
Light Emitting Diodes (LEDs), LED Structures, LED types, Fabrication of LED, Light Source Materials, Internal Quantum Efficiency, Modulation Capacity, Transient Response, Power– Bandwidth Product, Laser Diodes, Laser Diode Modes and Threshold Conditions, Single mode operation, Mode locking, Q-switching, Holography, Resonant Frequencies, Laser Diode Structures and Radiation Patterns, Single Mode Lasers, Modulation of Laser Diodes, Temperature Effects, Light Source Linearity, Modal Partition and Reflection Noise.

Module II: Detectors (10 hours)
PIN Photo-Detector, Avalanche Photodiodes, Photo-Detector Noise, Noise Sources, Signal-to-Noise Ratio, Depletion Layer Photocurrent, Response Time, Avalanche Multiplication Noise, Temperature Effects on Avalanche Gain, Photodiode Materials.

Module III: Amplifiers and Switches (10 hours)
Optical Amplifiers, Semiconductor Laser Amplifiers, Fiber Amplifiers, Rare Erbium Doped Fiber Amplifiers, Raman Fiber Amplifiers, Brillion Fiber Amplifiers, Amplifier Gain, Noise Figure, Bandwidth, Photonic Switching, Integrated Optical Switches.

Module IV: Connectors and Couplers (10 hours)
Cylindrical Ferrule Connector, Bi-Conical Ferrule Connectors, Double Eccentric Connectors, Duplex Fiber Connectors, Expanded Beam Connectors, Beam Splitter, Three Port Couplers, Four Port Couplers, Directional Couplers, Star Couplers, Lenses for Coupling Improvement.

Suggested Readings
1. J. Wilson, J.F.B. Hawkes, “Optoelectronics - An Introduction”, Prentice Hall of India Private Limited.
2. G. Keiser, “Optical Fiber Communications”, McGraw Hill.
3. D.K. Mynbaev and L.L. Scheiner, “Fiber Optic Communications Technology”, Pearson.
4. S.K. Sarkar, “Optical Fibers and Fiber Optic communication system”, S. Chand and Co.
5. J.C. Palais, “Fiber Optic Communications”, Pearson.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H		H	H
CO 2	H	H	M	H
CO 3	H	H	M	L
CO 4	H	H	M	

EEEL0100: ELECTRICAL AND ELECTRONICS MATERIALS
(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes
1. Describe basic terminologies related to properties of materials used in electrical engineering. (Remembering)
2. Explain the electrical and thermal characteristics of conducting, semiconducting, insulating and magnetic materials for the manufacturing of electrical machines and electronic components. (Understanding)
3. Implement advanced studies in solar photovoltaic material for green and clean power generation in view of sustainable development through environmental and safety aspects. (Applying)
4. Compare different material behavior. (Analyzing)
5. Check the performance of different electrical materials. (Evaluating)

Objective
The objective of the course is to provide the knowledge of different electrical engineering materials and their applications in designing electrical equipment. The course also provides the study of thermal properties for the efficient design and long-life cycle of electrical equipment.

Module I: Conductors (8 hours)

Classification: High conductivity, high resistivity materials, Fundamental requirements of high conductivity materials and high resistivity materials, Mobility of electron in metals, Factors affecting conductivity and resistivity of electrical material.
Thermoelectric Effect: See back effect, Peltier effect, Thomson effect. Commonly used high conducting materials, properties, characteristics and applications of copper, aluminum, bronze, brass, High resistive materials, Constantan, platinum, nichrome, properties, characteristics, Materials used for AC and DC machines.

Module II: Semiconductors and Superconductors (8 hours)
General concepts, energy bands, Types of semiconductors: intrinsic Semiconductors, extrinsic Semiconductors. Compound semiconductor, amorphous semiconductor. Hall effect, drift, mobility, diffusion in Semiconductors. Semiconductors and their applications.
Superconductors: Superconductivity, Properties of Superconductors, Critical field, Meissner effect, Type-I and type-II Superconductors.

Module III: Dielectrics and Insulators (8 hours)
Properties of gaseous, liquid and solid dielectric, dielectric as a field medium, Electric conduction in gaseous, liquid and solid dielectric, Breakdown in dielectric materials, mechanical and electrical properties of dielectric materials, Effect of temperature on dielectric materials, polarization, loss angle and dielectric loss. Petroleum based insulating oils, transformer oil, capacitor oils, and properties. Classification of insulation (Solid) and application in AC and DC machines. Solid electrical insulating materials, fibrous, paper boards, yarns, cloth tapes, sleeving wood, impregnation, plastics, filling and bounding materials, fibrous, film, mica, rubber, mica-based materials, ceramic materials.

Module IV: Magnetic Materials (8 hours)
Basic terms, Classification of magnetic material, diamagnetic, paramagnetic, ferromagnetic, antiferromagnetic and amorphous material. Hysteresis loop, magnetic susceptibility, coercive force, curie temperature. Magnetostriction, factors affecting permeability and hysteresis loss. Common magnetic materials, Soft and hard magnetic materials. Electric steel, sheet steel, cold rolled grain-oriented silicon steel, hot rolled grain-oriented silicon steel, hot rolled silicon steel sheet.

Module V: Insulating Materials (6 hours)
Gaseous materials-Oxide gases, electronegative gases, hydrocarbon gases; Liquid materials-mineral oils, silicon liquids, hydrocarbon liquids; Solid Materials-Paper and boards, Resins (Polymers), Rubbers-natural and synthetic, glass, ceramics, asbestos.

Module VI: Modern Engineering Materials (7 hours)
Materials for Electronic Components - Resistors, Capacitors, Inductors, Relays, Bipolar transistors, Field effect transistor (FET), Integrated circuits, Power devices.
Nanotechnology – Introduction, Nano-devices, applications.
Solar/Photovoltaic Cell- Introduction, Photo-generation of charge carriers, p-n junction, Light absorbing materials: Silicon thin films, concentrating photovoltaic.

Suggested Readings

1. S. L. Uppal and G.C. Garg, “Electrical Wiring, Estimating & Costing”, Khanna publishers, 2008.
2. K. B. Raina, “Electrical Design, Estimating & Costing”, New age International, 2007.
3. S. Singh and R. D. Singh, “Electrical estimating and costing”, Dhanpat Rai and Co., 1997.
4. S.P. Seth, “A Course in Electrical Engineering Materials”, Dhanpat Rai Publishing Co Pvt Ltd.
5. Web site for IS Standards.
6. H. Joshi, “Residential Commercial and Industrial Systems”, McGraw Hill Education, 2008.
7. A. J. Dekker, “Electrical Engineering Materials”. PHI Pvt. Ltd.
8. C. S. Indulkar and S. Thiruvengadam, “Electrical Engineering Materials”, S. Chand Publication.
9. G. P. Chhaiotra and B.K. Bhat, “Electrical Engineering Materials”, Khanna Publication, 1991.
10. N. Alagappan and N.T. Kumar, “Electrical Engineering Materials”, 34th edition, Technical Teachers' Training Institute, Madras, Tata McGraw-Hill Education.
11. P.L. Kapur, “A Text Book of Electrical and Electronics Engineering Materials”, 8th edition, Khanna Publishers.
12. S.K. Bhattacharya, “Electrical and Electronics Engineering Materials and Components”, Khanna Publishers.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1		H		H		
CO 2	H	H		H		

CO 3	M	H	M	H		
CO 4	H	H	H	M	M	M
CO 5	L	H	M			H

EEOT0101: OPTIMIZATION TECHNIQUES
(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes
1. Define and explain the importance in solving engineering problems using Linear Programming. (Remembering)
2. Identify and describe the various types of formulation methods like Simplex Method, Dual Simplex Method. (Understanding)
3. Establish the need for linear programming and classify different non-linear programming methods in solving system. (Analysing)
4. Evaluate the performance characteristics of genetic algorithm and particle swarm optimization. (Evaluating)

Objective
This subject introduces optimization theory and its importance in solving of engineering problems. Students can learn linear and nonlinear programming, constrained and unconstrained optimization in this subject

Module I: Introduction & Linear Programming (18 hours)
Importance in solving system engineering problems, Introduction to Linear Programming problem-Formulation, Simplex Method, Dual Simplex Method, Sensitivity Analysis, Duality in Programming.

Module II: Introduction to Nonlinear Programming (10 hours)
Unconstrained optimization-formulation of quadratic optimization problems, gradient descent and steepest descent methods, Quasi-Newton Method, Fibonacci and golden section, Quadratic Interpolation method.

Module III: Constrained Optimization (10 hours)
Direct optimization, Cutting plane methods, methods of feasible direction, analytic center cutting plane methods, Multi-objective optimization-Genetic Algorithm, Kuhn-Tucker conditions.

Module IV: Dynamic Programming (7 hours)
Principle of optimality, recursive equation approach, application to shortest route, Cargo Loading, allocation & production, schedule problems.

Suggested Readings
1. S. S. Rao, Optimization theory and applications, Wiley Eastern Ltd.
2. K. V. Mittal, Optimization methods, Wiley Eastern Ltd.
3. R. Fletcher, “Practical Optimization”, John Wiley and Sons, New York.
4. M. S. Bazaraa, H. D. Sherali and C. Shetty, “Nonlinear Programming, Theory and Algorithms”, John Wiley and Sons, New York.
5. N. A. Kheir, “System modeling and computer simulation”, Marcel Decker, New York.
6. G.A Korn., “Interactive Dynamic System Simulation”, McGraw Hill, N.Y.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	L		
CO 2	H	L		
CO 3	M	H	M	
CO 4		M	M	H

EEGE0102: GREEN ENERGY
(3 Credits: 45 Hours) (L-T-P: 3-0-0)

Course Outcomes
1. List and recognize the various renewable energy resources and their importance. (Remembering)
2. Summarize the power generation using renewable energy resources. (Understanding)
3. Identify the potential fields of renewable energy applications. (Applying)
4. Experiments with modeling of renewable energy resources. (Evaluating)

Objective

The objective of this course is to introduce the different renewable energy resources and their applications. The course helps in understanding the importance and potential of renewable energy resources, the working principles and mechanisms of the different renewable energy sources and their analysis in the current context.

Module I: Introduction (3 hours)

Energy needs of India, classification of energy sources, energy efficiency and energy security, importance of renewable energy resources.

Module II: Solar Energy (11 hours)

Basic concepts, types of collectors, collection systems, photo voltaic (PV) technology: solar thermal effect, solar cells, characteristics of PV systems, equivalent circuit, and array design, building integrated PV system and efficiency calculations, applications.

Module III: Wind Energy (10 hours)

Wind power systems, wind speed and power relation components, turbine types, turbine rating. Choice of generators and site selection, wind energy forecasting, variable speed operation, maximum power operation.

Module IV: Bio energy (9 hours)

Bio-mass and bio-gas: principles of bio-conversion, bio-gas digesters types, gas yield, and combustion characteristics, fermentation and wet processes, applications-utilization for cooking.

Module V: Other renewable energy Resources (12 hours)

Hydro energy, Geothermal energy, ocean thermal energy, wave energy, Tidal energy, waste to energy, heat to energy, Fuel cells: types and applications.

Suggested Readings

1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems", John Wiley and Sons, 2004.
3. G.D. Rai, Non-conventional energy sources, Khanna publishers.
4. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 1984.
5. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems", John Wiley and Sons Ltd., 2006.
6. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
7. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	L	L	L	L	L
CO 2		M	M	M	
CO 3		H	H	L	L
CO 4		H	H		

EEEU0103: ENERGY EFFICIENCY IN ELECTRICAL UTILITIES

(4 Credits- 60 Hours) (L-T-P : 4-0-0)

Objective

The objective of this course is to familiarize the students regarding the various electrical systems and the methods adopted for determining the efficiency of the common household and industrial electrical utilities. The course also deals with the energy conservation bills and codes in practice in India. This course is designed for all engineering students, scholars, academicians and practitioners.

Course/Learning Outcomes:

At the end of the course, the students will be able to:

1. Explain energy management based on demand/load control. (Understanding)
2. Identify opportunities for Energy Saving in Electrical Utilities. (Applying)
3. Examine the implementation of ECBC in Electrical Installations in Buildings. (Analyzing)
4. Estimate efficiency of Electrical Equipment installed at various utilities. (Evaluating)

Module I: Electrical Systems (24 hours)

Electric Power Supply Systems, Electricity Billing, Load Management, Demand Control, Significance of Power Factor, Transformers, Transmission and Distribution Losses, Demand Side Management, Harmonics, Analysis of Electrical Power Systems.

Module II: Energy Efficiency in Electrical Utilities (16 hours)
Energy efficiency calculations and energy saving opportunities in electrical utilities: Electrical Motors, Compressors, HVAC and Refrigeration Systems, Fans and Blowers, Pumps and Pumping System, Cooling Towers, Lighting System, Diesel and Natural Gas Generating System.

Module III: Energy Conservation in Buildings and ECBC (20 hours)
Building definition as in the Energy Conservation Bill 2010, Energy Conservation Building Code (ECBC), Compliance approaches, ECBC guidelines on building envelope, heating ventilation and air conditioning system, service hot water, lighting, electrical power, building water pumping systems. Uninterruptible power supply. Escalators and elevators. Building Management System (BMS), star rating of buildings, energy efficiency measures in buildings.

Suggested Readings

1. Martinez, Daniel M., Ben W. Ebenhack and Travis P. Wagner, “Energy Efficiency: Concepts and Calculations”, Elsevier, 2019.
2. Desideri, Umberto and Francesco Asdrubali (eds.), “Handbook of energy efficiency in buildings: a life cycle approach”, Butterworth-Heinemann, 2018.
3. Sumper, Andreas, and Angelo Baggini, “Electrical energy efficiency: technologies and applications”, John Wiley & Sons, 2012.
4. “Energy Efficiency in Electrical Utilities: Guide Book for NCE”, Bureau of Energy Efficiency, 2015.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H		
CO 2		M	H
CO 3		L	H
CO 4		H	

EEED0104: ELECTRICAL DISTRIBUTION SYSTEM ANALYSIS
(4 Credits- 60 Hours) (L-T-P: 4-0-0)

Course Outcomes
1. Define terms related to electrical power distribution system. (Remembering)
2. Explain the concepts of various distribution transformers and feeders, load characteristics, and associated factors. (Understanding)
3. Model various components of an electrical distribution system. (Applying)
4. Analyze distribution systems, short circuit faults and load flows. (Analyzing)
5. Evaluate the Electrical distribution system for optimum performance. (Evaluating.

Objective
The objective of this course is to make the students familiar with topics on electrical distribution system planning, load characteristics, application of distribution transformers, design of sub-transmission lines, distribution substations, primary systems, and secondary systems, voltage drop and power-loss calculations, application of capacitors, harmonics on distribution systems, voltage regulation, and smart grid concepts. This course shall introduce the modeling of the components (feeders, distribution transformer, regulators, capacitors, loads, distributed generation, storage, etc.) and analysis methods (load flow, short-circuit, etc.), specially developed for the distribution system.

Module I: Structure & Planning of a distribution system (13 hours)
Introduction to Electrical Distribution System, Distribution System Planning, Factors Affecting System Planning, Present Distribution System Planning Techniques, Central Role of the Computer in Distribution Planning, Distribution System Automation, load characteristics, Diversified demand, Non-coincident demand, Coincidence factor, Contribution factor problems, Relationship between the Load and Loss Factors, Load Forecasting.
Distribution feeder configurations and substation layouts, Nature of loads in a distribution system, Load allocation in a distribution system.

Module II: Design consideration and Approximate methods of analysis (15 hours)

Types of Distribution transformers, Regulation, Efficiency, single-phase transformer connections, Three-phase transformer connections, Auto-transformer, Booster transformer, phasor diagrams, Grounding Transformers.
Radial type, Loop type primary feeder, primary feeder loading, Radial Feeders with Uniformly Distributed Load, Introduction to Secondary Systems, secondary Banking, Secondary networks.
Computation of transformer and feeder loading; "K" Factors and their applications, voltage drop and power loss calculations; Distribution of loads and various geometric configurations.

Module III: Modeling of distribution system components (17 hours)
3-phase and Non 3-phase primary lines, Single-phase two-wire laterals with ungrounded neutral, Single-phase two-wire ungrounded laterals, Application of capacitors to distribution systems, Effect of series and shunt capacitors, power factor correction, Economic justification for capacitors, Optimum location for capacitor bank.
Modeling of Overhead lines, feeders and cables, Single and three-phase distribution transformers, Voltage regulators, Load models in distribution system; Application and modeling of Capacitor banks; Modeling of Distributed generation.

Module IV: Distribution system analysis (15 hours)
Load flow analysis: Algorithms & Examples - Backward/forward sweep method, Direct approach method, Direct approach method for weakly meshed systems, Gauss Implicit Z-matrix Method.
Short-circuit analysis: Sequence-components vs. phase-variable based methods; Direct approach method for Short-circuit analysis- LG, LLG, LLLG, and LL Faults, Weakly meshed system; Applications of distribution system analysis and future smart-grid.

Suggested Readings

1. Turan Gönen, "Electric Power Distribution Engineering", 3rd Edition, CRC Press, 2014.
2. William H. Kersting, "Distribution System Modeling and Analysis", 4th Edition, CRC Press, 2018.
3. Abdelhay A. Sallam, Om P. Malik, "Electric Distribution Systems", 2nd Edition, Wiley-IEEE, 2019.
4. Biswarup Das (Ed.), "Power Distribution Automation", IET Power and Energy, 75, 2016.
5. Juan M. Gers, "Distribution System Analysis and Automation", IET Power and Energy, 68, 2013.
6. S. Pabla, "Electric Power Distribution", McGraw Hill Education (India) Pvt. Limited, 2011.
7. T. A. Short, "Electric Power Distribution Equipment and Systems", CRC Press, 2006.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M		L
CO 2	L	H	M	
CO 3		L	H	M
CO 4		M		H
CO 5		M	L	H

EEDM0105: DC MICROGRID
(4 Credits - 60 hours) (L-T-P: 4-0-0)

Course Outcomes
1. List the various microgrid components. (Remembering)
2. Describe the modeling and control of microgrid. (Understanding)
3. Solve problems related to microgrid operation and control. (Applying)
4. Experiments with modeling of renewable energy resources. (Evaluating)

Objective
This course details the fundamental concepts of microgrid and its components, types, advantages of microgrid compared to the central conventional grid. Particularly the course describes general concepts and application, control strategies and principle of operation of DC microgrid.

Module I: Introduction of microgrid (10 hours)
Overview of microgrids, concepts of microgrids, microgrid and distributed generation, microgrid vs conventional power system, AC and DC microgrid with distributed energy resources, power electronics for microgrid, power electronic converters in microgrid applications.

Module II: Modeling of microgrid components (20 hours)

Distributed energy resources (DERs) modelling I: PV system, MPPT, and grid-tied interface – Distributed energy resources modeling, Microturbine, energy storage and other DERs, Distribution power flow, Modeling of converters in microgrid power system (AC /DC and DC/AC Converters Modeling), Modeling of Renewable Energy Resources (Modeling of Wind Energy System, Photovoltaic System, Modeling of Energy Storage System.

Module III: Control of Microgrid (15 hours)
Microgrid Dynamics and Modeling, Microgrid Operation Modes and Standards, Microgrid Control Architectures, Intelligent Microgrid Operation and Control, Energy Management in Microgrid System, DC Microgrid System Architecture and AC Interface, DC Microgrid Dynamics and Modeling, Control of DC Microgrid System, Applications of DC Microgrids, Cyber Security in Microgrids.

Module IV: Stability analysis of Microgrid (15 hours)
Stability in Microgrid, Stability Analysis of DC Microgrid, Stability Analysis of DC Microgrid, DC Microgrid stabilization strategies (passive damping method), DC Microgrid Stabilization Strategies (Impedance/Admittance stability criteria), DC microgrid stabilization using nonlinear Techniques.

Suggested Readings

1. Fusheng Li, Ruisheng Li and Fengquan Zhou, “Microgrid Technology and Engineering Application”, Elsevier, 2015
2. S. Chowdhury and P. Crossley, “Microgrids and Active Distribution Networks”, Institution of Engineering and Technology, 2009
3. Nikos Hatziargyriou, “Microgrids Architectures and Control”, John Wiley Sons, 2014
4. Manuela Sechilariu and Fabrice Locment, “Urban DC Microgrid: Intelligent Control and Power Flow Optimization”, Butterworth-Heinemann, 2016

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M		
CO 2	H	H		
CO 3		L	H	L
CO 4		H		

EEPO0106: PRACTICAL APPLICATIONS OF OPAMP

(4 Credits - 60 hours) (L-T-P: 4-0-0)

Course Outcomes
1. Understand the operation of the basic building blocks of analog system. (Understanding)
2. Understand and analyze the Op-Amps. (Understanding)
3. Understand feedback techniques and its advantages. (Understanding)
4. Design amplifiers using Op-Amps. (Creating)

Objective
This course is a system design-oriented course aimed to provide exposure on applications of op-amps and its importance in the real world. Since analog circuits play a crucial role in the implementation of an electronic system, this course emphasis 0n complete system design with initial discussion on circuit design. As part of this course, students can build analog systems using analog ICs and study their macro models.

Module I: Basics of Op-Amps (15 hours)
Understanding the Datasheet of Op-Amps, introduction to op-amps and discussion on its characteristics by simulation and experiment, basics of Hysteresis and the need of hysteresis in switching circuits.

Module II: Some applications of Op-Amps (15 hours)
Op-Amp Circuits Analog-to-Digital Converter (ADC) Digital-to-Analog Converter (DAC) using Op-Amps
To design and build a function generator capable of generating square wave and a triangular wave of a known frequency using simulation and experiment by TI analog system lab kit pro.

Module III: Advanced applications of Op-Amps (15 hours)
To design and build a voltage-controlled oscillator using simulation and TI analog system lab kit pro.
To design and build an automatic volume control using simulation and TI analog system lab kit pro.

To design and build a constant current drive circuit for measuring unknown resistance using simulation and experiment on breadboard.

Module IV: Signal conditioning of Op-Amps (15 hours)
To design and build a temperature-controlled system using op-amps as ON-OFF controller and Proportional controller by simulation and Experiment on breadboard.
To design and build a signal conditioning circuit for the thermocouple to compensate for temperature correction.
To design and Implement a speed controller of a DC motor using simulation and experiment.

Suggested Readings

1. A.S. Sedra and K.C. Smith, "Microelectronic Circuits", New York, Oxford University Press, 1998.
2. J.V. Wait, L.P. Huelsman and G.A. Korn, "Introduction to Operational Amplifier theory and applications", McGraw Hill U. S., 1992.
3. J. Millman and A. Grabel, "Microelectronics", McGraw Hill Education, 1988.
4. P. Horowitz and W. Hill, "The Art of Electronics", Cambridge University Press, 1989.
5. P.R. Gray, R.G. Meyer and S. Lewis, "Analysis and Design of Analog Integrated Circuits", John Wiley & Sons, 2001.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2	H	M	M	
CO 3				H
CO 4			H	H
CO 5			M	H

EESD0107: SENSORS AND TRANSDUCERS

(4 Credits - 60 hours) (L-T-P: 4-0-0)

Course Outcomes
1. Make use of different types of electrical and industrial sensors as well as transducers for practical applications. (Applying)
2. Determine the performance parameters of the electrical sensors for relevant application. (Analyzing)
3. Test electrical circuits and set-up using sensors and transducers of different types. (Creating)

Objective
The objective of this course is to familiarize the students with the various electrical sensors and transducers used in different applications. Measurement techniques for electrical as well as non-electrical quantities using the sensors and transducers are to be dealt with in detail in the subject.

Module I: Introduction to Electrical Measurement (6 hours)
Electrical measurement and measuring instruments, Analog and digital instruments, Performance of measuring instruments-Error, Accuracy, Precision, Sensitivity, Resolution and Repeatability of measurement. Primary and Secondary instruments.

Module II: Sensors and Transducers (22 hours)
Introduction to Sensors and Transducers, Classification of Transducers, Advantages and Disadvantages of Electrical Transducers, Transducers Actuating Mechanisms, Resistance Transducers, Variable Inductance Transducers, Capacitive Transducers, Piezoelectric Transducers, Hall Effect Transducers, Thermoelectric Transducers, Photoelectric Transducers.
Stain Gages, Load Cells, Proximity Sensors, Pneumatic Sensors, Light Sensors, Tactile Sensors, Fiber Optic Transducers, Digital Transducers, Recent Trends – Smart Pressure Transmitters, Selection of Sensors, Rotary – Variable Differential Transformer.
Synchros and Resolvers, Induction Potentiometers, Micro Electromechanical Systems.

Module III: Measurement of Non – Electrical Quantities (17 hours)
Temperature Measurement, Flow Measurement – Introduction, Electromagnetic Flow meters, Ultrasonic Flow Meters, Thermal Meters, Wire Anemometers.
Measurement of Displacement, Measurement of Velocity/ Speed, Measurement of Acceleration, Measurement of Force, Measurement of Torque, Measurement of Shaft Power.
Measurement of Liquid Level, Measurement of Viscosity.

Suggested Readings

1. Mike J. Usher and D. A. Keating, “Sensors and transducers: characteristics, applications, instrumentation, interfacing”, Macmillan International Higher Education, 1996.
2. A. K. Sawhney, “A Course in Electrical and Electronic Measurements and Instrumentation”, Dhanpat Rai and Company, 2019.
3. D. Patranabis, “Sensors and Tranducers”, PHI Learning Pvt. Ltd., 2003.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1		H	M
CO 2	L	H	
CO 3		M	H

EEPI0108: PROCESS CONTROL AND INSTRUMENTATION

(4 Credits – 60 hours) (L-T-P: 4-0-0)

Course Outcomes

At the end of this course, students will be able to

1. Understand any kind of process by framing it in block diagram, mathematical model and different process variables. (Understanding)
2. Select different types of controller like electronic, pneumatic and hydraulic. (Remembering)
3. Explain advanced control techniques for process control. (Evaluating)
4. Design various controllers like PI, PID, PD for application in process control. (Creating)

Objective

This course aims to provide in depth understanding of designing and implementing practical control strategies in process control.

Module I: Introduction (8 hours)

Introduction to Process Control. Control objectives, servo regulatory control, classification of process variables.

Module II: Modeling of processes (12 hours)

Modeling basics, Degree of Freedom, Mass Balance, Energy Balance equations, linearization of nonlinear systems, Modeling of Level Tank System, Continuous Stirred Tank Heater, Continuous Stirred Tank Reactor, Transfer function. Dynamic behavior of first and second order processes, Obtaining First Order Plus Time Delay (FOPTD) model with Process Reaction curve. Obtaining second order model of processes.

Module III: Elements of process control (15 hours)

Dead time, Interacting and non-interacting systems, self -regulation, inverse response, capacity of process, integrating systems, multi capacity process. Dynamic behavior of first and second order processes, Obtaining First Order Plus Time Delay (FOPTD) model with Process Reaction curve. Obtaining second order model of processes.

Module IV: Common controller modes (15 hours)

Controller Modes, ON-OFF, Multi position, time proportional controller, Theory Proportional, Integral and Derivative modes, PI, PD, PID Controller, Dynamic Behavior of closed loop systems with P, I, D, PI, PID modes. Application and tuning, ZN Tuning (Open-loop and Closed loop), Performance criteria, Integral criteria, pneumatic and electronic controllers to realize various control actions.

Module V: Some advance control Techniques (10 hours)

Cascade Control, Feed-forward Control, ratio Control, Selective Control, Inferential Control, Introduction to adaptive control. Examples of Drum Boiler, Heat Exchanger and CSTR, Feedforward+Feedback Control of Heat Exchanger, Air Fuel Ratio Control for Drum Boilers. Level Control in Drum Boiler, Shrinking and Swelling, Inverse response of Drum Boiler.

Suggested Readings

1. Stephanopoulos. G, “Chemical Process Control”, Prentice Hall of India, New Delhi, 1984.
2. Curtis. D. Johnson, “Process control Instrumentation Technology”, Prentice Hall of India, New Delhi, 1984.
3. F.G. Shinskey, “Process Control Systems Application Design and Adjustment”, McGraw Hill International.1988.
4. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp, “Process Dynamics and Control”, Wiley Dreamtech India (P) Ltd, New Delhi, 2013.
5. B. Wayne Bequette, “Process control, modeling, Design and simulation”, Prentice Hall of India (P) Ltd., 2015.

6. Thomas Marlin, “Process Control Designing Processes and Control for Dynamic Performance”, Tata MC Graw Hill,2012.
7. Surekha Bhanot, “Process Control Principles and Applications”, Oxford 2008.

Mapping of COs to Syllabus

Course Outcomes	Module 1	ModuleII	Module III	Module IV	Module V
CO1	M	H			
CO2				H	
CO3				H	L
CO4				M	H

EEEM0109: ELECTRICAL MACHINES (Minor)

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Explain principle of operation of various electrical machines. (Understanding)
2. Identify different types of dc and ac machines. (Applying)
3. Classify different types of dc and ac machines. (Analyzing)
4. Compare the performances in terms of losses, efficiency, and regulation of different types of dc and ac machines. (Evaluating)

Objective

This course on Electrical Machines, generally offered for students who do not major in Electrical Engineering, is an introductory course in electro-mechanical energy conversion devices. This course gives an introduction to DC as well as AC machines and transformers, to enable the students to use this knowledge for applying to situations arising in their disciplines.

Module I: D.C. Machines (15 hours)

Operating principle, generator & motor action, construction, types of excitation, emf & torque equations, power stages & efficiency. Commutation & Armature Reaction, characteristics & application of d.c generators, starting & speed control of d.c motors, characteristics & applications of d.c motors, electric braking.

Design of D.C Machines: Output equation, Main dimensions, Armature design, Armature windings, Design of commutator and brushes, Design of Field systems, Design of interpoles.

Module II: Transformers (10 hours)

Operating principle, classification, construction, emf equation, phasor diagrams, equivalent circuit model, losses & efficiency, voltage regulation, polarity test, autotransformers, three-phase transformer connections, & instrument transformers.

Module III: Induction Machines (10 hours)

Three-phase induction motors. Principle of operation, construction, types. Rotating magnetic field, emf equation of an AC Machine, torque developed in an induction motor, equivalent circuit model, torque-speed characteristics, starting & speed control. Single phase induction motors, starting, application.

Module IV: Synchronous Machines (10 hours)

Construction, types & operating principle of synchronous generator, A.C armature windings, equivalent circuit, phasor diagrams, voltage regulation, parallel operation, synchronization, Power Angle characteristics, effect of field excitation change. Synchronous Motor, principle, starting, hunting, damper windings. Special Purpose Motors: Stepper Motor, Universal Motor, shaded-pole Motor.

Suggested Readings

1. Fitzgerald, Kingslay and Umans, “Electric Machinery”, Tata McGraw-Hill.
2. Chapman, “Electric Machinery Fundamentals”, McGraw-Hill Higher Education.
3. Nagrath and Kothari, “Electric Machines”, Tata McGraw-Hill.
4. Guru and Hiziroglu, “Electric Machinery and Transformer, Oxford University press.
5. P.S. Bimbhra, “Electric Machinery”, Khanna Publishers.
6. Vincent Deltoro, “Basic Electric Machines”, Prentice Hall.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	H	H	H
CO 2	M	M	M	M

CO 3	M	M	M	M
CO 4	H	H	H	H

EEEW0110: ELECTRICAL WIRING

(3 Credits - 45 hours) (L-T-P: 2-0-2)

Course Outcomes

1. Define and explain the difference between direct current and alternating current. (Remembering)
2. Describe conditions likely to affect severity of electrical shock while maintaining safety during installation. (Remembering)
3. Demonstrate the different conductor systems used in residential and light commercial wiring in accordance with the codes and authorities for installation. (Applying)
4. Analyze the essential tools for residential wiring and be able to discuss the basic principles of tool-use and care. (Analysing)

Objective

To improve student electrical wiring skills through systematic training to enable students to create and test different electrical circuits using suitable electrical equipment, wires, protective devices and wiring accessories.

Module I: Basic Electrical Circuits (9 hours)

Measurement of Electrical quantities like Voltage, Currents, Resistance, Impedance, power factor and energy, Various Electrical Symbols, Electricity conductor, insulator, and resistance, Single-phase & three-phase circuits, Serial connection-diagram, Series and Direct Board-different types.

Module II: Different types of electrical wiring / installations (12 hours)

Two-way switch-wiring, 3-phase wiring, Overhead service connection, Definition and testing procedure of voltage current power MCB and bus bars, Earthing Connection – Different earthing systems.

Module III: Fundamentals of electricity-safety measures and precautions, first aid/Tools and equipment (12 hours)

Safely handling Tools & Equipment /Fire Fighting and use of fire extinguishers, Fires in electrical Circuits & Precautions, General Safety of Tools & equipment, Measuring tools, wire gauges etc. Classification, Identification of the electrical equipment cables, wires and electrical accessories.

Module IV: House Wiring Practical (12 hours)

House Wiring by PVC Casing Capping including Testing, House Wiring by PVC Rigid Pipe including Testing, Industrial Wiring by MS Pipe Including Testing, Measurement of Earth Resistance by Earth Tester, Common Faults in AC & DC Fans, Regulators and Remedies

Suggested Readings

1. J.B. Gupta, “A Course in Electrical Installation Estimating and Costing”, S.K. Kataria & Sons.
2. S.L. Uppal and G.C. Garg, “Electrical Wiring Estimating & Costing”, Khanna Publishers.
3. Satheesh Kumar, “Electrical Wiring: An Introduction”, Ane Books Pvt. Ltd.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	L		M
CO 2	L	L	H	M
CO 3	M	H	L	H
CO 4	M	M	H	H

EEBC0111: BASIC COMMUNICATION SYSTEMS

(3 Credits - 45 hours) (L-T-P: 3-0-0)

Objective

This course is intended as a base course to introduce a student with core areas other than Electronic communication, to basic communication systems. It introduces a student to Signals and different types of modulation. On completion of the course a student should be able to undertake other courses which have elements of Communication Techniques included in them.

Course Outcomes

1. Compare the performance of AM, FM and PM schemes with reference to SNR. (Understanding)
2. Understand noise as a random process and its effect on communication receivers. (Understanding)
3. Evaluate the performance of PCM, DPCM and DM in a digital communication system. (Evaluating)
4. Identify source coding and channel coding schemes for a given communication link. (Applying)

Module I (6 hours)

a. Review of signals and systems and Fourier analysis.
b. Introduction to Probability and Random process, Random variables, distribution and density functions. Statistical averages, Power spectral density, Energy spectral density, Correlation and convolution. Review of signals and systems and Fourier analysis.

Module II (17 hours)

a. Modulation, need for modulation and its types, Amplitude modulation, generation and detection of AM, DSB-SC, SSB-SC and VSB, Introduction to AM receivers and transmitters, super heterodyne receiver.
b. Angle modulation- Frequency and phase modulation, Relationship between FM and PM waves, Generation and detection of FM – NBFM and WBFM, Introduction to FM transmitters. Noise in AM and FM.

Module III (10 hours)

a. Pulse Modulation- Sampling of analog signal, Sampling theorem, PAM-generation and detection, PPM and PDM and its generation, quantization, PCM, PCM systems, Encoder-decoder, DPCM, DM and ADM, TDM and FDM.
b. Baseband binary PAM systems. Intersymbol interference (ISI). Nyquists's criterion for distortionless baseband binary transmission. Nyquist and Raised Cosine Pulses. Square-root Splitting of the Nyquist Pulse. Baseband M-ary, PAM systems. Optimum detection. Matched filters, correlation receivers.

Module IV (12 hours)

a. Digital Modulation- Binary communication, On-Off Keying and ASK, Frequency Shift Keying (FSK), Phase shift keying (PSK) and QPSK.
b. Detection of binary signals, Multi symbol signalling, Quadrature Amplitude Modulation (QAM). Introduction to Information theory and coding.

Suggested Readings

1. George Kennedy, “Electronic Communication Systems”, McGraw Hill.
2. Taub and Schilling, “Principles of Communication Systems”, TMH.
3. B.P. Lathi, “Modern Digital and Analog Communication Systems”, Oxford University press.
4. Roddy Coolen, “Communication Systems”, PHI.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1		H	M	
CO 2	H		M	
CO 3		M	H	
CO4			M	H

EESD0116: POWER SYSTEM DYNAMICS AND CONTROL

(3 Credits – 45 hours) (L-T-P: 3-0-0)

Course Outcomes

1. Define basic terminologies and problems related to power system dynamics. (Remembering)
2. Understand the problem of power system stability and its impact on the system. (Understanding)
3. Model different power system components for the study of stability. (Applying)
4. Analyse steady-state and transient power system dynamics and use numerical integration methods. (Analysing)
5. Explain the Angular stability analysis in Single Machine Infinite Bus System and in multi-machine systems, frequency and voltage stability, methods to improve stability. (Evaluating)

Objective

The objective of this course is to introduce the students to power stability problems and the basic concepts of modeling and analysis of dynamical systems. Modeling of power system components - generators, transmission lines, excitation and prime mover controllers - is covered in detail. Stability of single machine and multi-machine systems is analyzed using small-signal analysis techniques. The impact of stability problems on power system planning and operation is also brought out.

Module I: Introduction to Power System Operations (3 hours)
Introduction to power system stability. Introduction to Power System Control. Power system stability problem- basic concepts and definitions- rotor angle stability, voltage stability and voltage collapse, classification of stability. Design and operating criteria for stability.

Module II: Analysis of Power System Dynamics and Numerical Methods (5 hours)
Swing Equation. Analysis of Steady State. Analysis of Transient Stability. Equal Area Criterion. Analysis using Numerical Integration Techniques- Euler Method, Modified Euler method, Runge-Kutta method. Numerial approximation of solutions, A-Stabilty. Numerical stability of explicit integration methods, Stiffness in transient stability. Implicit integration methods.

Module III: Modeling of Synchronous Machines and Associated Controllers (12 hours)
Modeling of synchronous machine: Physical Characteristics. Rotor position dependent model. D-Q Transformation. Model with Standard Parameters. Steady State Analysis of Synchronous Machine. Short Circuit Transient Analysis of a Synchronous Machine. Synchronization of Synchronous Machine to an Infinite Bus. Modeling of Excitation and Prime Mover Systems. Physical Characteristics and Models. Excitation System Control. Automatic Voltage Regulator. Prime Mover Control Systems. Speed Governors.

Module IV: Modeling of other Power System Components (10 hours)
Modeling of Transmission Lines and Loads. Transmission Line Physical Characteristics. Transmission Line Modeling. Load Models - induction machine model. Frequency and Voltage Dependence of Loads. Other Subsystems – HVDC and FACTS controllers, Wind Energy Systems.

Module V: Stability Analysis (11 hours)
Angular stability analysis in Single Machine Infinite Bus System. Angular Stability in multi-machine systems – Intra-plant, Local and Inter-area modes. Frequency Stability: Centre of Inertia Motion. Load Sharing: Governor droop. Single Machine Load Bus System: Voltage Stability. Introduction to Torsional Oscillations and the SSR phenomenon. Stability Analysis Tools: Transient Stability Programs, Small Signal Analysis Programs.

Module VI: Enhancing System Stability (4 hours)
Planning Measures. Stabilizing Controllers (Power System Stabilizers). Operational Measures- Preventive Control. Emergency Control.

Suggested Readings

1. K. R. Padiyar, “Power System Dynamics, Stability and Control”, B. S. Publications, 2002.
2. P. Kundur, “Power System Stability and Control”, McGraw Hill, 1995.
3. P. Sauer and M. A. Pai, “Power System Dynamics and Stability”, Prentice Hall, 1997.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H	M				
CO 2		H	M		H	L
CO 3			H	H	L	
CO 4		H		M	H	
CO 5	M				H	H

EEEL0096: ELECTRICAL MACHINES
(3 Credits - 45 hours) (L-T-P: 3-0-0)

Course Outcomes
1. Explain principle of operation of various electrical machines. (Understanding)
2. Identify different types of dc and ac machines. (Applying)
3. Classify different types of dc and ac machines. (Analyzing)
4. Compare the performances in terms of losses, efficiency, and regulation of different types of dc and ac machines. (Evaluating)

Objective
This course on Electrical Machines, generally offered for students who do not major in Electrical Engineering, is an introductory course in electro-mechanical energy conversion devices. This course gives an introduction to DC as well as AC machines and transformers, to enable the students to use this knowledge for applying to situations arising in their disciplines.

Module I: D.C. Machines (15 hours)
Operating principle, generator & motor action, construction, types of excitation, emf & torque equations, power stages & efficiency. Commutation & Armature Reaction, characteristics & application of d.c generators, starting & speed control of d.c motors, characteristics & applications of d.c motors, electric braking.
Design of D.C Machines: Output equation, Main dimensions, Armature design, Armature windings, Design of commutator and brushes, Design of Field systems, Design of interpoles.

Module II: Transformers (10 hours)
Operating principle, classification, construction, emf equation, phasor diagrams, equivalent circuit model, losses & efficiency, voltage regulation, polarity test, autotransformers, three-phase transformer connections, & instrument transformers.

Module III: Induction Machines (10 hours)
Three-phase induction motors. Principle of operation, construction, types. Rotating magnetic field, emf equation of an AC Machine, torque developed in an induction motor, equivalent circuit model, torque-speed characteristics, starting & speed control. Single phase induction motors, starting, application.

Module IV: Synchronous Machines (10 hours)
Construction, types & operating principle of synchronous generator, A.C armature windings, equivalent circuit, phasor diagrams, voltage regulation, parallel operation, synchronization, Power Angle characteristics, effect of field excitation change. Synchronous Motor, principle, starting, hunting, damper windings. Special Purpose Motors: Stepper Motor, Universal Motor, shaded-pole Motor.

Suggested Readings
1. Fitzgerald, Kingslay and Umans, “Electric Machinery”, Tata McGraw-Hill.
2. Chapman, “Electric Machinery Fundamentals”, McGraw-Hill Higher Education.
3. Nagrath and Kothari, “Electric Machines”, Tata McGraw-Hill.
4. Guru and Hiziroglu, “Electric Machinery and Transformer, Oxford University press.
5. P.S. Bimbhra, “Electric Machinery”, Khanna Publishers.
6. Vincent Deltoro, “Basic Electric Machines”, Prentice Hall.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	H	H	H
CO 2	M	M	M	M
CO 3	M	M	M	M
CO 4	H	H	H	H

LABORATORY COURSES

BTIP13: INTERNSHIP SEMINAR
(3 Credits)

Course Outcomes
1. Relate theory and practical with real life examples. (Remembering)
2. Explain the engineering processes involved in the industry. (Understanding)
3. Identify the importance of learning the practical aspects of engineering education. (Applying)
4. Analyse application of the theory into the practical field. (Analysing)
5. Value the engineering education and its utility. (Evaluating)
6. Discuss the actual technological advancements in the industry. (Creating)

EEBL6027: BASIC ELECTRICAL ENGINEERING LABORATORY
(1 Credit- 30 hours) (L-T-P: 0-0-2)

Course Outcomes
1. Find different parameters related to basic electrical circuits. (Remembering)
2. Explain the procedure for performing experiments related to DC and AC circuits. (Understanding)
3. Identify various rotating AC and DC machines. (Applying)
4. Compare the theoretical prediction with experimental results. (Analyzing)
5. Check errors and correction of meters by calibration (Evaluating)
6. Construct a circuit to perform a particular experiment. (Creating)

List of experiments:
1. Calibration of a Voltmeter.
2. Calibration of an Ammeter.
3. Calibration of milliammeter as a voltmeter.
4. Calibration of a millivoltmeter as an ammeter.
5. Verification of Thevenin's theorem.
6. Resonance in series RLC circuit
7. Reversal of direction of rotation of 3-phase induction motor by changing phase sequence.
8. Different types of Connections of the transformer.
9. Demonstration of DC and AC machines.
10. Demonstration of LT switchgear.

Mapping of COs to Syllabus

Course Outcomes	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp 10
CO 1	H	H	H	H	H	H	H	H	H	H
CO 2	H	H	H	H	H	M	M	M	M	M
CO 3				L		L	L	L	L	L
CO 4	M	M	M	M	H	H	H	H	H	H
CO 5	H	H	H	H	L	L	L	L	L	L
CO 6	H	H	H	H	H	H	H	H	H	H

EEAE6028: ANALOG ELECTRONICS LAB
(1 Credit - 30 hours) (L-T-P: 0-0-2)

Course Outcomes
1. Explain the working principle and operate the various components used in the laboratory. (Understanding)
2. Identify different electronic components and devices. (Applying)
3. Experiment with various electronic components. (Applying)
4. Analyze the characteristics of various electronic components and circuits such as diodes, BJTs, FETs, Voltage Regulators, amplifiers and filters. (Analyzing)
5. Design various electronic circuits based on the requirement. (Creating)

Objective

This course aims to familiarize hands-on experiments on different circuits based on diodes, BJT, JFET etc. The course also aims to familiarize simple electronic amplifier designs, OpAmp configurations and wave generators.

List of experiments:
1. To study the Characteristics of a diode.
2. To Study the Characteristics of Zener Diodes.
3. Half-wave and Full-wave rectifiers.
4. Clamping and Clipping circuits.
5. Static Characteristics of a Bipolar Junction Transistor (CE Mode).
6. To Study The Characteristics of JFET.
7. Series voltage Regulator.
8. Design of amplifiers: Transistor amplifiers with and without feedback.
9. Inverting and non-inverting op-amps.
10. Op-amp linear applications: adders, subtractors.
11. Op-amp based active filters.
12. Square wave generators.

Suggested Readings

1. P. Horowitz and W. Hill, “The Art of Electronics”, Cambridge University Press, 1989.

Mapping of COs to Syllabus

Course Outcomes	Expt 1	Expt 2	Expt 3	Expt 4	Expt 5	Expt 6	Expt 7	Expt 8	Expt 9	Expt 10	Expt 11	Expt 12
CO 1	H	H	H	H	H	H	H	H	H	H	H	H
CO 2	M	M	M	M	M	M	M	M	M	M	M	M
CO 3		H				H						
CO 4		H	H			H						
CO 5										H	H	H

EEMC6029: ELECTRICAL MACHINES LAB-I
(1 Credits - 30 hours) (L-T-P: 0-0-2)

Course Outcomes
1. Select various dc machines and single-phase transformers for different applications. (Remembering)
2. Utilize different machines for different applications, e.g., speed control, voltage control, load tests etc. (Applying)
3. Evaluate efficiency, voltage regulation speed regulation of dc machines and single-phase transformers. (Evaluating)

List of experiments:
1. To obtain magnetization characteristics of a d.c. shunt generator
2. To obtain load characteristics of a d.c. compound generator –
   a. Cumulatively compounded
   b. Differentially compounded
3. To obtain load characteristics of a dc shunt generator
4. To obtain load characteristics of a dc series generator
5. To obtain efficiency of a dc shunt machine using Swinburn’s test
6. To perform Hopkinson’s test and determine losses and efficiency of DC machine
7. To obtain speed-torque characteristics of a dc shunt motor
8. To obtain speed control of dc shunt motor using-
   a. armature resistance control
   b. field control
9. To obtain speed control of dc separately excited motor using the Ward Leonard method
10. To study polarity and ratio test of single-phase transformers
11. To obtain efficiency and voltage regulation of a single-phase transformer by Sumpner’ s test

Mapping of COs to Syllabus

Course Outcomes	Expt.1	Expt.2	Expt.3	Expt.4	Expt.5	Expt.6	Expt.7	Expt.8	Expt.9	Expt.10	Expt.11
CO 1	H										
CO 2		H	M	H			H	H	H	H	H

CO 3					H	H					

EEDE6030: DIGITAL ELECTRONICS LAB

(1 Credit - 30 hours) (L-T-P: 0-0-2)

Course Outcomes

1. Demonstrate the truth table of various expressions and combinational circuits using logic gates. (Understanding)
2. Identify different components of digital electronics. (Applying)
3. Evaluate various combinational circuits such as adders, subtractors, comparators, multiplexers and de-multiplexers. (Evaluating)
4. Design various combinational circuits. (Creating)
5. Construct flips-flops counters and shift registers. (Creating)

Objective

This course will enable students to get practical experience in design, realization and verification of Demorgan's Theorem, SOP, POSforms. They will be able to realize Full/Parallel Adders, Subtractors, Multiplexer, Demultiplexers, Decoders , Flip-Flops, Shift registers and counters using logic gates.

List of Experiments:

1. To verify the truth tables of the basic logic gates.
2. To verify De-morgan's Theorem for 2 variables using universal gates.
3. To verify the sum-of product and product-of-sum expressions using universal gates.
4. To design and implement a Full Adder using basic logic gates.
5. To design and implement a Full subtractor using basic logic gates.
6. To design and implement 4-bit Parallel Adder/ subtractor using IC 7483.
7. To realize 4:1 Multiplexer using gates.
8. To realize 1:8 Demux and 3:8 Decoder using IC74138.
9. To realize the following flip-flops using NAND Gates. (a) Clocked SR Flip-Flop (b) JK Flip-Flop.
10. To realize the following shift registers using IC7474 (a) SISO (b) SIPO (c) PISO (d) PIPO.
11. To realize the Ring Counter and Johnson Counter using IC7476.
12. To realize the Mod-N Counter using IC7490.

Mapping of COs to Syllabus

Course Outcomes	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp 10	Exp 11	Exp 12
CO 1	H	H	H	M	M	M	L	L	L	L	L	L
CO 2	H	L	M	M	M	M	H	L	L	L	L	L
CO 3				H	H	H	H	H	H	H	H	H
CO 4			H	H	H	H						
CO 5									H	H	H	H

EEMS6031: ELECTRICAL MACHINES-II LAB

(1 Credit-30 hours) (L-T-P : 0-0-2)

Course Outcomes

1. Study the method of synchronization of alternators with the infinite bus. (Remembering)
2. Explain the procedure for performing experiments related to AC machines. (Understanding)
3. Combine the different components to perform a particular experiment on AC machines. (Creating)
4. Determine the characteristics of different types of AC machines and their performances. (Evaluating)

Objective

This course provides a basic understanding of different characteristics of AC machines, machine parts and helps to gain the skills for operating AC machines.

List of experiments:

1. To perform no load and blocked rotor tests on a three-phase squirrel cage induction motor and determine equivalent circuit.
2. To perform load test on a three-phase induction motor and draw:
   a. Torque -speed characteristics

   b. Power factor-line current characteristics
3. To perform no load and blocked rotor tests on a single phase induction motor and determine equivalent circuit.
4. To study speed control of three phase induction motor by keeping the V/f ratio constant.
5. To study speed control of three phase induction motor by varying supply voltage.
6. To perform open circuit and short circuit tests on a three-phase alternator and determine voltage regulation at full load and at unity, 0.8 lagging and leading power factors by (i) EMF method (ii) MMF method.
7. To determine V-curves and inverted V-curves of a three-phase synchronous motor.
8. To study synchronization of an alternator with the infinite bus by using: (i) dark lamp method (ii) two bright and one dark lamp method.
9. Scott connection of 3-phase transformer
10. Load test of 3-phase transformer

Mapping of COs to Syllabus

Course Outcomes	Experiment 1	Experiment 2	Experiment 3	Experiment 4	Experiment 5	Experiment 6	Experiment 7	Experiment 8	Experiment 9	Experiment 10
CO 1						M		H		
CO 2	M	M	M	M	M	M	M	M	M	M
CO 3	M	M	M	M	M	M	M	M	M	M
CO4		H				H	H			

EEPE6032: POWER ELECTRONICS LAB

(1 Credit –30 hours) (L-T-P : 0-0-2)

Course Outcomes
1. Define different power electronics components.(Remembering).
2. Construct various firing circuits of SCR.(Creating)
3. Determine the V-I characteristics of different types of power electronics switches. (Evaluating)
4. Design circuits for AC to DC, DC to DC and DC to AC conversions. (Creating)

Objective

The objective of the course is to Analyse the various characteristics of the power electronics devices, design and test various arrangements of power devices based rectifiers and inverters and choppers under power electronics systems.

List of Experiments:
1. Study of R, RC and UJT firing circuits.
2. Study UJT firing circuits.
3. Study of V-I characteristics of SCR.
4. Determination of Holding current and Latching current of SCR.
5. Single phase half-wave controlled rectifier
6. Single phase full-wave controlled bridge rectifier.
7. Study of V-I characteristics of MOSFET.
8. Study of UJT firing circuit.
9. Study of BUCK converter.
10. Study of BOOST converter.
11. Study of BUCK-BOOST converter.
12. Study of Single-phase square wave inverter.
13. Study of PWM inverter.

Suggested Readings
1. M.R. Rashid, Power Electronic Circuits, Devices and Applications, Third Edition, PHI.
2. N. Mohan, T.M. Underloned and W.P. Robbins, Power Electronic Converters, Applications and Design, John Wiley and Sons.

Mapping of COs to Syllabus

Course Outcomes	Expt. 1	Expt. 2	Expt. 3	Expt. 4	Expt. 5	Expt. 6	Expt. 7	Expt. 8	Expt. 9	Expt. 10	Expt. 11	Expt. 12	Expt. 13
CO 1	M	M	M	M	M	M	M	M					

CO 2									H	H	H	M	
CO 3		H	H				H	H					
CO 4					H	H					H	H	H

EESS6033: POWER SYSTEM STEADY STATE ANALYSIS LAB

(2 Credits - 60 hours) (L-T-P: 0-0-4)

Course Outcomes

1. Recall characteristics of IGBT and thyristor. (Remembering)
2. Demonstrate the knowledge of Y-bus and Z-bus formation. (Understanding)
3. Find various performance parameters of a power system by using given data. (Analyzing)
4. Develop program for economic dispatch problems of electrical energy. (Creating)

List of Experiments:

1. Simulation of IGBT Inverters
2. Simulation of Thyristor Converters
3. Transient Stability Studies
4. Short Circuit Studies
5. Evaluation of Z-Bus and Y-Bus
6. Economic Load Dispatch
7. Gauss Seidel Load Flow analysis
8. Newton Raphson Load Flow analysis
9. Load Forecasting and Unit Commitment

Suggested Readings

1. C.L. Wadhwa, Electrical Power systems, (5^{th} Edition) New Age International Publishers.
2. D.P. Kothari, I.J. Nagrath, Power System Engineering, Second edition, Tata McGraw Hill.

Mapping of COs to Experiments

Course Outcomes	Expt.1	Expt.2	Expt.3	Expt.4	Expt.5	Expt.6	Expt.7	Expt.8	Expt.9
CO 1	M	M							
CO 2			H	H					
CO 3					H		H	H	
CO 4						H			H

EERE6034: RENEWABLE ENERGY LAB

(2 Credits - 60 hours) (L-T-P: 0-0-4)

Course Outcomes

1. Identify the V-I characteristics of solar panels. (Applying)
2. Utilize the concepts of Solar Energy and Wind Energy conversion techniques in practical situations. (Applying)
3. Determine the power output from Solar and Wind Farms. (Evaluating)

List of Experiments:

1. Power Curves
2. Build a Wind Farm model.
3. Test the Capabilities of Solar PV array in partial shading condition.
4. Effect of Temperature on Solar Panel Output
5. Variables Affecting Solar Panel Output
6. Effect of Load on Solar Panel Output
7. Wind Turbine Output: The Effect of Load
8. Test the Capabilities of Solar Panels and Wind Turbines

Mapping of COs to Syllabus

Course Outcomes	Expt. 1	Expt. 2	Expt. 3	Expt. 4	Expt. 5	Expt. 6	Expt. 7	Expt. 8
CO 1	H							
CO 2		H	M	H			H	H
CO 3					H	H		

EECT6035: CONTROL LAB 1

(2 Credits - 60 hours) (L-T-P: 0-0-4)

Course Outcomes

1. Name the MATLAB commands associated with a robust control system. (Remembering)
2. Model common non-linearities used in control systems. (Applying)
3. Model and analyse digital control system. (Applying)
4. Design and simulate control system models. (Creating)

List of experiments:

1. Design and simulation of Linearised models using MATLAB/PSPICE.
2. Simulation and analysis of State space models for continuous time and discrete time systems using MATLAB/PSPICE.
3. Design and Simulation of LTI models of Feedback Control System using MATLAB/PSPICE.
4. Simulation and analysis of Digital Control System using MATLAB/PSPICE.
5. Simulation and Stability analysis of control systems with common nonlinearities using MATLAB/PSPICE.
6. Familiarization and use of the MATLAB command associated with Robust Control Systems.
7. Familiarization and use of PSIM software.

EECL6036: CONTROL LAB 2

(2 Credits - 60 hours) (L-T-P: 0-0-4)

Course Outcomes

1. Compare position, velocity, and adaptive control. (Understanding)
2. Explain adaptive control system (understanding)
3. Explain analog and digital servo system. (Understanding)
4. Construct PLC based system.(Creating)
5. Design ladder logic for PLC. (Creating)

List of experiments:

1. Designing of Ladder logic for various practical applications.
2. Execution of the Ladders using PLC's.
3. Study of Analog and Digital Servo Systems.
4. Experiment on Position Control System.
5. Experiment on Velocity Control System.
6. Experiment on Adaptive Control System.
7. Experiment on Nonlinear Control Systems.

EEPL6037: POWER SYSTEM PROTECTION LAB

(2 Credits) (L-T-P: 0-0-4)

Course Outcomes

1. Show the ability to propose models for radial and parallel feeder protection. (Remembering)
2. Demonstrate applications of practical power system protection schemes. (Understanding)
3. Apply the knowledge of different types of relays components in practical power system applications. (Applying)
4. Examine the performance characteristics of relays in equipment protection. (Analyzing)
5. Evaluate fault currents due to different types of faults in a network. (Evaluating)

List of experiments (any 8):

1. Introduction to Power System Protection
2. Evaluate fault currents due to different types of faults in a network
3. Over Current Relay (OCR) Testing System - To Plot IDMT Characteristics of OCR
4. Over Current Relay Testing System - To Perform Experiment on Definite/ Instantaneous Mode Setting of the relay.
5. Characteristics of a Differential Relay - To Plot Characteristics of % Biased Differential Relay (Merz-Price Method).
6. Pick-up Test for Differential Relay
7. Transformer Differential Protection Testing - For Transformer In-Zone Trips Fault
8. Transformer Differential Protection Testing - For Transformer Out-Zone or Non-Trip Faults
9. Principle of Reverse Power Protection

10. Concept of Radial Feeder Protection
11. Concept of Parallel Feeder Protection

Mapping of COs to Syllabus

Course Outcomes	Exp.1	Exp. 2	Exp.3	Exp.4	Exp.5	Exp.6	Exp.7	Exp.8	Exp.9	Exp.10	Exp.11
CO 1	H	H				M			M	H	H
CO 2	L	L	H	H			H	H			
CO 3			H	M	H	M			H	H	H
CO 4			H	M	H	H			L		
CO 5	L	H	H			H	H				

EEPA6038: POWER ELECTRONICS APPLICATION TO POWER SYSTEM LABORATORY

(2 Credits - 30 hours) (L-T-P: 0-0-4)

Course Outcomes

1. Identify the suitable power electronic devices for designing different power electronic converters. (Applying)
2. Examine the performance characteristics of different types of FACTS devices. (Analyzing)
3. Experiment with various power electronic circuits used in power system applications. (Evaluating)
4. Design different types of power electronic converters. (Creating)

List of Experiments:

Any ten experiments will be performed

1. Three phase fully controlled rectifier
2. Multi-level inverters
3. Active power filters
4. Non-isolated DC- DC converter
5. Characteristic of SVC
6. Characteristic of STATCOM
7. Characteristic of TCSC
8. Improvement of power quality using shunt compensation
9. Improvement of power quality using series compensation
10. Solar power integration to grid
11. Vector control of inverter

Suggested Readings

1. N. G. Hingorani and L. Gyugyi, “Understanding FACTS: Concepts and Technology of FACTS Systems”, Wiley-IEEE Press, 1999.
2. M.R. Rashid, Power Electronic Circuits, Devices and Applications, Third Edition, PHI.

Mapping of COs to Experiments

Course Outcomes	Expt.1	Expt.2	Expt.3	Expt.4	Expt.5	Expt.6	Expt.7	Expt.8	Expt.9	Expt.10	Expt.11
CO 1	H	H	H	H							
CO 2					H	H	H	L	L		L
CO 3	M	M	M								
CO 4	H	H		M						L	

EEAL6039: ADVANCED CONTROL LAB 1

(2 Credits - 60 hours) (L-T-P: 0-0-4)

Course Outcomes

1. Analyse non-linear systems. (Analysing)
2. Examine responses of discrete time systems from state space modeling. (Analysing)
3. Design and simulate pole placement design for regulator. (Creating)
4. Design and simulate discrete control system models. (Creating)

List of experiments:

1. State space modelling of discrete time systems and study of responses.
2. Pole placement design for regulator and tracking discrete time systems.

3. Observer design for discrete time systems.
4. Design of digital Kalman filter.
5. Optimal control design of digital systems.
6. Analysis of non-linear systems using describing function methods.
7. Phase plane analysis of nonlinear systems.

EEAC6040: ADVANCED CONTROL LAB 2

(2 Credits - 60 hours) (L-T-P: 0-0-4)

Course Outcomes

1. Demonstrate the position control of DC servomotor with P, PI control actions. (Understanding)
2. Determine Magnetic Amplifier Characteristics with different possible connections.(Evaluating)
3. Measure the AC servo motor characteristics. (Evaluating)
4. Determine the time response of a closed-loop second-order process with P Control, PI and PID control. (Evaluating)
5. Design compensation systems using lead, lag and lead-lag compensator. (Creating)

List of experiments:

1. Characteristics of Synchros: (a) Synchro transmitter characteristics (b) Implementation of error detector using synchro pair.
2. Determination of Magnetic Amplifier Characteristics with different possible connections.
3. To determine the time response of a closed-loop second-order process with P Control, PI Control and PID control and to determine the effect of disturbance on a process.
4. To study the compensation of the second order process by using: (a) Lead Compensator (b) Lag Compensator (c) Lead-Lag Compensator.
5. To determine AC servo motor characteristics.
6. To study the position control of DC servomotor with P, PI control actions

EEMP6041: MINI PROJECT (M.Tech)

(2 Credits - 60 hours) (L-T-P: 0-0-4)

Course Outcomes

1. Apply practical knowledge within the chosen area of technology for project development. (Applying)
2. Demonstrate the skills to carry out research work independently. (Understanding)
3. Plan for executing projects with a comprehensive and systematic approach. (Applying)
4. Take part in development of technical projects as an individual or in a team. (Analyzing)
5. Develop effective communication skills for presentation of project related activities. (Creating)

Process:

1. Literature Review
2. Synopsis Presentation
3. Progress Presentation
4. Hardware/Software Project Execution
5. Final Presentation and Demonstration of the Project

EEMM6042: MICROPROCESSOR AND MICROCONTROLLER LAB

(1 Credits - 30 hours) (L-T-P: 0-0-2)

Course Outcomes

1. Demonstrate the usage of Keil software in writing, compiling and debugging 8051 programs (Understanding)
2. Make use of the 8051 assembly language instructions to write programs for a given problem. (Applying)
3. Examine the output of each line of an 8051 program code. (Analysing)

List of Experiments

1. Interfacing of 8051 development kit to PC and programmer.
2. Data transfer operation from registers and internal data memory.
3. Addition and subtraction of two 8 bit numbers.
4. Addition of two 16-bit numbers.

5. Addition of an array of 8-bit numbers.
6. Subtraction of two 16-bit numbers.
7. Multiplication and division of two 8-bit numbers.
8. Multiplication of two 16-bit numbers.
9. Interfacing of LEDs and Switches.
10. Interfacing of seven segment displays.
11. Interfacing of 16 x 2 LCD.
12. Interfacing of ADC.

Mapping of COs to Syllabus

Course Outcomes	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp 10	Exp 11	Exp 12
CO 1	H											
CO 2		H	H	H	H	H	H	H	H	H	H	H
CO 3		H	H	H	H	H	H	H	M	M	M	M

EERS6043: POWER SYSTEMS LABORATORY-I

(1 Credit: 30 hours) (L-T-P: 0-0-2)

Course Outcomes

1. Recall the basic concept of programming language. (Remembering)
2. Demonstrate the ability to model and simulate the compensation techniques in transmission line. (Understanding)
3. Develop simple model for power system protection. (Applying)
4. Find various performance parameters of a power system by using given data. (Analyzing)
5. Experiments with Solar PV cell and formulate the I-V and P-V characteristics of PV panels. (Evaluating)

Objective

This course is the stepping-stone to make students understand how to model and analyze the power system under steady state operating condition, under faulted conditions and the transient behavior of power system whenever it is subjected to a fault.

List of Experiments:

1. Introduction to simulation software.
2. To Study the Ferranti Effect of a transmission line/cable.
3. Reactive power compensation (capacitive/ inductive)
4. Computation of inductance for overhead transmission line.
5. Computation of capacitance for overhead transmission line.
6. Fault current calculation for single line to ground fault.
7. Computation of power from solar generation.
8. To Study the over-current relay and the effect of PSM and TSM.
9. To study the differential Protection of a three-phase delta-delta connected transformer.

Suggested Readings

1. C.L. Wadhwa, “Electrical Power systems”, 5th Edition, New Age International Publishers.
2. D.P. Kothari, I.J. Nagrath, “Power System Engineering”, Second edition, Tata McGraw Hill.
3. V.K Mehta, Rohit Mehta, “Principles of Power Systems”, S. Chand.
4. Ashfaq Husain, “Electrical Power systems”, 5th Edition, CBS Publishers.
5. R. Gupta, “Generation of Electrical Energy”, S. Chand & Co. Ltd. N. Delhi
6. Leon Freris, David Infield, “Renewable Energy in Power Systems”, Wiley, A John Wiley & Sons, Ltd, Publication, 2012.

Mapping of COs to Experiments

Course Outcomes	Expt.1	Expt.2	Expt.3	Expt.4	Expt.5	Expt.6	Expt.7	Expt.8	Expt.9
CO 1	H	H	L						
CO 2			H						
CO 3								H	H
CO 4				H	H	H			
CO 5							H		

EECS6044: CONTROL SYSTEMS LABORATORY

(1 Credit - 30 hours) (L-T-P: 0-0-2)

Course Outcomes
1. Recall different SciLab functions used in control system analysis. (Remembering)
2. Understand and simulate the transfer function of a system. (Understanding)
3. Develop SciLab code for control system analysis. (Applying)
4. Analyse stability of system with pole-zero map. (Analyzing)
5. Determine the transient and steady-state of a system. (Evaluating)

Objective
This course aims to familiarize different concepts of control systems with SciLab simulations.

List of experiments:
Part I:
Basics of Scilab
Introduction to SciLab: variables, loop, functions etc.
Matrix operations
Plotting
Introduction to Xcos
Part II:
Concepts of control systems simulation with Scilab
(Any seven experiments from the following list)
To study transfer function of first order and second order systems with SciLab simulations.
To Study the block diagram reduction techniques with SciLab simulations.
To Study the pole-zero plotting with SciLab simulations.
To Study the time-response of a first order system with SciLab simulations.
To Study the time-response of a second order system with SciLab simulations.
To Study the Bode diagram of different systems with SciLab simulations.
To Study the Nyquist diagram of different systems with SciLab simulations.
Transfer function to state-space and state-space to transfer conversion with SciLab simulations.
Speed control of a DC motor with SciLab simulations.

Mapping of COs to Syllabus

Course Outcomes	Expt 1	Expt 2	Expt 3	Expt 4	Expt 5	Expt 6	Expt 7	Expt 8	Expt 9
CO 1	H	H	H	H	H	H	H	H	H
CO 2	H	H						H	
CO 3			H	H	H				
CO 4			H						
CO 5				H	H				

EEMI6045: MINI PROJECT-I
(1 Credit)

Course Outcomes
1. Use different components to make the circuits used in the projects. (Applying)
2. Examine a designed circuit for expected output. (Analyzing)
3. Experiment with the designed circuits for the expected results. (Evaluating)
4. Design circuits to obtain desired output. (Creating)

EEPS6046: POWER SYSTEMS LABORATORY-II
(1 Credits -30 hours) (L-T-P: 0-0-2)

Course Outcomes
1. Find Y-bus parameters. (Remembering)
2. Apply knowledge of Y- bus matrix for load flow problem. (Applying)
3. Analyze load-frequency control in Power System. (Analysing)
4. Compare performance of series and shunt compensation. (Evaluating)

Experiments
1. Formation of Y-bus matrix using programming language.

2. Load flow analysis using Gauss seidel Method.
3. Load flow analysis using Newton Raphson Method.
4. Series compensation.
5. Shunt compensation.
6. Automatic Load Frequency control.
7. Automatic Voltage Regulator.
8. Contingency analysis of the power system.
9. Application of various numerical methods for power system analysis.
10. Generation of V-I and V-P characteristics of Solar PV Power Plant.

Mapping of COs to Syllabus

Course Outcomes	Expt.1	Expt.2	Expt.3	Expt.4	Expt.5	Expt.6	Expt.7	Expt.8	Expt.9	Expt.10
CO 1	H									
CO 2		H	M	H			H	H	H	H
CO 3					M	H	M			
CO 4					H	H				

EEMI6047: MEASUREMENTS AND INSTRUMENTATION LAB

(1 Credits - 30 hours) (L-T-P: 0-0-2)

Course Outcomes

At the end of the course, students will be able to

1. Select the electrical measuring instruments for determining a particular electrical parameter. (Remembering)
2. Make use of statistical data analysis and computerized data analysis to determine an unknown electrical parameter. (Applying)
3. Decide the best methods to determine an electrical parameter. (Evaluating)

List of Experiments:

1. Measurement of a batch of resistors and estimating statistical parameters.
2. Measurement of L using a bridge technique as well as LCR meter.
3. Measurement of C using a bridge technique as well as LCR meter.
4. Measurement of High resistance and Insulation resistance using Megger.
5. Usage of DSO for steady state periodic waveforms produced by a function generator.
6. Download of one-cycle data of a periodic waveform from a DSO and use values to compute the RMS values using a C program.
7. Usage of DSO to capture transients like a step change in R-L-C circuit.
8. Current Measurement using Shunt, CT, and Hall Sensor
9. Measurement of medium resistance using Wheatstone’s bridge.
10. Measurement of three-phase real power using two wattmeter method.
11. Measurement of three-phase reactive power using two wattmeter method.
12. Study of smart energy meter.
13. Measurement of earth resistance using earth tester megger

Mapping of COs to Syllabus

Course Outcomes	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp 10	Exp 11	Exp 12	Exp 13
CO 1	H	H	H	H	L	L	L	L	H	H	H	L	L
CO 2	H	H	H	H	M	M	M	L	H	H	H	L	M
CO 3	H	H	H	H	M	M	M	H	H	H	H	H	H

EEED6055: ELECTRONIC DESIGN LABORATORY

(3 Credits - 45 hours) (L-T-P: 1-0-4)

Course Outcomes

1. Recall the basic concepts of electrical and electronics measurements. (Remembering)
2. Classify various OpAmp based amplifiers. (Understanding)
3. Estimate the output of different electronic components used in the electronic system design. (Evaluating)
4. Create an electronic system. (Creating)

Objective

This course aims to familiarize the students with the concepts of practical measurement and instrumentation system. The course enables one to understand the concept of data acquisition with popular development boards such as Arduino. At the end of the course, students should be able to design basic electronic systems.

Theory: Electronics Design Concepts (15 hours)

Basic concepts on measurements; Noise in electronic systems; Sensors and signal conditioning circuits; Introduction to electronic instrumentation and PC based data acquisition; Electronic system design, Analog system design. Interfacing of analog and digital systems, Embedded systems, Electronic system design employing microcontrollers, CPLDs, and FPGAs, PCB design and layout; System assembly considerations.

List of Experiments:

1. To study different temperature sensors.
2. Study of OpAmp based amplifiers.
3. Study of instrumentation amplifier.
4. Study of Arduino microcontroller development board for designing of embedded systems.
5. Data acquisition using Arduino microcontroller development board.
6. Group projects involving various electronic hardware.

Suggested Readings

1. A. S. Sedra and K. C. Smith, “Microelectronic circuits”, Oxford University Press, 2007.
2. 2 P. Horowitz and W. Hill, “The Art of Electronics”, Cambridge University Press, 1997.
3. H.W. Ott, “Noise Reduction Techniques in Electronic Systems”, Wiley, 1989.
4. W.C. Bosshart, “Printed Circuit Boards: Design and Technology”, Tata McGraw Hill, 1983.
5. G.L. Ginsberg, “Printed Circuit Design”, McGraw Hill, 1991.

Mapping of COs to Syllabus

Course Outcomes	Experiment1	Experiment 2	Experiment 3	Experiment 4	Experiment 5	Experiment 6
CO 1	H	M				
CO 2			M		H	
CO 2			M		H	
CO 3				L	H	

EEMI6049: MINI PROJECT-II

Course Outcomes

1. Recall the benefits of using microcontrollers and microprocessors in circuits. (Remembering)
2. Identify suitable controllers and processors among the different controllers and processors available for their work. (Applying)
3. Compare the difference between the circuits using controllers and those not using it. (Analysing)
4. Construct a fully automotive circuit depending upon their requirement. (Creating)

EEDI6050: DISSERTATION PHASE-I

(10 Credits) (L-T-P : 0-0-20)

Course Outcomes

1. Select a project of interest. (Remembering)
2. Defend the topic of interest for continuing work, by doing initial studies on it. (Understanding)
3. Prepare a working methodology for the project for its successful completion. (Applying)
4. Design and experiment on the selected project. (Analysing)
5. Devise tools and methods for experimenting and troubleshooting for getting expected outcomes. (Evaluating)
6. Explain, justify and defend the project work by presenting the work and writing a report. (Creating)

Objective

During this Phase-I of the M.Tech dissertation, the student will start a research project, applying the knowledge acquired during the first two semesters and also incorporating the recent trends in the chosen area. It should include phases of design, implementation and reporting. This project is to be executed individually within or outside the campus. The mode and components of evaluation and the weightage attached to them shall be published by the department/Institute at the beginning of the semester. At least one review paper is expected to be published by the student in this phase.

EEDI6051: DISSERTATION PHASE–II

(16 Credits) (L-T-P: 0-0-32)

Course Outcomes

1. Define the problem encountered in Phase-I and find suitable methodology to be adopted for the project work. (Remembering)
2. Classify the whole project work in various modules and explain the working model of the proposed work by demonstrating the different modules. (Understanding)
3. Apply mathematical skills to learn how these skills are important in engineering and construct software implementation skills and design skills especially from a systems perspective. (Applying)
4. Analyse the advanced electrical power or control systems and different problems encountered in designing a system. (Analysing)
5. Evaluate the complete system and perceive future scopes of the work carried out. (Evaluating)
6. Elaborate the performance of the work done, contrast on limitations of the system designed. and compile a technical report on the project (Creating)

Objective

During the Phase-II of M.Tech dissertation, the student will carry forward and complete the work that they have started in Phase-I. It is required that the student will publish at least one research paper in a well-known reputed journal to augment their work during this phase. Published papers will carry extra weightage during evaluation. The mode and components of evaluation and the weightage attached to them shall be published by the department at the beginning of the semester.

EEMP6053: MAJOR PROJECT PHASE-I

(1 Credit)

Course Outcomes

1. Find different areas of research in the field of electrical engineering. (Remembering)
2. Explain the importance of research in the chosen topic of interest. (Understanding)
3. Apply theoretical knowledge to find out an appropriate topic of importance for research in the undergraduate level. (Application)
4. Analyse research work of technological importance published in various reputed national and international journals. (Analysing)
5. Decide on a research problem and objective of research to be carried out within a semester. (Evaluating)
6. Compile the part of project work completed this semester. (Creating)

During the last year of their study, B. Tech. students are required to take up a major project. This may be an individual project or a group project. The Major Project is an integral learning experience that encourages students to break away from the compartmentalization of the different courses they have studied during the three years of their study and aims to provide opportunities to explore the interrelationships and interconnectedness of the various courses and gather them together into a single learning experience.

The major project focuses upon the following:

a. Interdisciplinary: The major project provides a platform for students to apply the knowledge and skills acquired from different courses.
b. Collaboration: It encourages students to work in groups over an extended period of time. They clarify the task, plan their work, share the responsibilities and work towards the successful completion of the project.
c. Process and Product: Project work focuses on both process and product. The process would include collaboration, gathering and processing of information. The product may take the form of a working model, a complete software package, etc.
d. Written and Oral presentation: Project work provides students with opportunities to present their findings as a written thesis in a prescribed format and orally with an intended audience and purpose in mind.

During the first phase in the seventh semester, students are expected to choose the project, prepare a synopsis under the guidance of a project supervisor appointed by the department, present the synopsis to the committee set up for the purpose, get approval for the synopsis and start the project work. Students are expected to submit weekly activity reports and present a progress seminar during this phase. They will also undergo a viva voce examination, in which they will be examined on all the basic areas of the discipline in which they have chosen their project.

a. E-resource for learning
b. LaTeX, www.spoken-tutorial.org

EEMP6054: MAJOR PROJECT (PHASE II) AND VIVA VOCE

(3 Credits)

During the second phase, students are expected to focus on the process and completion of the projects and prepare project reports under the guidance of the Supervisors. The internal assessments shall be evaluated by the DPEC and the external assessment shall be done by the external examiner(s) assisted by the DPEC and the supervisor. The modality and components of the internal assessment and their weightages shall be notified at the beginning of each semester. The External assessment shall have the following components:

Project Implementation:	40 marks
Seminar presentation:	20 marks
Viva voce examination:	20 marks
Project documentation:	20 marks

Course Outcomes

1. Show different stages of project work for the selected topic. (Remembering)
2. Summarize the contribution of the project to the benefit of the society. (Understanding)
3. Make use of observations, experimental and theoretical findings for establishing a conclusion. (Applying)
4. Analyse the observations and results obtained during the project work. (Analysing)
5. Evaluate the results obtained from the project work. (Evaluating)
6. Compile a technical report on the project work. (Creating)

VALUE ADDED COURSES

EEAL0113: AUTOCAD ELECTRICAL

(2 Credits: 30 hours) (L-T-P : 0-1-2)

Course Outcomes

1. Demonstrate methods of customizing AutoCAD Electrical symbols, circuits, and databases, title block linking, reporting tools, templates, and project files. (Understanding)
2. Build schematic drawings such as ladder logic and single wire and multi wire circuits, panel drawings, and PLC-I/O circuits using automated commands for symbol insertion, component tagging, wire numbering, and drawing modification. (Creating)

Objective

The main objective of this course is to learn how to use the powerful electrical drawing creation tools in the AutoCAD Electrical software.

Module I: Introduction to auto CAD Electrical (6 hours)

Introduction to Electrical CAD interface, Electrical Components and wires, Design methodologies,Project files, Accessing project files,Add a drawing to a project file, managing drawings in a project, Project manager Drawing list.

Module II: Schematic I and schematic II (6 hours)

a. schematic I: Single wires/ Components, Referencing, Ladders, Insert wires, Edit wires, 3 phase components,Source and destination Signal Arrows, Insert component, parent/child components
b. Schematic II: Multiwire and circuits, Dashed Link Lines, 3 Phase Ladders.

Module III Editing Commands and panel drawings (6 hours)

a. Editing commands: Edit Component, Updating Drawings, Scoot & Align, Move & Copy Component, Delete & Surfer Component, Copy Catalogue Assignment, Copy Installation/Location Code Values, Attribute Editing Commands:
b. Insert Footprint and component, Edit footprint, Assign Item numbers, Add balloons.

Module IV: Terminals and Point-to-Point Wiring Drawings (6 hours)

a. Terminals: Insert Terminal Symbols, Multiple Level Terminals, Multiple Insert Component command, insert jumpers, Terminal Strip Editor, DIN Rail Command.
b. Point-to-Point Wiring Drawings: Insert & Edit Connectors, Insert Splices, Insert Multiple Wires, Bend Wires.

Module V: Symbol creation (6 hours)

Schematic Symbols, Naming Convention, Icon Menu Wizard, AutoCAD Electrical Databases, Project & Catalog Databases, Footprint Lookup Database, Insert PLC, Insert Individual PLC I/O Points.

Suggested Readings:

1. James D. Bethune, “Engineering Graphics with AutoCAD 2020”, Macromedia Press.
2. Gaurav Verma and Matt Weber, “AutoCAD Electrical 2021 Black Book”, 6th Edition, Cadcamcae Works.
3. Sham Tickoo, “AutoCAD Electrical 2021: A Tutorial Approach”, 2nd Edition, CADCIM Technologies.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module v
CO 1	H	M	M	M	H
CO 2		H	M	M	

EEAR0112: INTRODUCTION TO ARDUINO AND RASPBERRY PI

(2 Credits - 30 hours) (L-T-P:0-1-2)

Course Outcomes

1. List the different I/O pins available on the Arduino and Raspberry Pi. (Remembering)
2. Execute software programs on Arduino and Raspberry Pi. (Applying)

Module I : Introduction to Arduino (15 hours)

Introduction to Arduino, Arduino boards and their specification, Arduino integrated development environment, Arduino UNO development board, Programming the Arduino boards, Interfacing LEDs, Interfacing switches, interfacing LCDs, Serial communication, Interfacing analog sensors, PWM control, DC motor interfacing, Servo motor interfacing, Stepper motor interfacing. Circuit design, programming, testing and debugging.

Module II: Introduction to the Raspberry Pi (15 hours)
Introduction to the Raspberry Pi: Features, GPIO. Linux System Administration: Overview, Files & Process, Directories, Basic commands etc. Some common Troubleshooting, Network configuration: interfaces, Configuring the Raspberry Pi: config.txt, cmdline.txt. Pi as Media Centre, Web Server etc.Introduction to python: IDLE, variables, input, loop, installing GPIO library. Hardware hacking, Pi with Arduino, IOT etc.

Suggested Readings:
1. Arduino Programming: Step-by-step guide to mastering arduino hardware and software by Mark Torvalds
2. Raspberry Pi User Guide by Gareth Halfacree and Eben Upton

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II
CO 1	H	H
CO 2	H	H

EEEL0114: ELECTRICAL WIRING
(2 Credits - 30 hours) (L-T-P: 0-1-2)

Course Outcomes
1. Define and explain the difference between direct current and alternating current. (Remembering)
2. Describe conditions likely to affect severity of electrical shock while maintaining safety during installation. (Remembering)
3. Demonstrate the different conductor systems used in residential and light commercial wiring in accordance with the codes and authorities for installation. (Applying)
4. Analyze the essential tools for residential wiring and be able to discuss the basic principles of tool-use and care. (Analysing)

Objective
To improve student electrical wiring skills through systematic training to enable students to create and test different electrical circuits using suitable electrical equipment, wires, protective devices and wiring accessories.

Module I: Basic Electrical Circuits (9 hours)
Measurement of Electrical quantities like Voltage, Currents, Resistance, Impedance, power factor and energy, Various Electrical Symbols, Electricity conductor, insulator, and resistance, Single-phase & three-phase circuits, Serial connection-diagram, Series and Direct Board-different types.

Module II: Different types of electrical wiring / installations (12 hours)
Two-way switch-wiring, 3-phase wiring, Overhead service connection, Definition and testing procedure of voltage current power MCB and bus bars, Earthing Connection – Different earthing systems.

Module III: Fundamentals of electricity-safety measures and precautions, first aid/Tools and equipment (12 hours)
Safely handling Tools & Equipment /Fire Fighting and use of fire extinguishers, Fires in electrical Circuits & Precautions, General Safety of Tools & equipment, Measuring tools, wire gauges etc. Classification, Identification of the electrical equipment cables, wires and electrical accessories.

Module IV: House Wiring Practical (12 hours)
House Wiring by PVC Casing Capping including Testing, House Wiring by PVC Rigid Pipe including Testing, Industrial Wiring by MS Pipe Including Testing, Measurement of Earth Resistance by Earth Tester, Common Faults in AC & DC Fans, Regulators and Remedies.

Suggested Readings
1. J.B. Gupta, “A Course in Electrical Installation Estimating and Costing”, S.K. Kataria & Sons.
2. S.L. Uppal and G.C. Garg, “Electrical Wiring Estimating & Costing”, Khanna Publishers.
3. Satheesh Kumar, “Electrical Wiring: An Introduction”, Ane Books Pvt. Ltd.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H	L	

CO 2	L	L	H
CO 3	M	H	L
CO 4	M	M	H

EEPY0115: PYTHON FOR ELECTRICAL ENGINEERING

(2 Credits: 30 hours) (L-T-P: 0-1-2)

Course Outcomes

1. Simulate Electrical Systems using Python. (Applying)
2. Evaluate the performance of new Electrical designs using Python. (Evaluating)
3. Construct Electrical systems using Python. (Creating)

Objective

The objective of this course is to familiarize the students with the Python Programming environment and its various applications in simulating Electrical Systems. The course will be a combination of tutorial and practical classes, focusing on hands-on exercises to be done by the students using Python and its various modules.

Module I: Introduction to Python (8 hours)

Python Packages, Anaconda, Python Editors, Resources, Installing Python. Python IDE, Python Shell, Running Python from the Console, Scripting Mode. Basic Python Program, Variables, Built-in Functions, Python Standard Library, Using Python Libraries, Packages and Modules, Plotting in Python.

Module II: Python Programming (6 hours)

Loops in Python programming, Creating Functions in Python, Creating Classes in Python, Creating Python Modules, File Handling in Python, Error Handling in Python, Debugging in Python, Installing and using Python Packages.

Module III: Python for Mathematics Applications (6 hours)

Mathematics in Python, Linear Algebra in Python, Complex Numbers in Python, Differential Equations, Optimization. Using Python for Simulations, Differential Equations, Discrete Systems, Real-Time Simulations.

Module IV: Python for Electrical Engineering Applications (10 hours)

Numerical Methods using Python, Numerical integration, Solving ordinary differential equations, Root finding, Interpolation, Curve fitting, Fourier transforms.

Python used for Control Applications, Transfer Functions, State Space Models, Frequency Response, Stability Analysis.

Applications of Python in- Electromagnetics, Circuit Analysis, Electrical Power Systems, Power Electronics, Signal Processing, Electrical System Modeling and Simulation.

Suggested Readings

1. Hans-Petter Halvorsen, “Python”. Available: https://www.halvorsen.blog/documents/programming/python/python.php
2. Hans-Petter Halvorsen, “Python for Science and Engineering”, 2019. Available: https://www.halvorsen.blog/documents/programming/python/resources/Python%20for%20Science%20and%20Engineering.pdf
3. Hans-Petter Halvorsen, “Python for Science and Engineering- YouTube Video playlist”.Available:https://www.youtube.com/playlist?list=PLdb-TcK6Aqj2hlH55Bn5oxFIvyoVbXxQS
4. Hans-Petter Halvorsen, “Python for Control Engineering”, 2020, Available: https://www.halvorsen.blog/documents/programming/python/resources/Python%20for%20Control%20Engineering.pdf
5. Hans-Petter Halvorsen, “Python for Control Engineering- YouTube Video Playlist”, Available:https://www.youtube.com/playlist?list=PLdb-TcK6Aqj1Kg6pV3zlrpUnPIRwG2_Ox
6. Hans Fangohr, ‘Introduction to Python for Computational Science and Engineering”,2018.Available: https://fangohr.github.io/python/book/Introduction-to-Python-for-Computational-Science-and-Engineering.pdf

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	M	M		H
CO 2			M	H
CO 3		M	L	H

EESL0200: SERVICE LEARNING

(2 Credits – 30 hours)

Course Outcomes

1. Define and explain the understanding of Community-University Engagement (CUE) and outline CUE in relation to higher education policy in India. (Remembering)
2. Analyze and identify the social responsibility of higher education institutions to facilitate engaged teaching, research & service. (Analyzing)
3. Determine the various methods and tools on Community-Based Participatory Research (CBPR). (Evaluating)
4. Evaluate how Higher education institutions can undertake community engagement post COVID-19. (Evaluating)
5. Design a plan for the engagement of students with the community through engaged teaching, research and service. (Creating)

Objective

The objective of this course is to understand the theory and practice of community university engagement. The students provide an insight on the theme of Social Responsibility of Higher Education Institution (HEI) and to introduce community based participatory research and the tools to facilitate engaged research.

Module I: Community University Engagement (CUE) (6 Hours)

History of Community University Engagement (CUE) in Indian Higher Education Policy, Fostering Social Responsibility by Higher Education: COVID-19 and Beyond, Current status and possible interventions, Recent initiatives, Principles of community engagement,

Module II: Social Responsibility of HEIs (5 Hours)

Understanding Social Responsibility of HEIs – Engaged Teaching, Research & Service, Community Engaged teaching and research, Community based participatory research, practice based learning, Community service, Effective Methods and Tools for Engaging Community in Research

Module III: Community Engagement through Electrical and Electronics Engineering (19 Hours)

Power sector scenario including generation, transmission, and distribution scenario of India, Duties and responsibilities of Assistant Electricity Meter Reader, Billing and cash collector and their career progression, Develop circuit and wiring diagram and electrical signage, code specifications to plan wiring layouts, consumption points accurately, as may be required, Standard location of service line connection, layout of main switch, circuit breakers required at main board, Install the protective device i.e.ratings as per the load, Replacement of damaged switches, MCB, fan- capacitor, regulator, lighting points i.e. holder, choke, starters, water coolers and their pump & motor, Operate principle of single phase motor, various types of motors like self start, capacitor start, capacitor run, universal motors and their applications and functions of condenser, Earth testing, Build a wind farm model, Application of drone technology in agriculture, search and rescue, wildlife tracking etc.

Suggested Readings

1. W. James Jacob, Stewart E. Sutin, John C. Weidman, John L. Yeager, “Community Engagement in Higher Education: Policy Reforms and Practice”, Springer, 2015.
2. David Coghlan, Mary Brydon-Miller, “The SAGE Encyclopedia of Action Research”, SAGE, 2014.
3. Book on Electricity rules.
4. Kronick, Robert F., “Emerging Perspectives on Community Schools and the Engaged University”, IGI Global,2019
5. Tami L. Moore, “Community-University Engagement: A Process for Building Democratic Communities”, John Wiley & Sons, 2014.
6. Marshall Welch, “Engaging Higher Education: Purpose, Platforms, and Programs for Community Engagement”, Stylus Publishing, 2016.
7. Barbara Jacoby, “Building Partnerships for Service-Learning”, John Wiley & Sons, 2003.
8. Becca Berkey, Emily A. Eddins, Patrick M. Green, Cara Meixner, “Reconceptualizing Faculty Development in Service-Learning/Community Engagement: Exploring Intersections, Frameworks, and Models of Practice”, Stylus Publishing, 2018.
9. Datasheets from the internet.

SCHOOL OF TECHNOLOGY

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VISION

To cultivate nation builders, with scientific and engineering expertise and moral integrity, committed towards the upliftment of society.

MISSION

The department of Electronics and Communication Engineering of Don Bosco College of Engineering and Technology, School of Technology, Assam Don Bosco University seeks to provide young and enthusiastic minds with sound theoretical and practical knowledge in electronics and communication technologies, so that they grow up into competent individuals, capable of:

- Converting ideas into reality
- Standing up to challenges to lead from the front and provide progressive solutions
- Contributing towards the growth and development of new technologies
- Creating a positive impact on global society and contributing towards the welfare of mankind

PROGRAM EDUCATIONAL OBJECTIVES

- To create highly professional graduates with sound knowledge in the field of Electronics and Communication Engineering through quality education.
- To cater to global technological needs and to contribute to the industry by delivering the expertise acquired, through problem solving and working on need based projects.
- To groom young minds with a strong sense of commitment towards the betterment of society and environment.

PROGRAM OUTCOMES (POS)

PO 1: **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6: **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11: **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES OF B. TECH IN ELECTRONICS AND COMMUNICATION ENGINEERING

PSO 1: **Knowledge and Analysis:** An ability to understand and analyse the principles and working of different electronic systems.

PSO 2: **Product Development:** An ability to utilize their knowledge, skills and resources to demonstrate and implement technology-based systems as per the requirement.

PSO 3: **Problem Solving:** Ability to offer real time and efficient solutions for the problems that are directly or indirectly related to Electronics and Communication Engineering areas and will contribute towards the development of society.

PSO 4: **Skill Development:** Ability to collaborate different fields of science and technology with right blend of attitude and aptitude for placements and higher education or to become a successful Entrepreneur and a worthy global citizen.

PROGRAMME OUTCOMES OF M.TECH. IN SIGNAL PROCESSING:

PO 1: Ability to apply the knowledge of science, mathematics, and engineering principles for developing problem solving attitude.

PO 2: Ability to identify, formulate and solve engineering problems in the signal processing areas such as Developing robust and problem specific algorithms for acquisition, processing, analysis, synthesis of signals, to be applied in Signal Processing, Machine Vision and Communication Networks.

PO 3: Ability to understand and use different software tools in the domain of signal processing. Analysis and Verification of algorithms, Functional and timing Simulation on platforms like MATLAB, code composer studio and assembly language.

PO 4: Ability to design and conduct experiments, analyze and interpret data, imbibe programming skills for development of simulation experiments.

PO 5: Ability to function as a member of a multidisciplinary team with sense of ethics, integrity and social responsibility.

PROGRAMME OUTCOMES OF M.TECH IN COMMUNICATIONS:

PO 1: Ability to apply the knowledge of science, mathematics, and engineering principles for developing problem solving attitude.

PO 2: Ability to identify, formulate and solve engineering problems in the broad areas like Systems Design using communication and networking platforms and tools. Explore recent developments in areas like optical communication, satellite communication, wireless communication, networking, RF-microwave, antennas, measurements and standards in communication.

PO 3: Ability to understand and use different software tools for Design, Analysis and Verification in the domain of communication and networking. System results are obtained through progressive steps such as Design entry, Synthesis, Functional and Timing Simulation.

PO 4: Ability to design and conduct experiments, analyze and interpret data, imbibe programming skills for development of simulation experiments.

PO 5: Ability to function as a member of a multidisciplinary team with sense of ethics, integrity and social responsibility.

PROGRAMME OUTCOMES OF M.TECH IN VLSI AND EMBEDDED SYSTEM:

PO 1: Ability to apply the knowledge of science, mathematics, and engineering principles for developing problem solving attitude.

PO 2: Identify, formulate and solve engineering problems in the broad areas like System Design using VLSI and Embedded Platforms and tools, Semiconductor Technologies, Applications in Signal Processing, Machine Vision and Communication Networks.

PO 3: Use different software tools in the domain of VLSI and Embedded Systems Design, Analysis and Verification such as Design entry, Synthesis, Functional and Timing Simulation, Floor-planning, Place and route, Layout editors, RTL schematic, Platform specific EDA sets, MATLAB.

PO 4: Design and conduct experiments, analyze and interpret data, imbibe programming skills for development of simulation experiments.

PO 5: Function as a member of a multidisciplinary team with sense of ethics, integrity and social responsibility.

BTECH

Sl. No.	COURSE	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
1	PSPT0038	H	L	L													
2	MACL0012	H	M														
3	CSPS0079	L	M			H											M
4	PSTC6016	H	L	L						M							

5	CSPL6069	L	M			H				M							M
6	CVED6024	H		M						M						L	L
7	BTIP7						H		M				H				
8	CHEC0027	H	L													L	
9	MAIN0013	H	M													L	
10	EEBE0038	M	H												M	M	L
11	EGEH0111										H		M				L
12	CHCE6006	H	M							M							
13	EEBL6027	M	H							M					M	M	L
14	MNWM6023			H		L				M					M		L
15	EGOC6005										H		M				L
16	BTIP9						H		M				H		L		
17	ECED0043	M	M	M										H		L	M
18	ECSS0044	M	H											M	L	H	L
19	ECNT0045	M	H	L										H	L	M	M
20	ECDS0046	L	M	H										H	M	H	L
21	MATC0026	M	H													M	M
22	MTEC0074											M	H				L
23	CHES0029			M				H								L	
24	ECED6034	M	M	M						M				H		M	M
25	ECDS6035	L	M	M						M				H	M	H	L
26	BTIA8				H	M	M						L		M		
27	BTIP10						H	H	M				H		L		M
28	ECAC0047		M	M										H		M	M
29	ECEL0048	L		M											H	M	
30	BOBI0001	H	M					L									M
31	ECDP0049		M	M	H									H		M	L
32	MNEE0042	H	M	M											M		
33	MTOB0069									M	M	H	M				M
34	ECAC6036		M	M						M				H		M	M
35	ECEL6037			M						M					H	M	
36	ECDP6038		M	M	H					M				H		M	L
37	BTIP11						M	L	H				H		L		M
38	ECAC0081	M	M	L										H	M	M	
39	ECMM0082		M	M		M								M	M	H	
40	ECCA0083		M	M										H			H
41	ECPS0084		M		M									M		H	M
42	ECPE0085	L	M		M									H		M	
43	ECBE0086	M	M												M		H
44	ECSS0087		M		M									H		M	L
45	ECNT0088	L	M											M	M		H
46	ECAC6052	M	M	L						M				H	M	M	
47	ECMM6053		M	M		H				M				M	M	H	
48	ECMI6054		L	M						H		M	L	M	H	L	L
49	BTIP12				M	M	L				H		L		M		M
50	ECCS0089		M	M										M	L	H	
51	ECNT0090	L	M			M								H			M
52	ECEW0091		M	M		M								H		M	
53	ECCD0092		M	M		M								H	M	M	
54	ECNE0093	L	M			M								M		H	M
55	ECIC0094		M		H									H		M	
56	ECRB0095	M		M		L	M								H		H
57	MTPO0106											H	M				L
58	ECEW6057		M	M		H				M				M		M	
59	ECNT6058	L	M			M								H			M

60	BTIP13				M	H	L			M	M			M			L
61	7.1 (Antenna and Wave Propagation)			M		M		L						H	M		
62	7.2.A (Embedded System)			H	M	M								M	H	L	
63	7.2.B (Mobile Communication and Networks)			M		L		L						H	L	M	
64	7.3.A (Wireless Sensor Network)			M		M								M		M	H
65	7.3.B (Satellite Communication)			M		M		L						H		M	
66	7.4 (Introduction to Artificial Intelligence and Machine Learning-OE)			M		M										H	M
67	7.5 (Financial Management and Accounting)											H	L				M
68	7.6 (Project-I)		M	M	H		M	H		H				M	H	M	M
69	7.7 (Training Seminar)							M			H			M			M
70	8.1.A (Fiber Optic Communication)			M		M								H		M	L
71	8.1.B (Adaptive Signal Processing)			H		M										H	M
72	8.2.A (Microwave Theory & Technique)		M	L		M		L						H		L	
73	8.2.B (Digital Image and Video			M	H	M									M	H	M

	Processing)																
74	8.2.C (Mixed Signal Design)		M	L		M								M	L	H	
75	8.3 (Internet of Things)			M		H								M	M	M	H
76	8.4 (Bioinformatics)	L	M											M		M	H
77	8.5 (Project-II)		M	M	H		M	H		H				M	H	M	M
78	8.6 (Essence of Indian Traditional Knowledge)						M		H				M				L

MAPPING of COURSES to PO/PSOs (M.Tech – Signal Processing)

Sl. No.	Course Type	COURSE	PO1	PO2	PO3	PO4	PO5	Remarks
1	Core 1	ECAP0053	H	H	H			Employability
2	Core 2	ECDV0054	M	H	H	M	L	Employability
3	Core	ECRM0042	L			M	H	
4	Audit 1	EGRW0015				L	M	
5	Prog. Specific Elective I	ECAU0055		H	H	M		Skill Development
6		ECCV0056		H	H	M	L	Skill Development
7		ECAA0057		H	H	M		Employability
8	Prog. Specific Elective II	ECSI0058	M	H	M	M		
9		ECVD0059	M	H	M	M		Skill Development
10		ECVC0060	L	H	H	H		Employability
11	Lab1	ECAP6041	M	H	H	H		
12	Lab2	ECDV6042	M	H	H	H		
13	Core 3	ECPM0069	L	H	H	H	L	Skill Development
14	Core 4	ECDE0070	M	H	M	M		
15	Prog. Specific Elective III	ECIA0071	M	H	M	H	H	Entrepreneurship
16		ECDD0072	H	M	H	L		Skill Development
17	Prog. Specific Elective IV	ECBS0073	M	H	H	H	M	Skill Development
18		ECDS0074	M	H	H			Employability
19	Lab3	ECPM6045	L	H	H	H	M	
20	Lab4	ECDE6046	M	M	H	H	M	
21	Project	ECMI6051	M	M	H	H	H	
22	Audit 2 (MOOCs)	EDCI0100					M	
23	Prog. Specific Elective V	ECAI0096	M	H	H	H	L	
24		ECOT0097	M	H	H	H		
25		ECRS0098	M	H	H	H	L	
26	Open Elective	Bioinformatics	H	H				
27	Dissertation (Phase I & II)	ECDI6059	M	M	H	H	H	

MAPPING of COURSES to PO/PSOs (M.Tech – Communication)

Sl. No.	Course Type	COURSE	PO1	PO2	PO3	PO4	PO5	Remarks
1	Core 1	ECAP0053	H	M	H			Employability
2	Core 2	ECWM0061	M	H		M		Employability
3	Core	ECRM0042	L			M	H	
4	Audit 1	EGRW0015				L	M	

5	Prog. Specific Elective I	ECSC0062	M	H	M			Skill Development
6		ECWN0063	L	H	H	H		Employability
7		ECON0064	L	H	H			Employability
8	Prog. Specific Elective II	ECCR0065		H	M			
9		ECSI0058	M	M	H	M		Skill Development
10		ECRC0066	M	H				
11	Lab1	ECAP6041	M	M	H	H		
12	Lab2	ECWM6043	M	H	H			
13	Core 3	ECRS0075	M	H	H	M		Skill Development
14	Core 4	ECCN0076		H	M			
15	Prog. Specific Elective III	ECDS0074	M	H	M	H	H	Entrepreneurship
16		ECIA0071	H	M	H	L		Skill Development
17	Prog. Specific Elective IV	ECPM0069	L	H	H	H		Skill Development
18		ECMS0077	M	H	H			Employability
19	Lab3	ECRS6047	M	M	H	H	M	
20	Lab4	ECCN6048	M	M	H	H	M	
21	Project	ECMI6051	M	M	H	H	H	
22	Audit 2 (MOOCs)	EDCI0100					M	
23	Prog. Specific Elective V	ECAI0096	M	M	H	H	L	
2		ECOT0097	M	H	H	H		
25		ECRS0098	M	H	H	H		
26	Open Elective	Bioinformatics	H	H				
27	Dissertation (Phase I & II)	ECDI6059	M	M	H	H	H	

MAPPING of COURSES to PO/PSOs (M.Tech – VLSI and Embedded System)

Sl. No.	Course Type	COURSE	PO1	PO2	PO3	PO4	PO5	Remarks
1	Core 1	ECAP0053	H	H	H	L		Employability
2	Core 2	ECMA0067	M	M	H	M		Employability
3	Core	ECRM0042	L			M	H	
4	Audit 1	EGRW0015				L	M	
5	Prog. Specific Elective I	ECPP0068	M	H	H			
6		ECAA0057		H	H	M		Employability
7	Prog. Specific Elective II	ECWM0061	M	H		M		Employability
8		ECDV0054	M	H	H	M	L	Employability
9	Lab1	ECAP6041	M	H	H	H	M	
10	Lab2	ECMA6044	M	H	H	H	M	
11	Core 3	ECDS0074	M	H	H			Employability
12	Core 4	ECSA0078	M	M	H	M	L	Employability
13	Prog. Specific Elective III	ECDD0072	H	M	H	L		Skill Development
14		ECIA0071	M	H	M	H	H	Entrepreneurship
15	Prog. Specific Elective IV	ECMT0079	M	H	M			Employability
16		ECBS0080	M	H	H			
17	Lab3	ECDS6049	M	H	H	H	M	
18	Lab4	ECSA6050	M	H	H	H	M	
19	Project	ECMI6051	M	M	H	H	H	
20	Audit 2 (MOOCs)	EDCI0100					M	
21	Prog. Specific Elective V	ECAI0096	M	H	H	H	L	
22		ECNN0099	M	H		H		
23		ECSD0100	M	H	H	H		
24	Open Elective	Bioinformatics	H	H				
25	Dissertation (Phase I & II)	ECDI6059	M	M	H	H	H	

DETAILED SYLLABUS

THEORY COURSES

ECRM0042 RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHT (L-T-P: 2-0-0)
(2 credits-30 hours)

Objective:
This course is designed to help students to identify research problems in various fields. It aims at giving potential researchers the knowledge of effectively analysing and interpreting results and presenting the findings to the scientific and technological community of the world. This course also aims at motivating students to bring about their creative ideas for innovation and establishing research impact in the global for a through intellectual ownership.

Course Outcomes
1. Find research problems in various fields (Remembering).
2. Illustrate the concepts related to patents, trademark and copyright (Understanding).
3. Apply scientific investigations to find solutions for research problems of interest (Applying).
4. Develop technical writing and presentation skills (Applying).
5. Analyze the available literature and compile literature review for knowing the state of the art in the areas of interest (Analyzing/ Creating).
6. Formulate a research problem for a given engineering domain (Creating)

Module I (12 Hours)
Meaning, sources, scope and objective of a research problem; Good research problem criteria and characteristics, errors in selecting a research problem; Research problem solutions– approaches for investigation; Approaches to effective literature studies; Data collection, analysis, interpretation and instrumentation; Plagiarism and ethical practices.

Module II (10 Hours)
Effective writing; Research proposal development and its format; Different report types.

Module III (8 Hours)
a. Nature of intellectual property: Patent, design, trade and copyright; Patenting and development process; Patent grant under PCT and procedure; Geographical indications.
b. Patent rights: Administration of patent systems, scope, information and databases, technology licensing.
c. New developments and case studies.

Suggested Readings
1. Goddard Wayne, Melville Stuart, Research Methodology: An Introduction For Science And Technology Students, Juta & Co. Ltd.
2. Kumar Ranjit, Research Methodology A Step By Step Guide For Beginners, SAGE publications Inc.
3. Halbert J. Debora, Resisting Intellectual Property, CRC press.
4. Menell S. Peter, Lemley A. Mark, Merges P. Robert, Intellectual Property In New Technological Age, Clause 8 Publishing.
5. C.R. Kothari, Research Methodology Methods and Techniques, New Age International

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H		L
CO 2	M		H
CO 3	H	L	
CO 4	L	H	M
CO 5	H	M	L
CO6	H	M	L

ECED0043 ELECTRONIC DEVICES (L-T-P: 3-0-0)
(3 credits-45 hours)

Objective:
This course introduces basic semiconductor material, semiconductor junction properties, electronic devices and electronic circuit design. The course will also help in understanding the operation of simple devices such as p-n junctions and

optoelectronic devices. More complex devices such as Bipolar Junction Transistors (BJT) and Field Effect Transistors (FETs), will also be introduced. It also introduces basic processes used in fabricating semiconductor devices and integrated circuits. The objective is to develop the background knowledge necessary to understand semiconductor physics and state-of-the-art semiconductor technology related to device fabrication processes.

Course Outcomes

1. Define the basic principles associated with how electrons behave. (Remembering)
2. Relate the basic principles of single pn junction devices and their operations. (Understanding)
3. Apply knowledge and understanding of bipolar junction devices and their operation principles to making electronic circuits. (Applying)
4. Examine operation and working of field effect transistors electronic circuits and deduce their outputs. (Analyzing)
5. Interpret processes that are used in fabricating electronic devices and ICs. (Evaluating)

Module I (3 Hours)

Introduction to Semiconductor Physics: Review of Quantum Mechanics, Electrons in periodic Lattices, E-k diagrams. Energy bands in intrinsic and extrinsic silicon

Module II (12 Hours)

P-N Junction: P-N junction characteristics, I-V characteristics, Carrier transport: diffusion current, drift current, mobility and resistivity; sheet resistance, design of resistors; Generation and recombination of carriers; Poisson and continuity equation; small signal switching models; Avalanche breakdown, Zener diode, Schottky diode LED, photodiode and solar cell; Diode circuits.

Module III (15 Hours)

Bipolar Junction Transistor: BJT types; BJT configurations; I-V characteristics, Ebers-Moll Model, BJT biasing; bias stability, small signal analysis, low frequency transistor models and analysis, estimation of voltage gain, input resistance, output resistance etc.

Module IV (9 Hours)

MOSFET: Introduction to MOSFET, MOSFET types; I-V characteristics, CMOS. Biasing and Stabilization of Q-point, small signal models of MOS transistor, MOS capacitor, C-V characteristics.

Module V (6 Hours)

Integrated circuit fabrication process: Oxidation, diffusion, ion implantation, photolithography, etching, chemical vapor deposition, sputtering, twin-tub CMOS process.

Suggested Readings

1. G. Streetman, and S. K. Banerjee, “Solid State Electronic Devices,” 7th edition, Pearson,2014.
2. D. Neamen , D. Biswas “Semiconductor Physics and Devices,” McGraw-Hill Education
3. S. M. Sze and K. N. Kwok, “Physics of Semiconductor Devices,” 3rd edition, John Wiley &Sons, 2006.
4. C.T. Sah, “Fundamentals of solid state electronics,” World Scientific Publishing Co. Inc, 1991.
5. Y. Tsividis and M. Colin, “Operation and Modeling of the MOS Transistor,” Oxford Univ.Press, 2011.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	M	M	M	
CO 2	L	H	H	H	
CO 3	L	H	H	H	
CO 4	L	H	H	H	
CO 5					H

ECSS0044 SIGNALS AND SYSTEMS (L-T-P: 2-1-0)

(3 credits-45 hours)

Objective:

The objective of this course on Signals and Systems is to acquaint the student with the various types of signals which form the basis of electronic communication and to provide the theoretical background necessary to understand the working of any electronic communication system.

Course Outcomes

1. Define different types of signals and systems. (Remembering)

2. Illustrate the fundamentals of LTI systems and different transforms. (Understanding)
3. Apply the knowledge of different transforms to study the properties of different signals and systems. (Applying))
4. Analyze the characteristics of different systems to implement in communication systems. (Analysing)

Module I (6 hours)
Signals and systems as seen in everyday life, and in various branches of engineering and science. Definition and Classification of signals: continuous and discrete time signals. Types of signals: Analog and Digital signals, Deterministic and random signals, periodic and aperiodic signals, power and energy signals, even and odd signals. Standard signals: Impulse, Step, Ramp, Exponential, Gate, Signum, Rectangular and Sinc. Analysis of different signal types. Operation on signals, System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability.

Module II (7 hours)
Linear shift-invariant (LSI) systems, impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs. Characterization of causality and stability of LSI systems. System representation through differential equations and difference equations.

Module III (12 hours)
Fourier series representation. The Continuous-time Fourier Transform (CTFT) and its properties. The Discrete-Time Fourier Transform (DTFT) and its properties. The Discrete Fourier Transform (DFT). The notion of a frequency response and its relation to the impulse response. Convolution/ multiplication and their effect in the frequency domain, magnitude and phase response. Parseval’s Theorem. Energy Spectral Density (ESD) and Power Spectral Density (PSD). Auto-correlation and Cross-correlation functions. The idea of signal space and orthogonal bases.

Module IV (11 hours)
The Laplace Transform: definition and properties, inverse Laplace transform, notion of eigen functions of LSI systems, a basis of eigen functions, region of convergence (ROC), poles and zeros of system. Initial value and final value theorem. Laplace domain analysis. Solution to differential equations and system behavior. The z-Transform for discrete time signals and systems: definition and properties, inverse Z-transform, eigen functions, region of convergence (ROC), z-domain analysis.

Module V (9 hours)
State-space analysis and multi-input, multi-output representation. The state-transition matrix and its role. Sampling: Definition, mathematical model and types. The Sampling Theorem and its implications: Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first- order hold, and so on. Aliasing, its effects and methods to eliminate aliasing. Relation between continuous and discrete time systems.

Suggested Readings

1. A.V. Oppenheim, A.S. Willsky and I.T. Young, “Signals and Systems”, Prentice Hall, 1983.
2. R.F. Ziemer, W.H. Tranter and D.R. Fannin, “Signals and Systems - Continuous and Discrete”, 4th edition, Prentice Hall, 1998.
3. P Ramesh Babu, R Ananda Natarajan, Signals and Systems, SciTech Publications, 2006.
4. Papoulis, “Circuits and Systems: A Modern Approach”, HRW, 1980.
5. B.P. Lathi, “Signal Processing and Linear Systems”, Oxford University Press, 1998.
6. Douglas K. Lindner, “Introduction to Signals and Systems”, McGraw Hill International, 1999.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H				
CO 2		H	M	M	
CO 3			H	H	
CO 4		M	L	L	H

ECNT0045 NETWORK THEORY (L-T-P: 2-1-0)
(3 credits-45 hours)

Objective:
The objective of this course is to introduce the laws that govern the response of electrical circuits and networks. This course will help in understanding various network theorems, two port networks, resonance circuits, electrical filter circuits and analysis of steady and transient state of electrical circuits.

Course Outcomes

1. Define various network theorems and mathematical tools used in network analysis. (Remembering)
2. Explain various network theorems, mathematical tools used in network analysis and various electrical circuits. (Understanding)
3. Implement network theorems and various electrical circuits. (Applying)
4. Compare various network theorems and various electrical circuits. (Analysing)
5. Choose network theorems and electrical circuits for various networks. (Evaluating)

Module I (20 hours)

Voltage division rule, current division rule. Star-Delta conversion, Kirchhoff's current law (KCL, Kirchhoff's voltage law (KVL), Node and Mesh analysis, matrix approach of network containing voltage and current sources, and reactances, source transformation and duality. Network theorems: Superposition, reciprocity, Thevenin's, Norton's, Maximum power transfer, compensation and Tallegen's theorem as applied to AC. circuits.

Module II (10 hours)

Trigonometric and exponential Fourier series: Discrete spectra and symmetry of waveform, steady state response of a network to non-sinusoidal periodic inputs, power factor, effective values, Fourier transform and continuous spectra, three phase unbalanced circuit and power calculation.

Laplace transforms and properties: Partial fractions, singularity functions, waveform synthesis, analysis of RC, RL, and RLC networks with and without initial conditions with Laplace transforms evaluation of initial conditions.

Module III (15 hours)

Transient behavior, concept of complex frequency, Driving points and transfer functions poles and zeros of immittance function, their properties, sinusoidal response from pole-zero locations, convolution theorem and Two four port network and interconnections, Behaviors of series and parallel resonant circuits, Introduction to band pass, low pass, high pass and band reject filters.

Suggested Readings

1. Van, Valkenburg.; "Network analysis"; Prentice hall of India, 2000
2. Sudhakar, A., Shyammohan, S. P.; "Circuits and Network"; Tata McGraw-Hill New Delhi, 1994
3. A William Hayt, "Engineering Circuit Analysis" 8th Edition, McGraw-Hill Education

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H	H	L
CO 2	H	H	H
CO 3	H	L	H
CO 4	H	L	H
CO 5	M	M	M

ECDS0046 DIGITAL SYSTEM DESIGN (L-T-P: 3-0-0)

(3 credits-45 hours)

Objective:

The objectives of this course are to introduce the concept of digital and binary systems and give students the concept of digital electronics. The course also provides fundamental concepts used in the design of digital systems, the basic tools for the design and implementation of digital circuits, modules and subsystems.

Course Outcomes

1. Define and illustrate various laws and axioms associated with digital logic design. (Remembering - Understanding)
2. Apply Boolean laws for solving and minimizing logic functions practically. (Applying)
3. Analyse different types of combinational and sequential circuits. (Analysing)
4. Evaluate the behaviour of different digital circuits. (Evaluating)
5. Design and build various combinational circuits and sequential circuits. (Creating)

Module I (8 hours)

Logic Simplification and Combinational Logic Design: Review of Boolean algebra and De Morgan's Theorem, SOP & POS forms, Canonical forms, Karnaugh maps up to 6 variables, Binary codes, Code Conversion.

Module II (9 hours)
MSI devices: Comparators, Multiplexers, Encoder, Decoder, Driver & Multiplexed Display, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder, Barrel shifter and ALU

Module III (12 hours)
Sequential Logic: Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Ripple and Synchronous counters, Shift registers, Finite state machines, Design of synchronous FSM, Algorithmic State Machines charts. Designing synchronous circuits like Pulse train generator, Pseudo Random Binary Sequence generator, Clock generation

Module IV (8 hours)
Logic Families and Semiconductor Memories: TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in, fan-out, Tristate TTL, ECL, CMOS families and their interfacing, Memory elements, Concept of Programmable logic devices like FPGA. Logic implementation using Programmable Devices.

Module V (8 hours)
VLSI Design flow: Design entry: Schematic, FSM & HDL, different modelling styles in VHDL, Data types and objects, Dataflow, Behavioural and Structural Modelling, Synthesis and Simulation VHDL constructs and codes for combinational and sequential circuits.

Suggested Readings
1. R.P. Jain, “Modern digital Electronics”, Tata McGraw Hill, 4th edition, 2009.
2. Douglas Perry, “VHDL”, Tata McGraw Hill, 4th edition, 2002.
3. W.H. Gothmann, “Digital Electronics- An introduction to theory and practice”, PHI, 2nd edition ,2006.
4. D.V. Hall, “Digital Circuits and Systems”, Tata McGraw Hill, 1989
5. Charles Roth, “Digital System Design using VHDL”, Tata McGraw Hill 2nd edition 2012.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H				
CO 2	H				
CO 3		H	H		
CO 4			H	M	
CO 5					H

ECAC0047 ANALOG CIRCUITS (L-T-P: 3-0-0)
(3 Credits – 45 hours)

Objective:
To understand the basic concepts in the design of electronic circuits using Linear Integrated Circuits and their application in the processing of analog signals. The course also helps in learning the linear and non-linear applications of operational amplifiers (OpAmps), the theory and applications of analog multipliers, ADC and DAC and a few special function integrated circuits.

Course Outcomes
1. Define the linear and non-linear applications of BJT and op-amp. (Remembering)
2. Classify and comprehend the working principle of different circuits based on BJT and op-amp. (Understanding)
3. Apply the methods learned in the class to design and implement practical projects. (Applying)
4. Analysis of modern analog circuits using integrated circuits. (Analysing)
5. Design, layout, and testing of Analog circuits. (Evaluating/ Creating)

Module I (10 hours)
High frequency transistor models, frequency response of single stage and multistage amplifiers, cascode amplifier. Various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues. Feedback topologies: Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth etc., calculation with practical circuits, concept of stability, gain margin and phase margin.

Module II (15 hours)
Oscillators: Review of the basic concept, Barkhausen criterion, RC oscillators(phase shift, Wien bridge etc.), LC oscillators (, output resistance and minimum sustainable voltage (VON), maximum usable load. Differential Hartley, Colpitt, Clapp etc.), non-sinusoidal oscillators. Current mirror: Basic topology and its variants, V-I characteristics amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR.

Module III (15 hours)
OPAMP design: design of differential amplifier for a given specification, design of gain stages and output stages, compensation. Open loop and closed loop concept, virtual ground, equivalent circuit, ideal characteristics, ideal transfer curve, OP-AMP applications: review of inverting and non-inverting amplifiers, integrator and differentiator, summing amplifier, difference amplifier, precision rectifier, comparator, zero crossing detector, Schmitt trigger and its applications. Active filters: Low pass, high pass, band pass and band stop, design guidelines.

Module IV (5 hours)
Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string etc. Analog-to digital converters (ADC): Single slope, dual slope, successive approximation, flash etc.

Suggested Readings
1. R. S. Sedha, A textbook of Applied Electronics, S. Chand & Company Ltd.
2. T.R. Ganesh Babu and B. Suseela, Linear Integrated Circuits, Scitech Publications (India) Pvt. Ltd.
3. J.V. Wait, L.P. Huelsman and GA Korn, Introduction to Operational Amplifier theory and applications, McGraw Hill, 1992.
4. J. Millman and A. Grabel, Microelectronics, 2nd edition, McGraw Hill, 1988.
5. P. Horowitz and W. Hill, The Art of Electronics, 2nd edition, Cambridge University Press, 1989.
6. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College11
7. Publishing, Edition IV 6. Paul R. Gray and Robert G.Meyer, Analysis and Design of Analog Integrated Circuits, John Wiley, 3rd Edition

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2		H	H	
CO 3			H	
CO 4			H	
CO 5			H	M

ECEL0048 ELECTRONIC MEASUREMENTS (L-T-P: 3-0-0)
(3 credits- 45 hours)

Objective:
The course is aimed at introducing the concept of measurement and the related instrumentation requirement as a vital ingredient of electronics and communication engineering to learn basic concepts of electronic measurements, importance of signal generators and signal Analysers in measurements and relevance of digital instruments in measurements.

Course Outcomes
1. Describe the fundamental concepts and principles of instrumentation. (Remembering)
2. Classify and explain the various types of instruments required in measurements. (Understanding)
3. Measure the various parameters related to Electronics measuring instruments. (Applying)
4. Elaborate the performance of different measuring instruments based on the nature and performance characteristics and assess their importance in measurement. (Evaluating)
5. Elaborate the function of various types transducers in measuring different physical parameters. (Evaluating)

Module I (10 hours)
a. Performance characteristics of instruments, Static characteristics, Accuracy, Resolution, Precision, Expected value, Error, Sensitivity. Errors in Measurement, Dynamic Characteristics- speed of response, Fidelity, Lag and Dynamic error. DC Voltmeters - Multirange, Range extension/Solid state and differential voltmeters, AC voltmeters - multi range, range extension, shunt. Thermocouple type RF ammeter, Ohmmeters series type, and shunt type, Multimeter for Voltage, Current and resistance measurements.
b. AC Bridges- Measurement of inductance- Maxwell's bridge, Anderson bridge. Measurement of capacitance - Schering Bridge. Wheatstone bridge. Wien Bridge, Errors and precautions in using bridges. Q-meter

Module II (20 hours)
a. Oscilloscopes CRT features, vertical amplifiers, horizontal deflection system, sweep, trigger pulse, delay line, sync selector circuits, simple CRO, triggered sweep CRO, Dual beam CRO, Measurement of amplitude and frequency, Lissajous method of frequency measurement, standard specifications of CRO.

b. Dual trace oscilloscope, sampling oscilloscope, storage oscilloscope, digital readout oscilloscope, digital storage oscilloscope. Probes for CRO- Active and Passive, attenuator type, Frequency counter, Time and Period measurement
c. Wave Analysers, Harmonic Distortion Analysers, Spectrum Analysers, Digital Fourier Analysers.
d. Signal Generator - fixed and variable, AF oscillators, Standard and AF sine and square wave signal generators, Function Generators, Square pulse, Random noise, sweep, Arbitrary waveform.

Module III (15 hours)
a. Transducers- active and passive transducers : Resistance, Capacitance, inductance; Strain gauges, LVDT, Piezo Electric transducers, Resistance Thermometers, Thermocouples, Thermistors. Introduction to various sensors- Optical, Bio-medical etc.
b. Measurement of physical parameters force, pressure, velocity, humidity, moisture, speed, proximity and displacement. Data acquisition systems.

Suggested Readings:
1. A.K. Sawhney, Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai, 2009
2. A.D. Helfrick and W.D. Cooper, Modern Electronic Instrumentation and Measurement Techniques,1st Ed.,PHI
3. H. S. Kalsi, Electronic Instrumentation, TMH India
4. D. Patranabis, Sensors and Transducers, 2nd Ed., PHI.
5. David A. Bell, Electronic Instrumentation and Measurements, 2nd Ed., PHI

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H		
CO 2	H	M	
CO 3		H	
CO 4	H		
CO 5			H

ECDP0049 DIGITAL SIGNAL PROCESSING (L-T-P: 2-1-0)
(3 credits – 45 hours)

Objective:
The course aims at providing a framework to understand various aspects of digital signal processing and will deal with the design methodology of digital FIR & IIR filters along with various signals, discrete time systems and transforms.

Course Outcomes
1. Define and outline the fundamental concepts of signals and systems. (Remembering)
2. Classify the different types of signals and discrete time systems, digital filters and different methods of designing digital filters. (Understanding)
3. Design and analyse digital filters for different specifications. (Applying/ Analysing)
4. Evaluate the method of different filter design techniques and different types of filters. (Evaluating)
5. Design different IIR and FIR systems. (Creating)

Module I (10 hours)
a. Discrete time signals: Sequences; Representation of signals on orthogonal basis; Sampling and reconstruction of signals; Elementary examples; Classifications of discrete time signals; Operations on discrete time signals.
b. Discrete time system: Discrete systems attributes; Properties of discrete time system; Classification of discrete time systems.

Module II (15 hours)
a. Analysis of LTI systems: Analysis and response (convolution sum) of discrete - time linear LTI system; Z-Transform; Constant coefficient differences equations and their solutions.
b. Frequency Analysis LTI systems: Discrete Fourier Transform (DFT); Circular convolution; Overlap savemethods and overlap add method; Fast Fourier Transform (FFT); FFT Algorithms.
c. Implementation of Discrete Time Systems: Recursive and non-recursive discrete time system; Realization of FIR & IIR system

Module III (10 hours)
a. Design of FIR Digital filters: Window method; Park-McClellan's method.

b. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Lowpass, Bandpass, Bandstop and High pass filters; Impulse Invariance method, Matched Z-transform method, Backward difference method and bilinear transformation method.

Module IV (10 hours)

a. Effect of finite register length in IIR & FIR filter design; Parametric and non-parametric spectral estimation.
b. Introduction to multirate signal processing.
c. Applications of DSP.

Suggested Readings:

1. J. G. Proakis and D. G. Manolakis, Digital Signal Processing – Principles, Algorithms and Applications, Pearson.
2. SK Mitra, Digital Signal Processing, Pearson
3. P Ramesh Babu, Digital Signal Processing, SciTech
4. S. Salivahanan, Digital Signal Processing, TMH
5. J. R. Johnson, Introduction of Digital Signal Processing, PHI.
6. Emmanuel C Ifeachor and Barrie W. Jervis, Digital Signal Processing: A Practical Approach, Pearson Education.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	H		
CO 2	H			
CO 3		M	H	
CO 4				H
CO 5				H

ECEC0050 ANALOG ELECTRONIC CIRCUITS (L-T-P: 3-0-0)

(3 Credit-45 hours)

Objective:

The course provides basic analog electronic circuit design techniques and analytical skills using diodes, op-amps, FETs and BJTs. The student will develop the ability to apply basic engineering sciences to the design, analysis and operation of electronics devices and circuits and problem solving skills of electronic circuits.

Course Outcomes

1. Define various terminologies related to different analog electronic devices and circuits. (Remembering)
2. Illustrate the basic working principle and operation of various electronic components and circuits. (Understanding)
3. Solve problems related to the modeling and design of various analog circuits. (Applying)
4. Analyse the characteristics/working principle/operation of various analog circuits. (Analysing)
5. Design and develop different analog electronic circuits. (Creating)

Module I (7 hours)

P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, LED, photodiode, clamping and clipping circuits

Module II (10 Hours)

PNP and NPN transistors, Structure and I-V characteristics of a BJT, BJT as a switch, BJT as an amplifier: small-signal model, biasing circuits, current mirror; common-emitter, common-base and common collector amplifiers, phototransistor, Small signal equivalent circuits (h-parameter model) and analysis CE configuration.

Module III (10 Hours)

JFET and MOSFET structure and I-V characteristics, JFET and MOSFET as a switch, as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, transconductance, CMOS inverter

Module IV (4 Hours)

Internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product, output voltage swing)

Module V (7 Hours)
Op-amp as Inverting and non-inverting amplifier. Op-Amp applications in constant gain multiplier, Voltage summing, Integrator, Differentiator and controlled sources. Differential amplifier, instrumentation amplifier, active filters, voltage regulator, Zero Crossing Detector, Square-wave and triangular-wave generators

Module VI (7 Hours)
555 Timer: Block diagram, Monostable operation, Astable operation Regulated Power Supply: Voltage feedback regulation, Current limiting characteristics, Power supply characteristics, Current boosters, Switching regulators

Suggested Readings

1. A. S. Sedra and K. C. Smith, Microelectronic Circuits, Oxford University Press, New York
2. J. Millman and A. Grabel, “Microelectronics”, McGraw Hill Education
3. S Salivahanan, N Suresh Kumar and A Vallavaraj, Electronic Devices and Circuits, Tata McGraw-Hill
4. Robert L. Boylestad and Lowis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education, New Delhi
5. David A. Bell, Electronic Devices and Circuits, 4th Edition, Prenice Hall of India, New Delhi
6. Ramakant A Gayakwad Op-Amps and Linear Integrated Circuits, 4th Edition, PHI Learning Publishers

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	H	M	H		
CO 2	H	H	H		H	H
CO 3	L	H	M		M	L
CO 4		L	L		H	M
CO 5	H	H	M		M	L

ECBE0051 BASIC ELECTRONICS (L-T-P: 1-0-0)
(1 Credit-15 hours)

Objective:
This course will provide a broad overview of basic electronic components, devices and circuits. The students will develop the ability to apply the basic knowledge in design, analysis and operation of these devices and circuits.

Course Outcomes
1. Define the various terminologies related to semiconducting materials, basic electronic devices, and simple electronic circuits and systems. (Remembering)
2. Illustrate the basic working principle and operation of various active components like diodes and transistors. (Understanding)
3. Apply the knowledge of transistors to design amplifiers and oscillators. (Applying)
4. Analyse the characteristics/working principle/operation of semiconductors devices and systems. (Analysing)
5. Evaluate the performance & characteristics of different types of electronic circuits. (Evaluating)
6. Design and develop different types of electronic circuits (Creating)

Module I (4 hours)
Diodes and Applications: Semiconductor Diode – Construction, Operation, V-I Characteristics, Static & Dynamic Resistance, Ideal versus Practical, , Diode Equivalent Circuits, Load Line Analysis; Diode as a Switch, Diode as a Rectifier, Half Wave and Full Wave Rectifiers with and without Filters; Breakdown Mechanisms, Zener Diode – Operation and Applications; Opto-Electronic Devices – LEDs, Photo Diode and Applications; Silicon Controlled Rectifier (SCR) – Operation, Construction, Characteristics, Ratings, Applications.

Module II (4 hours)
Transistors: Bipolar Junction Transistor (BJT) – Construction, Operation, Amplifying Action; BJT Configurations – Common Base, Common Emitter and Common Collector, Operating Point, Voltage Divider Bias Configuration; Field Effect Transistor (FET) – Construction, Characteristics of JFET, Depletion and Enhancement type Metal Oxide Semiconductor (MOS) FETs, Introduction to CMOS circuits.

Module III (4 hours)
Amplifiers & Oscillators: Classification of transistor amplifiers and oscillators; Small Signal Amplifiers – Basic Features, Common Emitter Amplifier, Coupling and Bypass Capacitors, Distortion, AC Equivalent Circuit; Feedback Amplifiers – Principle,

Advantages of Negative Feedback, Topologies,Current Series and Voltage Series Feedback Amplifiers; Oscillators – Basic Features, RC Phase Shift, Wien Bridge, High Frequency LC and Non-Sinusoidal type Oscillators.

Module IV (3 hours)
Operational Amplifiers and Applications: Introduction to Op-Amp, Op-Amp as Differential Amplifier, Parameters of Op-Amp – CMRR, PSRR, Slew Rate; Pin Configuration of 741 Op-Amp, Characteristics of Ideal Op-Amp, Concept of Virtual Ground, Inverting & Non-inverting amplifier.
Number System & Digital Electronics: Introduction to decimal and binary number system; Logic gates– AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR, universal gates.

Suggested Readings

1. David. A. Bell (2003), Laboratory Manual for Electronic Devices and Circuits, Prentice Hall, India
2. SantiramKal (2002), Basic Electronics- Devices, Circuits and IT Fundamentals, Prentice Hall, India
3. Thomas L. Floyd and R. P. Jain (2009), Digital Fundamentals by Pearson Education
4. Paul B. Zbar, A.P. Malvino and M.A. Miller (2009), Basic Electronics – A Text-Lab. Manual, TMH
5. R. T. Paynter (2009), Introductory Electronic Devices & Circuits, Conventional Flow Version, Pearson

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	M			
CO 2		H	H	
CO 3			H	
CO 4			H	H
CO 5			H	
CO 6				H

ECEE0052 BASIC ELECTRONICS ENGINEERING (L-T-P: 3-1-0)
(4 Credits-60 hours)

Objective:
This course is intended to give a preliminary understanding of the world of Electronics-Semiconducting materials and basic devices, simple circuits and communication systems. It will also serve to create a better appreciation of going digital and to generate continued interest in the course.

Course Outcomes
1. Define the various terminologies related to semiconducting materials, basic electronic devices, simple electronic circuits and systems,digital logic circuits and communication systems. (Remembering)
2. Illustrate the basic working principle and operation of various electronic components and circuits. (Understanding)
3. Solve problems related to the modeling and design of various analog and digital electronic circuits. (Applying)
4. Design and develop different types of electronic circuits. (Creating)

Module I (18 hours)
Semiconductor Devices and Applications: Introduction to types of semiconductors – Intrinsic & Extrinsic, N-type and P-types, Energy Band Diagram; Introduction to P-N junction Diode – Construction, Operation, and V-I characteristics, Static & Dynamic Resistance, Ideal versus Practical, Half wave and Full-wave Rectifiers with and without Filters; Breakdown Mechanisms, Zener diode and its characteristics, Zener diode as voltage regulator; Regulated power supply IC based on 78XX and 79XX series, Introduction to Bipolar Junction Transistor (BJT) – Construction, Operation; BJT Configurations – Common Base, Common Emitter and Common Collector, input-output and transfer characteristics, Operating Point; BJT as a single stage CE amplifier, frequency response and bandwidth.

Module II (16 hours)
Operational Amplifier and its Applications: Introduction to Operational Amplifiers – Equivalent circuit, Transfer Characteristics, Op-Amp input modes and parameters, Ideal Characteristics; Op- Amp in Open Loop Configuration, Op-Amp with Negative Feedback, Concept of Virtual Ground, Practical Op-Amp IC 741, Inverting and Non-inverting Amplifier; Applications of Op-Amp – Summing and Difference Amplifier, Unity Gain Buffer, Comparator, Integrator and Differentiator, Log Amplifier, Instrumentation Amplifier.
Timing Circuits and Oscillators: Oscillators – Basic Features, Barkhausen's criteria for oscillation, R-C phase shift and Wein bridge oscillator; RC-timing circuits, IC 555 and its applications as astable and mono-stable multi-vibrators

Module III (14 hours)
Digital Electronics Fundamentals: Number System and Boolean Algebra, Basic and Universal Gates –Symbols, Truth tables, logic expressions; Logic simplification using K- map, Logic ICs, Half and Full Adder/Subtractor, Multiplexers, Demultiplexers, Flip-Flops, Shift Registers and Counters; Block diagram of Microprocessor/Microcontroller and their applications.

Module IV (12 hours)
Electronic Communication Systems: The Elements of Communication System, IEEE Frequency Spectrum, Signals and its Classification, Types of Signals; Transmission Media – Wired and Wireless, Baseband and Passband transmission; Modulation – Types of Modulation, Need for modulation, AM and FM Modulation schemes; Mobile communication systems – Cellular Concept and Block Diagram of GSM System.

Suggested Readings
1. Bell, “Electronic Devices & Circuits” Oxford, 5th edition, 2015.
2. Floyd , “Electronic Devices” Pearson Education, 9th edition, 2012.
3. R.P. Jain , “Modern Digital Electronics”, Tata McGraw Hill, 3rd Edition, 2007.
4. Frenzel, “Communication Electronics: Principles and Applications”, Tata McGraw Hill, 3rd Edition,2001.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	M	H
CO 2	H	H		M
CO 3	H	M	H	
CO 4	H	M	L	L

ECAP0053 ADVANCED DIGITAL SIGNAL PROCESSING (L-T-P: 3-0-0)
(3 Credit-45 hours)

Objective:
This course is intended to make the students learn the essential advanced topics in digital signal processing that are necessary for successful post graduate-level research. The course includes a review of the linear constant-coefficient system properties covered in an undergraduate DSP course, and then examines a variety of filter structures, time-varying and adaptive systems, fast algorithms, and other topics relevant to the research areas of the students.

Course Outcomes
1. Recall and illustrate theory of different filters and algorithms. (Remembering, Understanding)
2. Choose the best algorithm for adaptive filter design. (Applying)
3. Understand theory of multirate DSP, solve numerical problems and write algorithms. (Understanding, Applying)
4. Analyse theory of prediction and solution of normal equations. (Analysing)
5. Examine applications of DSP at block level. (Analysing)
6. Interpret the utilization of advanced algorithms like LMS, MMSE etc., for designing adaptive filters. (Evaluating)
7. Design the various types of digital filters. (Creating)

Module I (10 Hours)
Overview of DSP: Discrete time signals and Systems. Characterization in time and frequency, LTI System, the Z-transform, DFT, FFT Algorithms, Digital filter design and structures: Basic FIR/IIR filter design & structures, design techniques of linear phase FIR filters, IIR filters by impulse invariance, bilinear transformation, FIR/IIR Cascaded lattice structures, and Parallel all pass realization of IIR, FIR differentiators.

Module II (7 Hours)
Multi rate DSP: Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, polyphase filters, QMF, digital filter banks, Applications in sub-band coding.

Module III (8 Hours)
inear prediction & optimum linear filters: Stationary random process, forward-backward linear prediction filters, solution of normal equations, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction.

Module IV (8 Hours)
Introduction to adaptive signal processing:Adaptive Filters, FIR adaptive filters: steepest descent adaptive filter, LMS algorithm, Gradient Adaptive Lattice, Minimum mean square criterion, Recursive Least Square algorithm, Applications: noise cancellation, channel equalization, adaptive recursive filters, recursive least squares, Kalman Filter.

Module V (7 Hours)
Estimation of Spectra from Finite-Duration Observations of Signals: Nonparametric Methods for Power Spectrum Estimation, Parametric Methods for Power Spectrum Estimation, Minimum Variance Spectral Estimation, Eigen analysis, Algorithms for Spectrum Estimation.

Module VI (5 Hours)
Application of DSP & Multi rate DSP: Application to Radar, introduction to wavelets, application to image processing, design of phase shifters, DSP in speech processing & other applications.

Suggested Readings

1. J. G. Proakis and D. G. Manolakis "Digital signal processing: Principles, Algorithm and Applications", 4th Edition, Prentice Hall, 2007.
2. N. J. Fliege, "Multirate Digital Signal Processing: Multirate Systems-Filter Banks– Wavelets", 1st Edition, John Wiley and Sons Ltd, 1999.
3. Bruce W. Suter, "Multirate and Wavelet Signal Processing", 1st Edition, Academic Press, 1997.
4. M. H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley & Sons Inc., 2002.
5. S. Haykin, "Adaptive Filter Theory", 4th Edition, Prentice Hall, 2001.
6. D. G. Manolakis, V.K. Inglean and S. M. Kogon, "Statistical and Adaptive Signal Processing", McGraw Hill, 2000.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H		M	L		
CO 2			M	H	L	
CO 3		H			M	L
CO 4			H	M	L	
CO 5	M		L			H
CO 6			M	L	H	

ECDV0054 DIGITAL IMAGE AND VIDEO PROCESSING (L-T-P: 3-0-0)
(3 credits- 45 hours)

Objective:
This course is intended to give the students an overview of important topics of image and video processing. The course starts with an introduction to the basics of image and video processing such as sampling, aliasing etc. and image transforms like DFT, DCT etc. and then moves on to advanced topics such as image and video restoration, segmentation, compression etc. It also introduces the students to concepts of colour image processing.

Course Outcomes
1. Define key stages of image processing (Remembering)
2. Explain key stages of image processing (Understanding)
3. Implement image enhancement, restoration, data compression techniques (Applying)
4. Compare object recognition tools (Analyzing)
5. Choose image enhancement technique and object recognition tool for specific applications (5, Evaluating)

Module I (10 Hours)
Digital Image and Video Fundamentals: Digital image and video fundamentals and formats, 2-D and 3-D sampling and aliasing, 2-D/3-D filtering, image decimation/interpolation, video sampling and interpolation, Basic image processing operations, Image Transforms. Need for image transforms, DFT, DCT, Walsh, Hadamard transform, Haar transform, Wavelet transform.

Module II (8 Hours)
Image and Video Enhancement and Restoration: Histogram, Point processing, filtering, image restoration, algorithms for 2-D motion estimation, change detection, motion-compensated filtering, frame rate conversion, deinterlacing, video resolution enhancement, Image and Video restoration (recovery).

Module III (10 Hours)
Image and Video Segmentation: Discontinuity based segmentation- Line detection, edge detection, thresholding, Region based segmentation, Scene Change Detection, Spatiotemporal Change Detection, Motion Segmentation, Simultaneous Motion Estimation and Segmentation Semantic Video Object Segmentation, Morphological image processing.

Module IV (7 Hours)
Colour image Processing: Colour fundamentals, Colour models, Conversion of colour models, Pseudo colour image processing, Full Colour processing.

Module V (5 Hours)
Image and Video Compression: Lossless image compression including entropy coding, lossy image compression, video compression techniques, and international standards for image and video compression (JPEG, JPEG 2000, MPEG-2/4, H.264, SVC), Video Quality Assessment.

Module VI (5 Hours)
Object recognition: Image Feature representation and description-boundary representation, boundary descriptors, regional descriptors, feature selection techniques, introduction to classification, supervised and unsupervised learning, Template matching, Bayes classifier.

Suggested Readings

1. Ed. Al Bovik ,"Handbook of Image and Video Processing", 2nd Edition, Academic Press,2000.
2. J. W. Woods, "Multidimensional Signal, Image and Video Processing and Coding", 2nd Edition, Academic Press,2011.
3. Rafael C. Gonzalez and Richard E. Woods," Digital Image Processing", 3rd Edition, Prentice Hall,2008.
4. M. Tekalp, "Digital Video Processing",2nd Edition, Prentice Hall,2015.
5. S. Shridhar, "Digital Image Processing", 2nd Edition, Oxford UniversityPress, 2016.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	M	M	M	M	M	M
CO 2	M	M	M	M	M	M
CO 3	H	H	H	L	H	L
CO 4	L	L	L	L	L	H
CO 5	H	H	L	L	L	H

ECAU0055 AUDIO PROCESSING (L-T-P: 3-0-0)
(3 credits – 45 hours)

Objective:
This course is intended to introduce the students to the fundamentals of audio processing and then move on to more advanced topics such as LPC, speech coding etc. The course also delves into applications of audio processing such as speech recognition and speaker recognition.

Course Outcomes
1. Define principal characteristics of speech, various speech analysis and synthesis systems (Remembering)
2. Explain principal characteristics of speech, various speech analysis and synthesis systems (Understanding)
3. Implement speech analysis and synthesis systems, speech coding, speech and speaker recognition(Applying)
4. Compare various techniques for speech analysis and synthesis, speech coding, speech and speaker recognition (Analyzing)
5. Choose suitable one amongst various techniques for speech analysis and synthesis, speech coding, speech and speaker recognition (Evaluating)

Module I (8 Hours)
Principle Characteristics of Speech: Linguistic information, Speech and Hearing, Speech production mechanism, Acoustic characteristic of speech Statistical Characteristics of speech. Speech production models, Linear Separable equivalent circuit model, Vocal Tract and Vocal Cord Model.

Module II (10 Hours)
Speech Analysis and Synthesis Systems: Digitization, Sampling, Quantization and coding, Spectral Analysis, Spectral structure of speech, Autocorrelation and Short Time Fourier transform, Window function, Sound Spectrogram, Mel frequency Cepstral Coefficients, Filter bank and Zero Crossing Analysis, Analysis –by-Synthesis, Pitch Extraction.

Module III (7 Hours)
Linear Predictive Coding Analysis: Principle of LPC analysis, Maximum likelihood spectral estimation, Source parameter estimation from residual signals, LPC Encoder and Decoder, PARCOR analysis and Synthesis, Line Spectral Pairs, LSP analysis and Synthesis.

Module IV (10 Hours)
Speech Coding: Reversible coding, Irreversible coding and Information rate distortion theory, coding in time domain: PCM, ADPCM, Adaptive Predictive coding, coding in Frequency domain: Sub band coding, Adaptive transform coding, Vector Quantization, Code Excited Linear Predictive Coding (CELP).

Module V (5 Hours)
Speech Recognition: Principles of speech recognition, Speech period detection, Spectral distance measure, Structure of word recognition system, Dynamic Time Warping (DTW), Theory and implementation of Hidden Markov Model (HMM).

Module VI (5 Hours)
Speaker recognition: Human and Computer speaker recognition Principles Text dependent and Text Independent speaker recognition systems. Applications of speech Processing.

Suggested Readings
1. Sadaoki Furui, "Digital Speech Processing, Synthesis and Recognition" 2nd Edition, Taylor & Francis, 2000.
2. Rabiner and Schafer, "Digital Processing of Speech Signals", Pearson Education, 1979.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	H	M	L	L	L
CO 2	H	H	M	L	L	L
CO 3	L	H	M	H	H	H
CO 4	L	H	M	H	H	H
CO 5	L	H	M	H	H	H

ECCV0056 COMPUTER VISION (L-T-P: 3-0-0)
(3 credits- 45 hours)

Objective:
The course is intended to make an insight into different aspects of Computer Vision and Machine learning, working principles, systems associated and applications.

Course Outcomes
1. Recall the working of camera and explain behavior of various sources, surfaces, shadows, human visual systems etc. (Remembering/ Understanding)
2. Illustrate the image formation models and feature extraction for computer vision. (Understanding)
3. Apply various image analysis operations on the images and videos such as segmentation, counting objects, shape determination, feature extraction etc. (Applying)
4. Analyze algorithms for high level vision analysis such as object detection and classifications using input features and classifiers. (Analyzing)
5. Evaluate the segmentation and motion detection and estimation techniques. (Evaluating)
6. Develop small applications and detect the objects in various applications. (Creating)

Module I (10 Hours)
Image Formation Models: Colour- Generation, Human Perception, Representation, Model for an Image Colour; Camera: Pinhole and Lens Types, geometric Camera model and Camera calibration; Monocular imaging system, Orthographic & Perspective Projection, Binocular imaging systems, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Radiometry, Projections, Transforms- Fourier, Hough and Radon; Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration.

Module II (8 Hours)
Feature Extraction: Image representations (continuous and discrete), Scene Segmentation and Labeling; Counting Objects; Edge detection, Edge linking, corner detection, texture, binary shape analysis, boundary pattern analysis, circle and ellipse detection, Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges;

Module III (10 Hours)
Shape Representation and Segmentation: Statistical Decision Theory; Pattern Recognition Principles; Clustering Approach- K-Means Clustering; Parametric Approach- Bayes' Classifier; Relaxation Approach; Shape Similarity Based Recognition; Expert System; Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet

descriptors, B-Splines, Least Squares and Eigen Vector Line Fitting, Medial representations, Multi-resolution analysis, Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation

Module IV (5 Hours)
Motion Detection and Estimation: Regularization theory, Optical computation, Stereo Vision, Motion estimation, Background Subtraction and Modeling, Optical Flow, KLT, Spatio Temporal Analysis, Dynamic Stereo; Motion parameter estimation, Structure from motion, Motion Tracking in Video.

Module V (7 Hours)
Object recognition: Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal component analysis, Shape priors for recognition, Geometric templates from spatial relations, Probabilistic and inferential methods- neural networks, support vector machines; Recognition by relations between templates.

Module VI (5 Hours)
Applications of Computer Vision: Automated Visual Inspection, Inspection of Cereal Grains, Surveillance, In-Vehicle Vision Systems, CBIR, CBVR, Activity Recognition, computational photography, Biometrics, stitching and document processing.

Suggested Readings

1. D. Forsyth and J. Ponce, “Computer Vision - A modern approach”, 2nd Edition, Pearson Prentice Hall, 2012
2. Szeliski, Richard, “Computer Vision: Algorithms and Applications”, 1st Edition, Springer Verlag London Limited, 2011.
3. Richard Hartley and Andrew Zisserman, “Multiple View Geometry in Computer Vision”, 2nd Edition, Cambridge University Press, 2004.
4. K. Fukunaga,“Introduction to Statistical Pattern Recognition”,2ndEdition, Morgan Kaufmann, 1990.
5. Rafael C. Gonzalez and Richard E. Woods,” Digital Image Processing”, 3rd Edition, Prentice Hall, 2008.
6. B. K. P. Horn, “Robot Vision”, 1st Edition, McGraw-Hill, 1986.
7. E. R. Davies “Computer and Machine Vision: Theory, Algorithms, Practicalities”, 4th Edition, Elsevier Inc, 2012.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H			L	M	M
CO 2		H	L			M
CO 3		M	H		L	L
CO 4	L			M	H	M
CO 5				H	M	L
CO 6	M	L	M	M	M	H

ECAA0057 ADVANCED COMPUTER ARCHITECTURE (L-T-P: 3-0-0)
(3 credits- 45 hours)

Objective:
The main objective of this course is to introduce the students with the concept of parallelism and pipelining, the design aspects and challenges. After this course students will be able to evaluate the issues in vector and array processors. They will also learn about high performance scalable multithreaded and multiprocessor systems.

Course Outcomes
1. Define the concept of pipelining and parallelism in various computer architectures. (Remembering)
2. Explain pipelining in software and hardware and hazards associated with it. (Understanding)
3. Identify various issues associated with vector and array processors. (Applying)
4. Analyse different types of multiprocessor architectures. (Analysing)
5. Compare the performance of multiprocessors and multithreaded architectures. (Evaluating)
6. Discuss parallel algorithms for multiprocessors. (Creating)

Module I (5 Hours)
Parallel Processing and Pipelining Processing- Architectural Classification, Applications of parallel processing, Instruction level Parallelism and Thread Level Parallelism, Explicitly Parallel Instruction Computing (EPIC) Architecture.

Module II (10 Hours)
Pipeline Architecture-Principles and implementation of Pipelining, Classification of pipelining processors, Design aspect of Arithmetic and Instruction pipelining, Pipelining hazards and resolving techniques, Data buffering techniques, Advanced pipelining techniques, Software pipelining, VLIW (Very Long Instruction Word) processor.

Module III (8 Hours)
Vector and Array Processor- Issues in Vector Processing, Vector performance modeling, SIMD Computer Organization, Static Vs Dynamic network, Parallel Algorithms for Array Processors: Matrix Multiplication.

Module IV (7 Hours)
Multiprocessor Architecture - Loosely and Tightly coupled multiprocessors, Inter Processor communication network, Time shared bus, Multiport Memory Model, Memory contention and arbitration techniques, Cache coherency and bus snooping, Massively Parallel Processors (MPP).

Module V (5 Hours)
Multithreaded Architecture- Multithreaded processors, Latency hiding techniques, Principles of multithreading, Issues and solutions, Parallel Programming Techniques: Message passing program development.

Module VI (10 Hours)
Parallel algorithms for multiprocessors- Classification and performance of parallel algorithms, operating systems for multiprocessors systems, Message passing libraries for parallel programming interface, PVM (in distributed memory system), Message Passing Interfaces (MPI).

Suggested Readings
1. Kai Hwang, Faye A. Briggs, “Computer Architecture and Parallel Processing” McGraw Hill Education, 2012.
2. Kai Hwang, “Advanced Computer Architecture”, McGraw Hill Education, 1993.
3. William Stallings, “Computer Organization and Architecture, Designing for Performance” Prentice Hall, 6th edition, 2006.
4. Kai Hwang, “Scalable Parallel Computing”, McGraw Hill Education, 1998.
5. Harold S. Stone “High-Performance Computer Architecture”, Addison-Wesley, 1993.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H				
CO 2	M	H			
CO 3	M		H		
CO 4				H	
CO 5				M	H
CO 6	L		M	L	H

ECSI0058 STATISTICAL INFORMATION PROCESSING (L-T-P: 3-0-0)
(3 credits- 45 hours)

Objective
This course is intended to introduce the students to the concepts of information processing. The course starts with the fundamental concepts of random variables and then moves on to random processes, random signal modelling, spectral analysis etc. It also covers concepts of information theory and source coding.

Course Outcomes
1. Define the statistical parameters associated with random variables and random processes. (Remembering)
2. Explain concept of various random signal models like MA, AR, ARMA etc. (Understanding)
3. Identify various hypothesis and methods to estimates parameters in statistical model. (Applying)
4. Inspect concepts of spectral analysis using functions like autocorrelation, periodogram etc.(Analyzing)
5. Evaluate information content, entropy, channel capacity etc. using various source and channel coding techniques (Evaluating)
6. Discuss application of information theory in the area of discrete mathematics (Creating)

Module I (10 Hours)
Review of random variables: Probability Concepts, distribution and density functions, moments, independent, uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Vector quantization, Tchebycheff inequality theorem, Central Limit theorem, Discrete & Continuous RandomVariables. Random process: Expectations, Moments, Ergodicity, Discrete-Time Random Processes Stationary process, autocorrelation and autocovariance functions, Spectral representation of random signals, Properties of power spectral density, Gaussian Process and White noise process.

Module II (5 Hours)
Random signal modeling: MA(q), AR(p), ARMA(p,q) models, Hidden Markov Model & its applications, Linear System with random input , Forward and Backward Predictions, Levinson Durbin Algorithm.

Module III (10 Hours)
Statistical Decision Theory: Bayes’ Criterion, Binary Hypothesis Testing, M-ary Hypothesis Testing, Minimax Criterion, Neyman-Pearson Criterion, Composite Hypothesis Testing. Parameter Estimation Theory: Maximum Likelihood Estimation, Generalized Likelihood Ratio Test ,Some Criteria for Good Estimators, Bayes’ Estimation Minimum Mean-Square Error Estimate, Minimum, Mean Absolute Value of Error Estimate Maximum A Posteriori Estimate , Multiple Parameter Estimation Best Linear Unbiased Estimator, Least-Square Estimation Recursive Least-Square Estimator.

Module IV (5 Hours)
Spectral analysis: Estimated autocorrelation function, Periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Parametric method, AR(p) spectral estimation and detection of Harmonic Signals.

Module V (8 Hours)
Information Theory and Source Coding: Introduction, Uncertainty, Information and Entropy, Source coding theorem, Huffman, Shanon-Fano, Arithmetic, Adaptive coding, RLE, LZW Data compaction, LZ-77, LZ-78. Discrete Memory less channels, Mutual information, channel capacity, Channel coding theorem, Differential entropy and mutual information for continuous ensembles.

Module VI (7 Hours)
Application of Information Theory: Group, Ring & Field, Vector, GF addition, multiplication rules. Introduction to BCH codes, Primitive elements, Minimal polynomials, Generator polynomials in terms of Minimal polynomials, Some examples of BCH codes, & Decoder, Reed- Solomon codes & Decoder, Implementation of Reed Solomon encoders and decoders.

Suggested Readings
1. Papoulis and S.U. Pillai, “Probability, Random Variables and Stochastic Processes”, 4th Edition, McGraw-Hill,2002.
2. D.G. Manolakis, V.K. Ingle and S.M. Kogon, “Statistical and Adaptive Signal Processing”, McGraw Hill,2000.
3. MouradBarkat , “Signal Detection and Estimation”, Artech House, 2nd Edition,2005.
4. R G. Gallager, “Information theory and reliable communication”, Wiley, 1st edition, 1968.
5. F. J. MacWilliams and N. J. A. Sloane, “The Theory of Error-Correcting Codes”, New York, North-Holland,1977.
6. Rosen K.H, “Elementary Number Theory”, Addison-Wesley, 6th edition, 2010.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H				
CO 2	M	H			
CO 3	M		H		
CO 4		M		H	
CO 5	L				H
CO 6	L			M	H

ECVD0059 VOICE AND DATA NETWORKS (L-T-P: 3-0-0)
(3 credits- 45 hours)

Objective:
This course is intended to give the students an exposure to the design criteria of voice and data networks. The course starts with network design and performance issues in general, moves on to introducing the students to issues in design of voice and data networks and then gives an extensive idea on voice networks and data networks.

Course Outcomes
1. Define the fundamental concepts of network design and network performance issues, network terminology etc. (Remembering)
2. Explain concepts of voice and data networks. (Understanding)
3. Apply designs of voice and data networks such as link layer design etc. (Applying)
4. Inspect concepts of inter-networking, IP protocol and addressing CIDR, TCP, UDP etc. (Analyzing)
5. Evaluate Queuing models, traffic models, Markov systems etc. (Evaluating)
6. Discuss congestion avoidance, quality of service in packet networks etc. (Creating)

Module I (8 Hours)
Network Design Issues, Network Performance Issues, Network Terminology, centralized and distributed approaches for networks design, Issues in design of voice and data networks.

Module II (7 Hours)
Layered and Layer less Communication, Cross layer design of Networks, Voice Networks (wired and wireless) and Switching, Circuit Switching and Packet Switching, Statistical Multiplexing.

Module III (8 Hours)
Data Networks and their Design, Link layer design- Link adaptation, Link Layer Protocols, Retransmission. Mechanisms (ARQ), Hybrid ARQ (HARQ), Go Back N, Selective Repeat protocols and their analysis.

Module IV (7 Hours)
Queuing Models of Networks, Traffic Models, Little's Theorem, Markov chains, M/M/1 and other Markov systems, Multiple Access Protocols, Aloha System, Carrier Sensing, Examples of Local area networks,

Module V (10 Hours)
Inter-networking, Bridging, Global Internet, IP protocol and addressing, Subnetting, Classless Inter domain Routing (CIDR), IP address lookup, Routing in Internet. End to End Protocols, TCP and UDP, Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit/ Fast Recovery.

Module VI (5 Hours)
Congestion avoidance, RED TCP Throughput Analysis, Quality of Service in Packet Networks. Network Calculus, Packet Scheduling Algorithms.

Suggested Readings

1. D. Bertsekas and R. Gallager, "Data Networks", 2ndEdition, Prentice Hall,1992.
2. L. Peterson and B. S. Davie, "Computer Networks: A Systems Approach", 5th Edition, Morgan Kaufman, 2011.
3. Kumar, D. Manjunath and J. Kuri, "Communication Networking: An analytical approach", 1st Edition, Morgan Kaufman,2004.
4. Walrand,"Communications Network: A First Course", 2nd Edition, McGraw Hill,2002.
5. Leonard Kleinrock, "QueueingSystems,Volume I: Theory", 1st Edition, John Wiley and Sons,1975.
6. Aaron Kershenbaum, "Telecommunication Network Design Algorithms", McGraw Hill, 1993.
7. Vijay Ahuja, "Design and Analysis of Computer Communication Networks", McGraw Hill,1987

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				
CO 2		H	H			
CO 3			H	M		
CO 4				H	H	
CO 5				H	H	
CO 6						H

ECVC0060 AUDIO, VIDEO CODING AND COMPRESSION (L-T-P: 3-0-0)
(3 credits- 45 hours)

Objective
This course is designed to give the students an idea about multimedia systems and processing. The course starts with basic coding techniques such as Huffman coding etc. and transforms such as DCT etc. and then gives an extensive idea on video and audio coding along with their compression systems.

Course Outcomes
1. Define the fundamental concepts of multimedia systems and processing. (Remembering)
2. Outline concepts of lossy and lossless image compression systems, still image compression standards etc. (Understanding)
3. Make use of standards of audio and video coding. (Applying)
4. Analyse motion estimation algorithms. (Analyzing)
5. Evaluate multimedia synchronization, audio-video interleaving video indexing and retrieval etc. (Evaluating)
6. Discuss applications of audio coding, video coding and various compression systems. (Creating)

Module I (5 Hours)
Introduction to Multimedia Systems and Processing, Lossless Image Compression Systems, Huffman Coding, Arithmetic and Lempel-Ziv Coding, Other Coding Techniques.

Module II (10 Hours)
Lossy Image Compression Systems, Theory of Quantization, Delta Modulation and DPCM, Transform Coding & K-L Transforms, Discrete Cosine Transforms, Multi-Resolution Analysis, Theory of Wavelets, Discrete Wavelet Transforms, Still Image Compression Standards: JBIG and JPEG.

Module III (8 Hours)
Video Coding and Motion Estimation: Basic Building Blocks & Temporal Redundancy, Block based motion estimation algorithms, other fast search motion estimation algorithms.

Module IV (5 Hours)
Video Coding Standards: MPEG-1 standards, MPEG-2 Standard, MPEG-4 Standard, H.261, H.263 Standards, H.264 standard.

Module V (7 Hours)
Audio Coding: Basic of Audio Coding, Audio Coding, Transform and Filter banks, Polyphase filter implementation, Format and encoding, Psychoacoustic Models.

Module VI (10 Hours)
Multimedia Synchronization: Basic definitions and requirements, References Model and Specification, Time stamping and pack architecture, Packet architectures and audio-video interleaving, Multimedia Synchronization, Playback continuity. Video Indexing and Retrieval: Basics of content based image retrieval, Video Content Representation, Video Sequence Query Processing.

Suggested Readings

1. Iain E.G. Richardson, "H.264 and MPEG-4 Video Compression", Wiley,2003.
2. Khalid Sayood, "Introduction to Data Compression", 4th Edition, Morgan Kaufmann, 2012
3. Mohammed Ghanbari, "Standard Codecs: Image Compression to Advanced Video Coding", 3rd Edition, The Institution of Engineering and Technology, 2011.
4. Julius O. Smith III, "Spectral Audio Signal Processing", W3K Publishing,2011.
5. Nicolas Moreau, "Tools for Signal Compression: Applications to Speech and Audio Coding", Wiley, 2011.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	H				
CO 2	L	H				
CO 3			H	H	H	
CO 4			H	H	M	
CO 5					H	H
CO 6					H	H

ECWM0061 WIRELESS AND MOBILE COMMUNICATION (L-T-P: 3-0-0)
(3 credits- 45 hours)

Objective
This course is intended to make the students learn the essential advanced topics in wireless communication. The course starts with an introduction to basics of wireless communication such as cellular concepts and then moves on to important advanced topics related to multiple access techniques, equalizers, fading etc. It also introduces the students to 4G and 5G standards that are relevant topics for today's times.

Course Outcomes
1. Define the fundamental concepts of cellular communication, multiple access techniques etc. (Remembering)
2. Outline concepts of GSM, GPRS etc. (Understanding)
3. Utilize GSM, CDMA etc. (Applying)
4. Analyse spectral efficiency based on multiple access techniques, equalizers in communication receivers etc. (Analysing)
5. Evaluate path loss, fading, diversity etc. (Evaluating)
6. Discuss 3G, 4G and 5G standards. (Creating)

Module I (10 Hours)
Cellular Communication Fundamentals: Cellular system design, Frequency reuse, cell splitting, handover concepts, Co channel and adjacent channel interference, interference reduction techniques and methods to improve cell coverage, Frequency management and channel assignment. GSM architecture and interfaces, GSM architecture details, GSM subsystems, GSM Logical Channels, Data Encryption in GSM, Mobility Management, Call Flows in GSM.2.5G Standards: High speed Circuit Switched Data (HSCSD), General Packet Radio Service (GPRS),2.75 G Standards: EDGE.

Module II (8 Hours)
Spectral efficiency analysis based on multiple access technologies: TDMA, FDMA and CDMA, Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas, Wireless network planning (Link budget and power spectrum calculations).

Module III (10 Hours)
Mobile Radio Propagation: Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings. Small Scale Fading and Multipath Propagation, Impulse Response Model, Multipath Measurements, Parameters of Multipath channels, Types of Small Scale Fading: Time Delay Spread; Flat, Frequency selective, Doppler Spread; Fast and Slow fading.

Module IV (5 Hours)
Equalization, Diversity: Equalizers in a communications receiver, Algorithms for adaptive equalization, diversity techniques, space, polarization, frequency diversity, Interleaving.

Module V (7 Hours)
Code Division Multiple Accesses: Introduction to CDMA technology, IS 95 system Architecture, Air Interface, Physical and logical channels of IS 95, Forward Link and Reverse link operation, Physical and Logical channels of IS 95 CDMA, IS 95 CDMA Call Processing, soft Handoff, Evolution of IS 95 (CDMA One) to CDMA 2000, CDMA 2000 layering structure and channels.

Module VI (5 Hours)
Higher Generation Cellular Standards: 3G Standards, evolved EDGE, enhancements in 4G standard, Architecture and representative protocols, call flow for LTE, VoLTE, UMTS, introduction to 5G.

Suggested Readings

1. V. K. Garg, J. E. Wilkes, “Principle and Application of GSM”, Pearson Education, 5thedition,2008.
2. V. K. Garg, “IS-95 CDMA & CDMA 2000”, Pearson Education, 4th edition,2009.
3. T. S. Rappaport, “Wireless Communications Principles and Practice”, 2ndedition,PHI, 2002.
4. William C. Y. Lee, “Mobile Cellular Telecommunications Analog and Digital Systems”, 2nd edition, TMH,1995.
5. Asha Mehrotra, “A GSM system Engineering” Artech House Publishers Bosten, London, 1997.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M	L			
CO 2	H		M		L	
CO 3	L			M	H	
CO 4		H	M		L	
CO 5		M	H	H	L	
CO 6				M	M	H

ECSC0062 SATELLITE COMMUNICATION (L-T-P: 3-0-0)
(3 Credits- 45 hours)

Objective
This course is intended to give the students an exposure to the important concepts of satellite communication. The course starts with fundamental principles of satellite communication and architecture of satellites. It then introduces the students to more advanced topics such as orbital analysis, satellite subsystems, link budget etc.

Course Outcomes
1. Define the brief history of satellite systems and fundamental concepts of satellite communication. (Remembering)

2. Outline concepts of satellite subsystems, modulation and multiple access schemes used in satellite communication etc. (Understanding)
3. Make use of orbital analysis, satellite link budget etc. (Applying)
4. Analyse phenomena in satellite communication such as effect of solar eclipse on satellite, Doppler shift etc. (Analysing)
5. Evaluate subsystems such as AOCS, communication subsystem etc. (Evaluating)
6. Discuss VSAT, DBS-TV etc. (Creating)

Module I (8 Hours)
Architecture of Satellite Communication System: Principles and architecture of satellite Communication, Brief history of Satellite systems, advantages, disadvantages, applications, and frequency bands used for satellite communication and their advantages/drawbacks.

Module II (10 Hours)
Orbital Analysis: Orbital equations, Kepler's laws of planetary motion, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc of a satellite, concepts of Solar day and Sidereal Day.

Module III (10 Hours)
Satellite subsystems: Architecture and Roles of various sub-systems of a satellite system such as Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication subsystem, power subsystems, antenna sub-system.

Module IV (7 Hours)
Typical Phenomena in Satellite Communication: Effect of Solar Eclipse on satellite, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift phenomena and expression for Doppler shift.

Module V (5 Hours)
Satellite link budget: Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions, Case study of Personal Communication system (satellite telephony) using LEO.

Module VI (5 Hours)
Modulation and Multiple Access Schemes used in satellite communication, Typical case studies of VSAT, DBS-TV satellites and few recent communication satellites launched by NASA/ ISRO, GPS.

Suggested Readings

1. Timothy Pratt and Others, "Satellite Communications", Wiley India, 2nd edition,2010.
2. S. K. Raman, "Fundamentals of Satellite Communication", PearsonEducation India,2011.
3. Tri T. Ha, "Digital Satellite Communications", Tata McGraw Hill, 2009.
4. Dennis Roddy, "Satellite Communication", McGraw Hill, 4th Edition, 2008.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	L		M		
CO 2			H	M	L	
CO 3	L	H	M			
CO4		L		H	M	
CO 5					H	
CO 6				L	M	H

ECWN0063 WIRELESS SENSOR NETWORKS (L-T-P: 3-0-0)
(3 Credits- 45 hours)

Objective
The objective of this course is to make the students to understand the basic WSN technology and supporting protocols, with emphasis placed on standardization basic sensor systems and provide a survey of sensor technology, medium access control protocols and address physical layer issues, sensor management , sensor network middleware, operating systems. Also to learn key routing protocols for sensor networks and main design issues, transport layer protocols for sensor networks, and design requirements

Course Outcomes

1. Recall and illustrate the Concepts, Network Architecture and Applications of Ad-hoc and Wireless Sensor Networks. (Remembering, Understanding)
2. Illustrate the Concepts, Architecture of ad-hoc and sensor networks and MAC layer protocols. (Understanding)
3. Identify the design of routing protocols for ad-hoc and wireless networks. (Applying)
4. Analyse the protocol design issues of Ad-hoc Networks. (Analysing)
5. Elaborate and Evaluate the QOS related performance measurements of ad-hoc and sensor networks. (Evaluating, Creating)

Module I (5 Hours)

Introduction: Introduction and overview of sensor network architecture and its applications, sensor network comparison with Ad Hoc Networks, Sensor node architecture with hardware and software details.

Module II (8 Hours)

Hardware:Examples like mica2, micaZ, telosB, cricket, Imote2, tmote, btnode, and Sun SPOT, Software (Operating Systems): tinyOS, MANTIS, Contiki, and RetOS.

Module III (7 Hours)

Programming tools: C, nesC. Performance comparison of wireless sensor networks simulation and experimental platforms like open source (ns-2) and commercial (QualNet, Opnet)

Module IV (10 Hours)

Overview of sensor network protocols:Sensor network protocols (details of at least 2 important protocol per layer): Physical, MAC and routing/ Network layer protocols, node discovery protocols, multi-hop and cluster based protocols, Fundamentals of 802.15.4, Bluetooth, BLE (Bluetooth low energy), UWB.

Module V (5 Hours)

Data dissemination and processing: Data dissemination and processing; differences compared with other database management systems, data storage; query processing.

Module VI (10 Hours)

Specialized features: Energy preservation and efficiency; security challenges; fault tolerance, Issues related to Localization, connectivity and topology, Sensor deployment mechanisms; coverage issues; sensor Web; sensor Grid, Open issues for future research, and Enabling technologies in wireless sensor network.

Suggested Readings

1. H. Karl and A. Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley & Sons, India, 2012.
2. C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Editors, “Wireless Sensor Networks”, Springer Verlag, 1st Indian reprint, 2010.
3. F. Zhao and L. Guibas, “Wireless Sensor Networks: An Information Processing Approach”, Morgan Kaufmann, 1st Indian reprint, 2013.
4. YingshuLi, MyT. Thai, Weili Wu, “Wireless sensor Network and Applications”, Springer series on signals and communication technology, 2008.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				L
CO 2		L	M	M	H	H
CO 3		H	L	M	M	M
CO4	L		H	M		M
CO 5			M	L	M	H

ECON0064 OPTICAL NETWORKS (L-T-P: 3-0-0)

(3 Credits- 45 hours)

Objective

This course is intended to give the students an exposure to the design criteria of optical networks. The course starts with fundamentals such as SONET etc. and then deals with practical optical network design issues such as network performance, fault management, optical layer protection schemes etc.

Course Outcomes
1. Define the fundamental concepts of optical networks. (Remembering)
2. Outline concepts of SONET, SDH etc. (Understanding)
3. Utilize WDM network elements, OADM architectures etc. (Applying)
4. Analyse network survivability, WDM network design etc. (Analysing)
5. Evaluate network management functions, optical layer services, interfacing etc. (Evaluating)
6. Discuss concepts of OTDM, PON, AON etc. (Creating)

Module I (5 Hours)
SONET/SDH: Optical transport network, IP, routing and forwarding, multiprotocol label switching.

Module II (8 Hours)
WDM network elements: Optical line terminals and amplifiers, optical add/drop multiplexers, OADM architectures, reconfigurable OADM, optical cross connects.

Module III (7 Hours)
Control and management: Network management functions, optical layer services and interfacing, performance and fault management, configuration management, optical safety.

Module IV (5 Hours)
Network Survivability: Protection in SONET/SDH & client layer, optical layer protection schemes

Module V (10 Hours)
WDM network design: LTD and RWA problems, dimensioning wavelength routing networks, statistical dimensioning models.

Module VI (10 Hours)
Access networks: Optical time division multiplexing, synchronization, header processing, buffering, burst switching, test beds, Introduction to PON, GPON, AON.

Suggested Readings
1. Rajiv Ramaswami, Sivarajan, Sasaki, “Optical Networks: A Practical Perspective”, MK, Elsevier, 3rd edition,2010.
2. C. Siva Ram Murthy and Mohan Gurusamy, “WDM Optical Networks: Concepts Design, and Algorithms”, PHI, EEE, 2001.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H		M	L		
CO 2	H	M	L	M		
CO 3		H	L		M	L
CO 4		H	H		H	
CO 5			H		M	
CO 6			M		L	H

ECCR0065 COGNITIVE RADIO (L-T-P: 3-0-0)
(3 Credits- 45 hours)

Objective
This course will help the students to understand the spectrum scarcity problem and how cognitive radio deals with this problem. It will also deal with the contribution of cognitive radio systems in wireless networks and its architectures that enable the development of the cognitive radio network (both centralized and distributed). After this course students will be able to learn the technologies to allow an efficient use of TVWS for radio communications. It also discusses various cognitive radio standards along with various research challenges for deployment of cognitive radio networks.

Course Outcomes
1. Recall and illustrate the fundamental concepts of cognitive radio networks. (Remembering, Understanding)
2. Develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it. (Applying)
3. Examine technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models/policies. (Analysing)

4. Elaborate and evaluate the fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimization techniques for better spectrum exploitation. (Evaluating, Creating)

Module I (10 Hours)
Introduction: Introduction to Cognitive Radios: Digital dividend, cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio.

Module II (10 Hours)
Spectrum Sensing: Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models (spectrum of commons, real time secondary spectrum market).

Module III (8 Hours)
Optimization Techniques of Dynamic Spectrum Allocation:Linear programming, convex programming, nonlinear programming, integer programming, dynamic programming, stochastic programming.

Module IV (7 Hours)
Dynamic Spectrum Access and Management: Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.

Module V (5 Hours)
Spectrum Trading: Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential).

Module VI (5 Hours)
Research Challenges in Cognitive Radio: Network layer and transport layer issues, cross layer design for cognitive radio networks.

Suggested Readings
1. Ekram Hossain, Dusit Niyato, Zhu Han, "Dynamic Spectrum Access and Management in Cognitive Radio Networks", Cambridge University Press, 2009.
2. Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks", John Wiley & Sons Ltd., 2009.
3. Bruce Fette, "Cognitive radio technology", Elsevier, 2nd edition, 2009.
4. HuseyinArslan, "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems", Springer, 2007.
5. Francisco Rodrigo Porto Cavalcanti, SorenAndersson, "Optimizing Wireless Communication Systems" Springer, 2009.
6. Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, 2009.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M	M	L	L	
CO 2		H	H	M		L
CO 3		H		H	M	L
CO 4	L	M	H	L	H	H

ECRC0066 RF AND MICROWAVE CIRCUIT DESIGN (L-T-P: 3-0-0)
(3 Credits- 45 hours)

Objective
The objectives of this course are to provide students with RF circuit fundamentals for designing various circuit building blocks in a typical RF transceiver. At the completion of the course, students should appreciate the workings of RF transceivers. They are expected to be able to design key building blocks of RF transceivers, including low-noise amplifiers, standard matching circuits, RF amplifiers, mixers, power amplifiers and RF oscillators.

Course Outcomes
1. Explain the behavior of RF passive components and model active components. (Understanding)
2. Perform transmission line analysis. (Applying, Analysing)
3. Demonstrate use of Smith Chart for high frequency circuit design. (Understanding)
4. Justify the choice/selection of components from the design aspects. (Evaluating)

5. Contribute in the areas of RF circuit design. (Creating)

Module I (8 Hours)
Transmission Line Theory: Lumped element circuit model for transmission line, field analysis, Smith chart, quarter wave transformer, generator and load mismatch, impedance matching and tuning.

Module II (7 Hours)
Microwave Network Analysis: Impedance and equivalent voltage and current, Impedance and admittance matrix, the scattering matrix, transmission matrix, Signal flow graph.

Module III (10 Hours)
Microwave Components: Microwave resonators, Microwave filters, power dividers and directional couplers, Ferromagnetic devices and components.

Module IV (5 Hours)
Nonlinearity And Time Variance in Microwave Circuits: Inter-symbol interference, random process & noise, definition of sensitivity and dynamic range, conversion gain and distortion.

Module V (10 Hours)
Microwave Semiconductor Devices And Modeling: PIN diode, Tunnel diodes, Varactor diode, Schottky diode, IMPATT and TRAPATT devices, transferred electron devices, Microwave BJTs, GaAs FETs, low noise and power GaAs FETs, MESFET, MOSFET, HEMT.

Module VI (5 Hours)
Amplifiers Design: Power gain equations, stability, impedance matching, constant gain and noise figure circles, small signal, low noise, high power and broadband amplifier, oscillators, Mixers design.

Suggested Readings

1. Matthew M. Radmanesh, "Advanced RF & Microwave Circuit Design: The Ultimate Guide to Superior
2. Design", AuthorHouse, 2009.
3. D.M.Pozar, " Microwave engineering" ,Wiley, 4th edition, 2011.
4. R.Ludwig and P.Bretchko, "R. F. Circuit Design", Pearson Education Inc, 2009.
5. G.D. Vendelin, A.M. Pavoi, U. L. Rohde, "Microwave Circuit Design Using Linear And Non Linear Techniques", John Wiley 1990.
6. S.Y. Liao, "Microwave circuit Analysis and Amplifier Design", Prentice Hall 1987.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M	H	L		L
CO 2	H	M	L			
CO 3	H	H	M	M		L
CO4		M	H	H	L	M
CO 5	L	L	M	M	H	H

ECMA0067 MICROCONTROLLERS AND APPLICATIONS (L-T-P: 3-0-0)
(3 credits- 45 hours)

Objective
The course helps to develop an in-depth understanding of the operation of microcontrollers, assembly language programming and microcontroller interfacing techniques. The students will be able to design and implement microcontroller based systems in both hardware and software and can apply this knowledge to more advanced structures.

Course Outcomes
1. Define various terminologies related to microprocessor and microcontrollers. (Remembering)
2. Compare between microprocessor and microcontroller and to explain the internal organization of 8051 microcontroller and PIC16C61 microcontroller. (Understanding)
3. Apply 8051 microcontroller to solve real life problems. (Applying)
4. Analyze the performance of 8051 microcontroller and to design and develop 8051 based system. (Analyzing)
5. Explain the fundamentals of PIC microcontroller. (Understanding)

Module I (7 hours)
Introduction: History of Microcontrollers and Microprocessors. Differences between Microcontrollers and Microprocessors, Introduction to MPU of different categories- such as Microcontroller-8051, AVR, PIC, etc., their specific features, advantages.

Module II (10 hours)
Microcontroller 8051: Introduction; MCS-51 Architecture; Registers, I/O Ports, Memory organization.

Module III (12 hours)
Assembly Language Microcontroller 8051: Instructions, Addressing modes, Arithmetical, Logical, Jumps, Loops and Call etc., Interrupts Timers/ Counters and Serial Communications.

Module IV (8 hours)
Application of MCS-51: Interfacing 7-segment display, LCD, Key board, ADC etc. Development of instrumentation system such as temperature, pressure, flow, frequency, pulse width, voltage, rpm, pH etc. monitoring. Generation of PWM wave, Data-logger, alarm enunciators, PID controller, programmable controller and interlock control.

Module V (8 hours)
Introduction to PIC microcontrollers: Architecture, Mid-Range instruction Set, Power Input and Decoupling, Reset, Watchdog Timer, System Clock/Oscillators.

Suggested Readings
1. M. A. Mazidi and J. G. Mazidi, the 8051 Microcontroller and Embedded Systems
2. A V Deshmukh, Microcontrollers: Theory and Applications
3. Subrata Ghoshal, 8051 Microcontroller-Internals, Instructions, Programming and Interfacing, Pearson
4. Md Ali Mazidi, Rolin D. Mc-Kindly and Janice Gillistie, the 8051 Microcontroller and Embedded System Using Assembly and C
5. Lyla B. Das, Embedded Systems-An Integrated Approach, Pearson
6. Relevant Data Sheets

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	M	L		
CO 2		H	M	M	
CO 3			H	M	
CO 4		L	M	H	
CO 5					H

ECPP0068 PARALLEL PROCESSING (L-T-P: 3-0-0)
(3 Credits- 45 hours)

Objective
The objective of this course is to expose the students to the concept of parallel processing and pipelining. In this course students are introduced to the limitations of different architectures of computer. After this course students will be able to Analyse the performance parameters for different architectures.

Course Outcomes
1. Define parallel processing and pipeling, multiprocessor architecture, multithreaded architectures and multithreaded processors (Remembering)
2. Explain parallel processing and pipeling, multiprocessor architecture, multithreaded architectures and multithreaded processors (Understanding)
3. Implement parallel programming techniques (Applying)
4. Compare various parallel processing and pipelining techniques, multiprocessor architecture, multithreaded architectures and multithreaded processors and various operating systems for multiprocessors. (Analyzing)
5. Choose suitable one amongst various parallel processing and pipeling techniques, multiprocessor architecture, multithreaded architectures and multithreaded processors and various operating systems for multiprocessors (Evaluating)

Module I (5 hours)
Overview of Parallel Processing and Pipelining, Performance analysis, Scalability

Module II (10 hours)
Principles and implementation of Pipelining, Classification of pipelining processors, Advanced pipelining techniques, Software pipelining

Module III (10 hours)
VLIW processors, Case study: Superscalar Architecture- Pentium, Intel Itanium Processor, Ultra SPARC, MIPS on FPGA, Vector and Array Processor, FFT Multiprocessor Architecture

Module IV (5 hours)
Multithreaded Architecture, Multithreaded processors, Latency hiding techniques, Principles of multithreading, Issues and solutions

Module V (10 hours)
Parallel Programming Techniques: Message passing program development, Synchronous and asynchronous message passing, Shared Memory Programming, Data Parallel Programming, Parallel Software Issues

Module VI (5 hours)
Operating systems for multiprocessors systems, Customizing applications on parallel processing platforms

Suggested Readings
1. Kai Hwang, Faye A. Briggs, "Computer Architecture and Parallel Processing", MGH International Edition
2. Kai Hwang, "Advanced Computer Architecture", TMH
3. V. Rajaraman, L. Sivaram Murthy, "Parallel Computers", PHI.
4. William Stallings, "Computer Organization and Architecture, Designing for performance" Prentice Hall, Sixth edition

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	L	H	H	M	L
CO 2	H	L	H	H	M	L
CO 3	M	M	L	L	H	L
CO 4	H	L	H	H	M	H
CO 5	H	L	H	H	M	H

ECPM0069 PATTERN RECOGNITION AND MACHINE LEARNING (L-T-P: 3-0-0)
(3 credits- 45 hours)

Objective
The course is intended to make an insight into different statistical models for pattern recognition problems. This course includes different statistical models, linear regression models, different machine learning tools like Neural Network, Fuzzy Logic and different clustering techniques.

Course Outcomes
1. Define various terminologies used in probability theory and statistics, Linear models, neural networks, linear discriminant functions (Remembering)
2. Explain various terminologies used in probability theory and statistics, Linear models, neural networks, linear discriminant functions, unsupervised learning methods (Understanding)
3. Implement various Linear models, neural networks, linear discriminant functions, unsupervised learning methods (Applying)
4. Compare various Linear models, neural networks, linear discriminant functions, unsupervised learning methods (Analyzing)
5. Choose suitable one amongst various neural networks, linear discriminant functions, unsupervised learning methods for specific application (Evaluating)

Module I (10 Hours)
Introduction to Pattern Recognition: Problems, applications, design cycle, learning and adaptation, examples, Probability distributions, Parametric Learning - Maximum likelihood and Bayesian Decision Theory- Bayes rule, discriminant functions, loss functions and Bayesian error analysis

Module II (5 Hours)
Linear models: Linear Models for Regression, linear regression, logistic regression Linear Models for classification

Module III (10 Hours)
Neural Network: Perceptron, multi-layer perceptron, back propagation algorithm, error surfaces, practical techniques for improving back propagation, additional networks and training methods, Adaboost, Deep Learning

Module IV (8 Hours)
Linear discriminant functions: Decision surfaces, two-category, multi-category, minimum squared error procedures, the Ho-Kashyap procedures, linear programming algorithms, Support vector machine

Module V (7 Hours)
Algorithm independent machine learning: Lack of inherent superiority of any classifier, bias and variance, re-sampling for classifier design, combining classifiers.

Module VI (5 Hours)
Unsupervised learning and clustering: k-means clustering, fuzzy k-means clustering, hierarchical clustering.

Suggested Readings

1. Richard O. Duda, Peter E. Hart, David G. Stork, “Pattern Classification”, 2nd Edition John Wiley & Sons, 2001.
2. Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, “The Elements of Statistical Learning”, 2nd Edition, Springer, 2009.
3. C. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	H	H	H	L	L
CO 2	H	H	H	H	L	H
CO 3	L	H	H	H	M	H
CO 4	L	H	H	H	M	H
CO 5	M	L	H	H	M	H

ECDE0070 DETECTION AND ESTIMATION THEORY (L-T-P: 3-0-0)
(3 Credits- 45 Hours)

Objective
The objective of the course is to familiarize the students with mathematical understanding of signal detection and estimation. This course also intends to use various approaches to formulate and solve problems for signal detection and parameter estimation from noisy signals.

Course Outcomes
1. Explain of data computing algorithms like PCA, SVD etc. (Understanding)
2. Identify various measures of random processes associated with LTI system. (Applying)
3. Analyse the concepts of random processes in detection and estimation theory. (Analysing))
4. Discuss the design of different types of filters like Kalman and Weiner. (Creating)

Module I (5 Hours)
Review of Vector Spaces: Vectors and matrices: notation and properties, orthogonality and linear independence, bases, distance properties, matrix operations, Eigenvalues and eigenvectors.

Module II (7 Hours)
Properties of Symmetric Matrices: Diagonalization of symmetric matrices, symmetric positive definite and semi definite matrices, principal component analysis (PCA), singular value decomposition.

Module III (10 Hours)
Stochastic Processes: Time average and moments, ergodicity, power spectral density, covariance matrices, response of LTI system to random process, cyclostationary process, and spectral factorization.

Module IV (10 Hours)
Detection Theory: Detection in white Gaussian noise, correlator and matched filter interpretation, Bayes‘ criterion of signal detection, MAP, LMS, entropy detectors, detection in colored Gaussian noise, Karhunen-Loeve expansions and whitening filters.

Module V (5 Hours)
Estimation Theory: Minimum variance estimators, Cramer-Rao lower bound, examples of linear models, system identification, Markov classification, clustering algorithms.

Module VI (8 Hours)
Topics in Kalman and Weiner Filtering: Discrete time Wiener-Hopf equation, error variance computation, causal discrete time Wiener filter, discrete Kalman filter, extended Kalman filter. Specialized Topics in Estimation: Spectral estimation methods like MUSIC, ESPIRIT, DOA Estimation.

Suggested Readings

1. Steven M. Kay, “Fundamentals of Statistical Signal Processing, Volume I: Estimation Theory”, Prentice Hall, 1993
2. Steven M. Kay, “Fundamentals of Statistical Signal Processing, Volume II: Detection Theory”, 1st Edition, Prentice Hall, 1998
3. Thomas Kailath, BabakHassibi, Ali H. Sayed, “Linear Estimation”, Prentice Hall, 2000.
4. H. Vincent Poor, “An Introduction to Signal Detection and Estimation”, 2nd Edition, Springer, 1998.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	H				
CO 2		L	H			
CO 3	M			H	H	
CO 4				L	M	H

ECIA0071 IOT AND APPLICATIONS (L-T-P: 3-0-0)
(3 credits- 45 hours)

Objective
The main objective of this course is to introduce the students with the concept of IOT and M2M. In this course they will study IOT architecture and applications in various fields along with the security and privacy issues in IOT.

Course Outcomes
1. Choose recent technologies related to IOT and Web technologies. (Understanding)
2. Illustrate the concept of IOT, M2M Security and privacy issues in IOT. (Understanding)
3. Apply the concept of IOT architecture and Web technologies. (Applying)
4. Analyze IOT architecture and applications in various fields. (Analyzing)

Module I (10 Hours)
IoT & Web Technology The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.

Module II (8 Hours)
M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT ValueChains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Module III (7 Hours)
IoT Architecture -State of the Art – Introduction, State of the art, Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

Module IV (10 Hours)
IoT Applications for Value Creations Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.

Module V (5 Hours)
Internet of Things Privacy, Security and Governance Introduction, Overview of Governance, Privacy and Security Issues

Module VI (5 Hours)
Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure

Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security

Suggested Readings

1. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014
2. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013
3. CunoPfister, “Getting Started with the Internet of Things”, OReilly Media, 2011

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M	M	L		M
CO 2		M			M	M
CO 3			L	L		L
CO4	M		M	H	L	

ECDD0072 DIGITAL DESIGN AND VERIFICATION (L-T-P: 3-0-0)

(3 credits- 45 hours)

Objective

The objective of the course is to familiarize the students with Front end design and verification techniques and create reusable test environments. This course also intends to perform verification of increasingly complex designs more efficiently and effectively.

Course Outcomes

1. Define combinational, sequential logic design and PLDs. (Remembering)
2. Explain the design methodology of HDL (VHDL/Verilog). (Understanding)
3. Explain the architecture of PLDs. (Understanding)
4. Apply HDL coding techniques for various combinational and sequential circuit design. (Applying)
5. Compare different circuit designs for speed, power and noise optimization. (Analysing)
6. Verify increasingly complex designs more efficiently and effectively. (Evaluating)
7. Use EDA tools like Xilinx, Cadence, Mentor Graphics for various electronic design. (Creating)

Module I (10 Hours)

Revision of basic Digital systems: Combinational Circuits, Sequential Circuits, Logic families. Synchronous FSM and asynchronous design, Metastability, Clock distribution and issues, basic building blocks like PWM module, prefetch unit, programmable counter, FIFO, Booth’s multiplier, ALU, Barrel shifter etc.

Module II (8 Hours)

Verilog/VHDL Comparisons and Guidelines, Verilog: HDL fundamentals, simulation, and testbench design, Examples of Verilog codes for combinational and sequential logic, Verilog AMS

Module III (7 Hours)

System Verilog and Verification: Verification guidelines, Data types, procedural statements and routines, connecting the test bench and design, Assertions, Basic OOP concepts, Randomization, Introduction to basic scripting language: Perl, Tcl/Tk

Module IV (8 Hours)

Current challenges in physical design: Roots of challenges, Delays: Wire load models Generic PD flow, Challenges in PD flow at different steps, SI Challenge - Noise & Crosstalk, IR Drop, Process effects: Process Antenna Effect & Electromigration.

Module V (7 Hours)

Programmable Logic Devices: Introduction, Evolution: PROM, PLA, PAL, Architecture of PAL’s, Applications, Programming PLD’s, FPGA with technology: Antifuse, SRAM, EPROM, MUX, FPGA structures, and ASIC Design Flows, Programmable Interconnections, Coarse grained reconfigurable devices.

Module VI (5 Hours)

IP and Prototyping: IP in various forms: RTL Source code, Encrypted Source code, Soft IP, Netlist, Physical IP, and Use of external hard IP during prototyping, Case studies, and Speed issues. Testing of logic circuits: Fault models, BIST, JTAG interface.

Suggested Readings

1. Douglas Smith, "HDL Chip Design: A Practical Guide for Designing, Synthesizing & Simulating ASICs & FPGAs Using VHDL or Verilog", Doone publications, 1998.
2. Samir Palnitkar, "Verilog HDL: A guide to Digital Design and Synthesis", Prentice Hall, 2nd Edition, 2003.
3. Doug Amos, Austin Lesea, Rene Richter, "FPGA based Prototyping Methodology Manual", Synopsys Press, 2011.
4. Christophe Bobda, "Introduction to Reconfigurable Computing, Architectures, Algorithms and Applications", Springer, 2007.
5. Janick Bergeron, "Writing Testbenches: Functional Verification of HDL Models", Second Edition, Springer, 2003.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M	L		H	
CO 2	M	H		L		
CO 3	M	M		L	H	
CO4	M	H	H	M	L	
CO 5	L	M	M	H		L
CO 6			M	H	H	
CO 7			L	L	M	H

ECBS0073 BIOMEDICAL SIGNAL PROCESSING (L-T-P: 3-0-0)

(3 credits- 45 hours)

Objective

The course will help to develop an in-depth understanding of different types of biomedical signals. The students will be able to identify and Analyse different biomedical signals.

Course Outcomes

1. Define the fundamentals of biomedical signals. (Remembering)
2. Interpret the various types of biomedical signals. (Understanding)
3. Experiment with various types of biomedical signals using various technological tool. (Applying)
4. Analyze and assess biomedical signals using various technological tool. (Analyzing)

Module I (5 hours)

Acquisition, Generation of Bio-signals, Origin of bio-signals, Types of bio-signals, Study of diagnostically significant bio-signal parameters

Module II (5 hours)

Electrodes for bio-physiological sensing and conditioning, Electrode-electrolyte interface, polarization, electrode skin interface and motion artefact, biomaterial used for electrode, Types of electrodes (body surface, internal, array of electrodes, microelectrodes), Practical aspects of using electrodes, Acquisition of bio-signals (signal conditioning) and Signal conversion (ADC's DAC's) Processing, Digital filtering

Module III (7 hours)

Biomedical signal processing by Fourier analysis, Biomedical signal processing by wavelet (time- frequency) analysis, Analysis (Computation of signal parameters that are diagnostically significant)

Module IV (9 hours)

Classification of signals and noise, Spectral analysis of deterministic, stationary random signals and non-stationary signals, Coherent treatment of various biomedical signal processing methods and applications.

Module V (8 hours)

Principal component analysis, Correlation and regression, Analysis of chaotic signals Application areas of Bio–Signals analysis Multiresolution analysis (MRA) and wavelets, Principal component analysis(PCA), Independent component analysis(ICA)

Module VI (6 hours)

Pattern classification–supervised and unsupervised classification, Neural networks, Support vector Machines, Hidden Markov models. Examples of biomedical signal classification examples

Suggested Readings

1. W. J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall, 1993.

2. Eugene N Bruce, “Biomedical Signal Processing and Signal Modeling”, John Wiley & Son’s publication, 2001.
3. Myer Kutz, “Biomedical Engineering and Design Handbook, Volume I”, McGraw Hill, 2009.
4. D C Reddy, “Biomedical Signal Processing”, McGraw Hill, 2005.
5. Katarzyn J. Blinowska, JaroslawZygarewicz, “Practical Biomedical Signal Analysis Using MATLAB”, 1st Edition, CRC Press, 2011.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				
CO 2		H	M	L		
CO 3			H	M	M	M
CO 4				H	H	M

ECDS0074 DSP ARCHITECTURE (L-T-P: 3-0-0)
(3 credits- 45 hours)

Objective

The objective of the course is to familiarize the students with architecture of various DSP hardware. It aims to equip the students with ability to design, programming (assembly and C), and testing code using Code Composer Studio environment and other tools at an intermediate to advanced level that will serve them well towards tackling various problems in this discipline.

Course Outcomes
1. Recall, illustrate and summarize the DSP Architecture. (Remembering, Understanding)
2. Make use of TMS320C6X family DSP processor. (Applying)
3. Explain and solve signal processing problems with the help of FPGA based DSP system. (Understanding, Applying)
4. Develop DSP based Assembly Language Programming. (Creating)
5. Examine and explain complete design of DSP system. (Analyzing, Evaluating)

Module I (10 Hours)

Programmable DSP Hardware: Processing Architectures (von Neumann, Harvard), DSP core Algorithms (FIR, IIR, Convolution, Correlation, FFT), IEEE standard for Fixed and Floating Point Computations, Special Architectures Modules used in Digital Signal Processors (like MAC unit, Barrel shifters), On-Chip peripherals, DSP benchmarking.

Module II (15 Hours)

Structural and Architectural Considerations: Parallelism in DSP processing, Texas Instruments TMS320 Digital Signal Processor Families, Fixed Point TI DSP Processors: TMS320C1X and TMS320C2X Family,TMS320C25 –Internal Architecture, Arithmetic and Logic Unit, Auxiliary Registers, Addressing Modes (Immediate, Direct and Indirect, Bit-reverse Addressing), Basics of TMS320C54x and C55x Families in respect of Architecture improvements and new applications fields, TMS320C5416 DSP Architecture, Memory Map, Interrupt System, Peripheral Devices, Illustrative Examples for assembly coding.

Module III (10 Hours)

VLIW Architecture: Current DSP Architectures, GPUs as an alternative to DSP Processors, TMS320C6X Family, Addressing Modes, Replacement of MAC Moduleby ILP, Detailed study of ISA, Assembly Language Programming, Code Composer Studio, Mixed C and Assembly Language programming, On-chip peripherals, Simple applications developments as an embedded environment.

Module IV (5 Hours)

Application of DSPs for signal processing, communication and multimedia. Multi-core DSPs: Introduction to Multi-core computing and applicability for DSP hardware.

Module V (5 Hours)

FPGA based DSP Systems: Limitations of P-DSPs, Requirements of Signal processing for Cognitive Radio (SDR), FPGA based signal processing design-case study of a complete design of DSP processor.

Suggested Readings

1. M. Sasikumar, D. Shikhare, Ravi Prakash, “Introduction to Parallel Processing”, 1st Edition, PHI, 2006.
2. Fayez Gebali, “Algorithms and Parallel Computing”,1st Edition, John Wiley & Sons, 2011
3. Rohit Chandra, Ramesh Menon, Leo Dagum, David Kohr, DrorMaydan, Jeff McDonald,“Parallel Programming in OpenMP”, 1st Edition, Morgan Kaufman,2000.

4. Ann Melnichuk,Long Talk, “Multicore Embedded systems”, 1st Edition, CRC Press,2010.
5. Wayne Wolf, “High Performance Embedded Computing: Architectures, Applications and Methodologies”, 1st Edition, Morgan Kaufman, 2006.
6. E.S.Gopi, “Algorithmic Collections for Digital Signal Processing Applications Using MATLAB”, 1st Edition, Springer Netherlands,2007.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	M	M		L
CO 2		H	M	L	
CO 3			L	M	H
CO 4			H	M	L
CO 5	M	M	L	H	H

ECRS0075: ANTENNAS AND RADIATING SYSTEMS (L-T-P: 3-0-0)

(3 Credits- 45 hours)

Objective

The objective of this course is to introduce students with the concept of antennas, their principle of operation, analysis and their applications. It will also cover the theory of wave propagation over ground, through the troposphere and ionosphere; diversity principles; propagation effects in microwave systems, satellite, space, and radar links.

Course Outcomes

1. Compute the far field distance, radiation pattern and gain of an antenna for given current distribution. (Applying)
2. Compute the array factor for an array of identical antennas. (Applying)
3. Estimate the input impedance, efficiency and ease of match for antennas. (Evaluating)
4. Design antennas and antenna arrays for various desired radiation pattern characteristics. (Creating)

Module I (10 Hours)

Types of Antennas: Wire antennas, Aperture antennas, Micro strip antennas, Array antennas Reflector antennas, Lens antennas, Radiation Mechanism, Current distribution on thin wire antenna. Fundamental Parameters of Antennas: Radiation Pattern, Radiation Power Density, Radiation Intensity, Directivity, Gain, Antenna efficiency, Beam efficiency, Bandwidth, Polarization, Input Impedance, radiation efficiency, Antenna Vector effective length, Friis Transmission equation, Antenna Temperature.

Module II (8 Hours)

Linear Wire Antennas: Infinitesimal dipole, Small dipole, Region separation, Finite length dipole, half wave dipole, Ground effects. Loop Antennas: Small Circular loop, Circular Loop of constant current, Circular loop with non-uniform current.

Module III (7 Hours)

LinearArrays: Two element array, N Element array: Uniform Amplitude and spacing, Broadside and End fire array, Super directivity, Planar array, Design consideration.

Module IV (8 Hours)

Aperture Antennas: Huygen’s Field Equivalence principle, radiation equations, Rectangular Aperture, Circular Aperture. Horn Antennas: E-Plane, H-plane Sectoral horns, Pyramidal and Conical horns.

Module V (7 Hours)

Micro strip Antennas: Basic Characteristics, Feeding mechanisms, Method of analysis, Rectangular Patch, Circular Patch.

Module VI (5 Hours)

Reflector Antennas: Plane reflector, parabolic reflector, Cassegrain reflectors, Introduction to MIMO.

Suggested Readings

1. Constantine A. Balanis, “Antenna Theory Analysis and Design”, John Wiley & Sons, 4th edition, 2016.
2. John D Kraus, Ronald J Marhefka, Ahmad S Khan, “Antennas for All Applications”, Tata McGraw-Hill, 2002.
3. R.C.Johnson and H.Jasik, “Antenna Engineering handbook”, Mc-Graw Hill, 1984.
4. I.J.Bhal and P.Bhartia, “Micro-strip antennas”, Artech house, 1980.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M	L	L		
CO 2		M	H	L	L	
CO 3	M	H	H	M		L
CO 4	M	L		H	H	

ECCN0076 ADVANCED COMMUNICATION NETWORK (L-T-P: 3-0-0)

(3 Credits- 45 hours)

Objective

The main objective of the course is to familiarize the students with concepts in communication networking. This course is intended to teach the students about various protocols in communication networking. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling various problems in this discipline.

Course Outcomes

1. Definition of basic taxonomy and terminology of the computer networking area. (Remembering)
2. Understand advanced concepts in Communication Networking. (Understanding)
3. Understand the mechanisms in Quality of Service in networking. (Understanding)
4. Apply the basic concepts to build efficient networks. (Applying)
5. Analyse the network from layers of OSI and TCP/IP model perspective. (Analysing)
6. Evaluate and measure the performance issues in different networks. (Evaluating)
7. Design and develop protocols for Communication Networks. (Creating)

Module I (8 Hours)

Overview of Internet-Concepts, challenges and history. Overview of -ATM. TCP/IP Congestion and Flow Control in Internet-Throughput analysis of TCP congestion control. TCP for high bandwidth delay networks. Fairness issues in TCP.

Module II (10 Hours)

Real Time Communications over Internet. Adaptive applications. Latency and throughput issues. Integrated Services Model (intServ). Resource reservation in Internet. RSVP; Characterization of Traffic by Linearly Bounded Arrival Processes (LBAP).Leaky bucket algorithm and its properties.

Module III (10 Hours)

Packet Scheduling Algorithms-requirements and choices. Scheduling guaranteed service connections. GPS, WFQ and Rate proportional algorithms. High speed scheduler design. Theory of Latency Rate servers and delay bounds in packet switched networks for LBAP traffic.; Active Queue Management - RED, WRED and Virtual clock. Control theoretic analysis of active queue management.

Module IV (7 Hours)

IP address lookup-challenges. Packet classification algorithms and Flow Identification- Grid of Tries, Cross producting and controlled prefix expansion algorithms.

Module V (5 Hours)

Admission control in Internet. Concept of Effective bandwidth. Measurement based admission control. Differentiated Services in Internet (DiffServ). DiffServ architecture and framework.

Module VI (5 Hours)

IPV4, IPV6, IP tunnelling, IP switching and MPLS, Overview of IP over ATM and its evolution to IP switching. MPLS architecture and framework. MPLS Protocols. Traffic engineering issues in MPLS.

Suggested Readings

1. Jean Wairand and Pravin Varaiya, “High Performance Communications Networks”, 2nd edition, 2000.
2. Jean Le Boudec and Patrick Thiran, “Network Calculus A Theory of Deterministic Queueing Systems for the Internet”, Springer Veriag, 2001.
3. Zhang Wang, “Internet QoS”, Morgan Kaufman, 2001.
4. Anurag Kumar, D. Manjunath and Joy Kuri, “Communication Networking: An Analytical Approach”, Morgan Kaufman Publishers, 2004.

5. George Kesidis, "ATM Network Performance", Kluwer Academic, Research Papers, 2005.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					
CO 2			H	M	M	M
CO 3		H				
CO 4						H
CO 5	H					M
CO 6					H	M
CO 7						H

ECMS0077 MIMO SYSTEM (L-T-P: 3-0-0)
(3 Credits- 45 hours)

Objective

This course covers the fundamentals of Multiple input multiple output (MIMO) antenna based wireless communication systems. This course covers important concepts of MIMO communication such as capacity computation, error probability analysis, transmitter and receiver design, multi-user communication, etc. After completion of the course the participants will be able to apply the methods for performance analysis and design of advanced wireless communication systems.

Course Outcomes

1. Explain channel modelling and propagation, MIMO Capacity, space-time coding, MIMO receivers, MIMO for multi-carrier systems (e.g. MIMO-OFDM), multi-user communications, multi-user MIMO. (Understanding)
2. Illustrate, Analyse and interpret the cooperative and coordinated multi-cell MIMO and MIMO in 4G (LTE, LTE-Advanced, WiMAX). (Understanding, Analysing, Evaluating)
3. Perform Mathematical modelling and analysis of MIMO systems. (Creating)

Module I (5 Hours)

Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems, MIMO vs. multi-antenna systems.

Module II (10 Hours)

Diversity, exploiting multipath diversity, transmit diversity, Space-time codes, The Alamouti scheme, Delay diversity, Cyclic delay diversity, Space-frequency codes, Receive diversity, The rake receiver, Combining techniques, Spatial Multiplexing, Spectral efficiency and capacity, Transmitting independent streams in parallel, Mathematical notation

Module III (10 Hours)

The generic MIMO problem, Singular Value Decomposition, Eigenvalues and eigenvectors, Equalising MIMO systems, Disadvantages of equalising MIMO systems, Predistortion in MIMO systems, Disadvantages of pre-distortion in MIMO systems, Pre-coding and combining in MIMO systems, Advantages of pre-coding and combining, Disadvantages of precoding and combining, Channel state information.

Module IV (8 Hours)

Codebooks for MIMO, Beam forming, Beam forming principles, increased spectrum efficiency, Interference cancellation, Switched beam former, Adaptive beam former, Narrowband beam former, Wideband beam former

Module V (7 Hours)

Case study: MIMO in LTE, Codewords to layers mapping, Pre-coding for spatial multiplexing, Pre- coding for transmit diversity, Beamforming in LTE, Cyclic delay diversity based pre-coding, Pre- coding codebooks, Propagation Channels, Time & frequency channel dispersion, AWGN and multipath propagation channels, Delay spread values and time variations, Fast and slow fading environments, Complex baseband multipath channels, Narrowband and wideband channels, MIMO channel models

Module VI (5 Hours)

Channel Estimation, Channel estimation techniques, Estimation and tracking, Training based channel estimation, Blind channel estimation, Channel estimation architectures, Iterative channel estimation, MMSE channel estimation, Correlative channel sounding, Channel estimation in single carrier systems, Channel estimation for CDMA, Channel estimation for OFDM.

Suggested Readings

1. Claude Oestges, Bruno Clerckx, "MIMO Wireless Communications : From Real-world Propagation to Space-time Code Design",Academic Press, 1st edition, 2010.

2. Mohinder Janakiraman, "Space - Time Codes and MIMO Systems", Artech House Publishers, 2004.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	H	H	M	M	
CO 2		L	M	H	H	L
CO 3	L	M	M	M	L	H

ECSA0078 EMBEDDED SYSTEMS AND APPLICATIONS (L-T-P: 3-0-0)

(3 Credits- 45 hours)

Objective

The objective of this course is to expose the students to the features of advanced microcontrollers such as PIC and AVR. In this course students are introduced to the architecture, programming and interfacing of all these microcontrollers. Industrial applications of these microcontrollers are also introduced in this course.

Course Outcomes

1. Define various terminologies related to PIC and AVR microcontroller. (Remembering)
2. Explain the internal organization of PIC and AVR microcontroller. (Understanding)
3. Apply and analyze PIC and AVR microcontroller based system. (Applying)
4. Design and develop PIC and AVR microcontroller based system. (Creating)

Module I (10 Hours)

PIC Microcontroller: Overview of PIC Microcontrollers, PIC16CXX Series: Architecture, Memory Organization, Registers, Oscillator Connections, Reset Actions, I/O ports, Interrupt, Timers, ADC, Watch Dog timer, Instruction Set

Module II (10 Hours)

PIC16F8XX Series:

a) Architecture, Memory Organization, Registers, Oscillator Connections, I/O ports, Interrupt, Timers, ADC, Instruction Set, Capture/Compare/PWM Module, MSSP Module, USART, Watch Dog Timer.
b) Assembly Language Programming using PIC16CXX and PIC16F8XX

Module III (10 Hours)

PIC24FXX Family Microcontroller: Architecture, Memory Organization, Registers, Oscillator Connections, I/O ports, Interrupt, Timers, Watch Dog timer, ADC, PWM, Serial Communications, Programming using Embedded C.

Module IV (15 Hours)

AVR Microcontroller:

a. Introduction, History, Importance of AVR, Naming Convention of AVR, Mega AVR Series.
b. ATMega8 Microcontroller: Architecture, Pin Diagram, Memory Organization, Registers, Oscillator Connections, I/O ports, Interrupt, Timers, ADC, Watch Dog timer.
c. ATMega16 Microcontroller: Architecture, Pin Diagram, Memory Organization, Registers, Oscillator Connections, I/O ports, Interrupt, Timers, ADC, Watch Dog timer.
d. Programming using ATMega8 and ATMega16.

Suggested Readings

1. V. Deshmukh, Microcontroller: Theory and Applications, TMG, 1st Edition
2. Md. Ali Mazidi, Rolin D. Mckinlay, Danny Causey, PIC Microcontroller and Embedded Systems: Using Assembly and C, Pearson, 1st Edition
3. Md. Ali Mazidi, SarmadNaimi, SepehrNaimi, The AVR Microcontroller and Embedded Systems: Using Assembly and C, Pearson, 1st Edition
4. Relevant Data Sheets

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			M
CO 2		H	M	L
CO 3		M	H	L
CO 4			M	H

ECMT0079 MEMORY TECHNOLOGIES (L-T-P: 3-0-0)
(3 Credits- 45 hours)

Objective
The course helps to develop an in-depth understanding of the various memory types. The students will be able to learn. After this course students will be able to design semiconductor memory circuits and subsystems. They can also identify various fault models, modes and mechanisms in semiconductor memories and their testing procedures.

Course Outcomes
1. Define various memory architecture. (Remembering)
2. Explain memory circuits and subsystems. (Understanding)
3. Apply various fault models, modes and mechanisms in semiconductor memories and their testing procedures. (Applying)
4. Analyse advanced memory technologies. (Analysing)
5. Assess various high density memory packing technologies. (Evaluating)
6. Discuss memory testing and reliability issues and start of the art memory chip design. (Creating)

Module I (10 hours)
Random Access Memory Technologies, Static Random Access Memories (SRAMs), SRAM Cell Structures, MOS SRAM Architecture, MOS SRAM Cell and Peripheral Circuit, Bipolar SRAM, Advanced SRAM Architectures, Application Specific SRAMs.

Module II (5 hours)
DRAMs, MOS DRAM Cell, BiCMOS DRAM, Error Failures in DRAM, Advanced DRAM Design and Architecture, Application Specific DRAMs. SRAM and DRAM Memory controllers.

Module III (5 hours)
Non-Volatile Memories, Masked ROMs, PROMs, Bipolar & CMOS PROM, EEPROMs, Floating Gate EPROM Cell, OTP EPROM, EEPROMs, Non-volatile SRAM, Flash Memories

Module IV (10 hours)
Semiconductor Memory Reliability and Radiation Effects, General Reliability Issues, RAM Failure Modes and Mechanism, Non-volatile Memory, Radiation Effects, SEP, Radiation Hardening Techniques. Process and Design Issues, Radiation Hardened Memory Characteristics, Radiation Hardness Assurance and Testing

Module V (10 hours)
Advanced Memory Technologies and High-density Memory Packing Technologies,Ferroelectric Random Access Memories (FRAMs), Gallium Arsenide (GaAs) FRAMs, Analog Memories, MagnetoResistive Random Access Memories (MRAMs), Experimental Memory Devices

Module VI (5 hours)
Memory Hybrids (2D & 3D), Memory Stacks, Memory Testing and Reliability Issues, Memory Cards, High Density Memory Packaging

Suggested Readings
1. Ashok K Sharma, “Advanced Semiconductor Memories: Architectures, Designs and Applications”, Wiley Interscience
2. KiyooItoh, “VLSI memory chip design”, Springer International Edition
3. Ashok K Sharma,” Semiconductor Memories: Technology, Testing and Reliability, PHI

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M	M			
CO 2	L	H	H	L		
CO 3		M	H	L		
CO 4			M	H		
C0 5				L	H	
C0 6				L	M	H

ECBS0080 COMMUNICATION BUSES AND INTERFACES (L-T-P: 3-0-0)

(3 Credits- 45 hours)

Objective

This main objective of this course is to introduce the students with the concept of various communication buses. After this course students will be able to develop APIs for configuration, reading and writing data onto serial bus and can also design and develop peripherals that can be interfaced to desired serial bus

Course Outcomes

1. Define various terminologies related to communication buses. (Remembering)
2. Compare various communication buses. (Understanding)
3. Explain the architecture of various communication buses. (Understanding)
4. Apply and analyze the concept of various communication buses. (Applying/ Analyzing)

Module I (8 hours)

Serial Busses, Physical interface, Data and Control signals, features

Module II (8 hours)

Limitations and applications of RS232, RS485, I2C, SPI

Module III (8 hours)

CAN - Architecture, Data transmission, Layers, Frame formats, applications

Module IV (8 hours)

PCI - Revisions, Configuration space, Hardware protocols, applications

Module V (8 hours)

USB - Transfer types, enumeration, Descriptor types and contents, Device driver

Module VI (5 hours)

Data Streaming Serial Communication Protocol, Serial Front Panel Data Port (SFPDP) using fiber optic and copper cable

Suggested Readings

1. Jan Axelson, "Serial Port Complete - COM Ports, USB Virtual Com Ports, and Ports for Embedded Systems", Lakeview Research, 2nd Edition
2. Jan Axelson, "USB Complete", Penram Publications
3. Mike Jackson, Ravi Budruk, "PCI Express Technology", Mindshare Press
4. Wilfried Voss, "A Comprehensible Guide to Controller Area Network", Copperhill Media Corporation, 2nd Edition, 2005.
5. Serial Front Panel Draft Standard VITA 17.1 – 200x
6. Technical references onwww.can-cia.org; www.pcisig.com; www.usb.org

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	L				
CO 2		H	M	M	M	
CO 3			H	H	H	
CO 4			L	L	L	H

ECAC0081 ANALOG AND DIGITAL COMMUNICATIONS (L-T-P: 3-0-0)

(3 credits – 45hrs)

Objective

This course is aimed at introducing to the student the fundamentals of the theory of Communication. The course will provide in-depth knowledge of communication fundamentals, various analog modulation techniques, base band and bandpass digital communications, performance of communication systems in the presence of noise.

Course Outcomes

1. Define various modulation techniques (Remembering)
2. Explain various modulation techniques (Understanding)
3. Implement techniques for analog as well as digital communication (Applying)
4. Compare various schemes of signal detection (Analyzing)

5. Choose schemes for signal generation and detection (Evaluating)

Module I (18 Hours)
Review of signals and systems, Frequency domain representation of signals, Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations. Angle Modulation, Representation of FM and PM signals, Spectral characteristics of angle modulated signals. Review of probability and random process. Gaussian and white noise characteristics, Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and De-emphasis, Threshold effect in angle modulation.

Module II (18 Hours)
Pulse modulation. Sampling process. Pulse Amplitude and Pulse code modulation (PCM),Differential pulse code modulation. Delta modulation, Noise considerations in PCM, Time Division multiplexing, Digital Multiplexers. Elements of Detection Theory, Optimum detection of signals in noise, Coherent communication with waveforms- Probability of Error evaluations. Baseband Pulse Transmission- Inter symbol Interference and Nyquist criterion. Pass band Digital Modulation schemes- Phase Shift Keying, Frequency Shift Keying, Quadrature Amplitude Modulation, Continuous Phase Modulation and Minimum Shift Keying.

Module III (9 Hours)
Digital Modulation tradeoffs. Optimum demodulation of digital signals over band-limited channels- Maximum likelihood sequence detection (Viterbi receiver).Equalization Techniques. Synchronization and Carrier Recovery for Digital modulation.

Suggested Readings
1. Haykin S., "Communications Systems", John Wiley and Sons, 2001.
2. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education,2002.
3. Taub H. and Schilling D.L., "Principles of Communication Systems”, Tata McGraw Hill,2001.
4. Wozencraft J. M. and Jacobs I. M., “Principles of Communication Engineering'',JohnWiley, 1965.
5. Barry J. R., Lee E. A. and Messerschmitt D. G., “Digital Communication'', KluwerAcademic Publishers, 2004.
6. Proakis J.G., “Digital Communications”, McGraw Hill,4th Edition, 2000.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H	H	L
CO 2	H	H	L
CO 3	M	M	M
CO 4	L	L	H
CO 5	M	M	M

ECMM0082 MICROPROCESSORS AND MICROCONTROLLERS (L-T-P: 3-0-0)
(3 Credits – 45 hrs)

Objective
The objective of the course is to expose the student to develop an in-depth understanding of the operation of microprocessors and microcontrollers and to introduce the assembly language programming and microprocessor/microcontroller interfacing techniques.

Course Outcomes
1. Explain and compare the internal organization of various microprocessors and microcontrollers. (Understanding)
2. Apply the knowledge of programming for interfacing peripheral devices. (Applying)
3. Compare the performance of various microprocessors. (Evaluating)
4. Develop and design systems using different microprocessor and microcontrollers. (Creating)

Module I (20 Hours)
Overview of microcomputer systems and their building blocks: Microprocessor architecture along with its operation: Pins and signals, Register organization, ALU, control unit, Timing and control module of 8085 microprocessor; memory organization; Instruction set and assembly language programming of 8085: Instruction set of 8085, Memory and I/O Addressing, Assembly language programming using 8085 instruction set, instruction cycle, machine cycles, T-states, state transition diagram, use of stack and subroutine; Concepts of interrupts and Direct Memory Access;Introduction to 8086 microprocessor

Module II (12 Hours)
Memory and I/O Interfacing: Interfacing memory (RAM and ROM), Interfacing a keyboard, interfacing a LED and seven segment displays, interfacing A/D converter, D/A converter; Programmable Peripheral Interface Devices: 8155, 8255, timer, serial I/O

using SID, SOD, parallel I/O; Asynchronous and synchronous data transfer using 8251A, Programming DMA controller: 8257, Programming interrupt controller: 8259, Arithmetic Coprocessors; System level interfacing design

Module III (8 Hours)
Concepts of virtual memory, Cache memory, Advanced Coprocessor Architectures- 286, 486, Pentium.

Module IV (5 Hours)
Microcontroller(Architecture and Programming): Introduction to 8051 Microcontrollers (Architecture, Pin description), 8051 Assembly level language programming, I/O port programming, 8051 addressing modes, arithmetic & logic instruction, 8051 interrupt, interfacing to 8255, Introduction to RISC processors; AVR-ATmega series

Suggested Readings

1. R. S. Gaonkar, Microprocessor Architecture: Programming and Applications with the 8085/8080A, Penram International Publishing, 1996
2. Krishna Kant, Microprocessors and Microcontrollers- Architecture, Programming and System Design 8085, 8086, 8051, 8096, PHI
3. Barry B Brey, The Intel Microprocessor (Architecture, programming and interfacing), Pearson.
4. M. A. Mazidi, J. Mazidi J. G. Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson.
5. M. A. Mazidi, S. Naimi, S. Naimi, The AVR Microcontroller and Embedded Systems, Pearson.

A. K. Roy and K. M. Burchandi, Advanced Microprocessor and peripherals (Architecture, programming and interfacing), TMH

6. Douglas V. Hall, Microprocessor and Interfacing, TMH
7. D A Patterson and J H Hennessy, "Computer Organization and Design The hardware and software interface. Morgan Kaufman Publishers.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	M	H
CO 2		H	M	L
CO 3		M	H	
CO 4	H	M	L	H

ECCA0083 COMPUTER ARCHITECTURE (L-T-P: 3-0-0)
(3 Credits – 45 hrs)

Objective
The objective this course on Computer Architecture is to acquaint the students with the knowledge of basic computer architecture. This course will also provide an idea on processor and memory organization. The concept of parallel processing and its application will also be given to the students.

Course Outcomes
1. Describe the basic principles of computer’s working (Understanding)
2. Analyze the performance of computers (Analyzing)
3. Illustrate how computers are designed and built (Applying/ Creating)
4. Understand and evaluate issues affecting modern processors (caches, pipelines etc.)(Evaluate)

Module I (10 Hours)
Basic Structure of Computers, Functional units, software, performance issues software, machine instructions and programs, Types of instructions, Instruction sets: Instruction formats, Assembly language, Stacks, Queues, Subroutines.

Module II (15 Hours)
Processor organization, Information representation, number formats. Multiplication & division, ALU design, Floating Point arithmetic, IEEE 754 floating point formats. Control Design, Instruction sequencing, Interpretation, Hardwired control - Design methods, and CPU control unit. Microprogrammed Control - Basic concepts, minimizing microinstruction size, multiplier control unit. Microprogrammed computers - CPU control unit

Module III (10 Hours)
Memory organization, device characteristics, RAMS, ROM, Memory management, Concept of Cache & associative memories, Virtual memory. System organization, Input - Output systems, Interrupt, DMA, Standard I/O interfaces

Module IV (10 Hours)
Concept of parallel processing, Pipelining, Forms of parallel processing, interconnect network

Suggested Readings

1. V .CarlHamacher, “Computer Organisation”, Fifth Edition.
2. A.S.Tanenbaum, “Structured Computer Organisation”, PHI, Third edition
3. Y.Chu, "Computer Organization and Microprogramming”, II, Englewood Chiffs, N.J., Prentice Hall.
4. M.M.Mano, “Computer System Architecture”, Edition
5. C.W.Gear, “Computer Organization and Programming”, McGraw Hill, N.V. Edition
6. Hayes J.P, “Computer Architecture and Organization”, PHI, Second edition

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	L	L
CO 2	H	M	L	L
CO 3		H	M	H
CO 4		M	H	L

ECPS0084 PROBABILITY THEORY AND STOCHASTIC PROCESSES (L-T-P: 3-0-0)
(3 credits-45 hours)

Objective
The objective of this course is to familiarize the students with probability theory, random variables and its characteristics. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling various problems in this discipline.

Course Outcomes
1. Define probability theory, random variable, laws of number, limit theorem and random process. (Remembering)
2. Explain PMF, PDF and CPDF of random variable. (Understanding)
3. Demonstrate an understanding of statistical properties like mean, variance, moments and various inequalities of random variable. (Applying)
4. Analyze convergence of random sequences. (Analyzing)
5. Evaluate PMF, PDF, CPDF and PSD in various random processes. (Evaluating)
6. Design LTI systems and estimate the statistical properties. (Creating)

Module I (8 Hours)
Basic Probability: Sets and set operations; Probability space; Conditional probability and Bayes theorem; combinatorial probability and sampling models.

Module II (10 Hours)
Discrete and Continuous Random Distributions: Discrete random variables, probability mass function, probability distribution function, example random variables and distributions; Continuous random variables, probability density function, probability distribution function, example distributions; Conditional distribution and density functions.

Module III (10 Hours)
Statistical Properties of Random Variable: Random variable - Mean, variance, moments, characteristic functions; Joint distributions, functions of one and two random variables; Two random variables- Mean, variance, moments, characteristic functions; Markov, Chebyshev and Chernoff bounds;

Module IV (7 Hours)
Random Sequences: Random sequences and modes of convergence (everywhere, almost everywhere, probability, distribution and mean square); Limit theorems; Strong and weak laws of large numbers, central limit theorem.

Module V (10 Hours)
Random Processes: Random process, Stationary processes, Mean and covariance functions, Ergodicity, Transmission of random process through LTI, Power spectral density.

Suggested Readings

1. H. Stark and J. Woods, “Probability and Random Processes with Applications to Signal Processing”, Third Edition, Pearson Education

2. A.Papoulis and S. Unnikrishnan Pillai, “Probability, Random Variables and Stochastic Processes”, Fourth Edition, McGraw Hill.
3. K. L. Chung, “Introduction to Probability Theory with Stochastic Processes”, Springer International
4. P. G. Hoel, S. C. Port and C. J. Stone, “Introduction to Probability”, UBS Publishers,
5. P. G. Hoel, S. C. Port and C. J. Stone, “Introduction to Stochastic Processes”, UBS Publishers
6. S. Ross, “Introduction to Stochastic Models”, Harcourt Asia, Academic Press.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	M		L	
CO 2	M	H			
CO 3		M	H		
CO 4		L	M	H	
CO 5		M	L		H
CO 6	L		M		H

ECPE0085 POWER ELECTRONICS (L-T-P: 3-0-0)
(3 credits-45 hours)

Objective
The course intends to introduce the students to the basic theories of power semiconductor devices and passive components and their practical applications in power electronics. Further, the students will be familiarized with the principle of operation, design and synthesis of different power conversion circuits and their applications and thereby provide a strong foundation for further study and practical application of power electronic circuits and systems.

Course Outcomes
1. Describe the basic operation and compare performances of various power semiconductor devices, passive components and switching circuits. (Understanding)
2. Build and test circuits using power devices such as SCR. (Applying)
3. Analyze and design controlled rectifier, DC to DC converters, DC to AC inverters (Analyzing)
4. Evaluate the role of power electronics in the improvement of energy usage efficiency and the applications of power electronics in emerging areas. (Evaluating)
5. Design and analyze power converters circuits and learn to select suitable power electronic devices by assessing the requirements of application fields. (Creating)

Module I (10 Hours)
Characteristics of Semiconductor Power Devices: Thyristor, power MOSFET and IGBT Treatment should consist of structure, Characteristics, operation, ratings, protections and thermal considerations.
Introduction to power devices: TRIAC, MOS controlled thyristor (MCT), Power Integrated Circuit (PIC) (Smart Power), Triggering/Driver, commutation and snubber circuits for thyristor, power MOSFETs and IGBTs (discrete and IC based).Concept of fast recovery and schottky diodes as freewheeling and feedback diode.

Module II (15 Hours)
Controlled Rectifiers: Single phase: Study of semi and full bridge converters for R, RL, RLE and level loads. Analysis of load voltage and input current- Derivations of load form factor and ripple factor, Effect of source impedance, Input current Fourier series analysis of input current to derive input supply power factor, displacement factor and harmonic factor.
Choppers: Quadrant operations of Type A, Type B, Type C, Type D and type E choppers, control techniques for choppers – Time Ratio Control (TRC) and Current Limit C(CLC), Detailed analysis of Type A chopper. Step up chopper. Multiphase Chopper.

Module III (10 hours)
Single-phase inverters: Principle of operation of full bridge square wave, quasi-square wave, PWM inverters and comparison of their performance. Driver circuits for above inverters and mathematical analysis of output (Fourier series) voltage and harmonic control at output of inverter (Fourier analysis of output voltage). Filters at the output of inverters, Single phase current source inverter.

Module IV (10 Hours)
Switching Power Supplies: Analysis of fly back, forward converters for SMPS, Resonant converters - need, concept of soft switching, switching trajectory and SOAR, Load resonant converter - series loaded half bridge DC-DC converter.

Applications: Power line disturbances, EMI/EMC, power conditioners. Block diagram and configuration of UPS, salient features of UPS, selection of battery and charger ratings, sizing of UPS. Separately excited DC motor drive.P M Stepper motor Drive.

Suggested Readings

1. Muhammad H. Rashid, "Power electronics" Prentice Hall of India.
2. Ned Mohan, Robbins, "Power electronics", edition III, John Wiley and sons.
3. P.C. Sen., "Modern Power Electronics", edition II, Chand& Co.
4. V.R.Moorthi, "Power Electronics", Oxford University Press.
5. Cyril W., Lander," Power Electronics", edition III, McGraw Hill.
6. G K Dubey, S R Doradla: Thyristorised Power Controllers", New Age International Publishers.SCR manual from GE, USA.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	L	
CO 2	L	H	M	M
CO 3		H	M	L
CO 4		H	M	H
CO 5		M	H	L

ECBE0086 BIOMEDICAL ELECTRONICS (L-T-P: 3-0-0)

(3 credits-45 hours)

Objective

The objective of this course is to familiarize students with human physiology and various aspects of measuring various parameters from the human body.

Course Outcomes

1. Define and characterize the sources of biomedical signals. (Remembering)
2. Explain the characteristics of medical instruments and related errors. (Understanding)
3. Apply Bio-electrodes and Bio-amplifiers to understand the principle of biomedical electronic circuits. (Applying)
4. Analyze the biological processes like other electronic processes. (Analysing)
5. Assess the needs of using various biomedical instruments & their limitations. (Evaluating)

Module I (15 hours)

Brief introduction to human physiology, Biomedical transducers: displacement, velocity, force, acceleration, flow, temperature, potential, dissolved ions and gases

Module II (15 hours)

Bio-electrodes and biopotential amplifiers for ECG, EMG, EEG, etc., Measurement of blood temperature, pressure and flow, Impedance plethysmography,

Module III (15 hours)

Ultrasonic, X-ray and nuclear imaging, Prostheses and aids: pacemakers, defibrillators, heart-lung machines, artificial-kidney, aids for the handicapped, Safety aspects.

Suggested Readings

1. C. Raja Rao and S. K. Guha, Medical Electronics and Biomedical Instrumentation, University Press, 2000.
2. W.F. Ganong, Review of Medical Physiology, 8th Asian Ed, Medical Publishers, 1977.
3. J.G. Webster, ed., Medical Instrumentation, Houghton Mifflin, 1978.
4. A. M. Cook and J.G. Webster, eds., Therapeutic Medical Devices, Prentice-Hall, 1982.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H	H	M
CO 2	M	H	L
CO 3	M	H	H
CO 4	L	H	M
CO 5	M	H	H

ECSS0087 SPEECH SIGNAL PROCESSING (L-T-P: 3-0-0)

(3 credits-45 hours)

Objective

This course intends to introduce the students to the fundamentals of speech and audio processing. The course starts with the basics of the human speech production system and then moves on to how signal processing has been used to analyse and model systems to replicate human speech.

Course Outcomes

1. Define and outline the fundamental concepts of digital signal processing related to speech processing. (Remembering)
2. Illustrate the fundamentals of digital speech processing including speech coding techniques, pitch estimation etc.(Understanding)
3. Analyse the human auditory system, speech signals, models for speech production etc. (Analysing)
4. Evaluate a speech signal, speech production system, LPC and CELP models etc. (Evaluating)
5. Design a simple model for speech production. (Creating)

Module I (10 Hours)

Introduction: Speech production and modelling, Human Auditory System; General structure of speech coders; Classification of speech coding techniques– parametric, waveform and hybrid; Requirements of speech codecs– quality, coding delays, robustness. Speech Signal Processing- Pitch-period estimation, all-pole and all-zero filters, convolution; Power spectral density, periodogram, autoregressive model, autocorrelation estimation.

Module II (15 Hours)

Linear Prediction of Speech: Basic concepts of linear prediction; Linear Prediction Analysis of non-stationary signals; Levinson-Durbin algorithm; Long term and short-term linear prediction models; Moving average prediction.

Linear Prediction Coding: LPC model of speech production; Structures of LPC encoders and decoders; Voicing detection; Limitations of the LPC model.

Module III (10 Hours)

Speech Quantization: Scalar quantization, uniform quantizer, optimum quantizer, logarithmic quantizer, adaptive quantizer, differential quantizers; Vector quantization.

Module IV (10 Hours)

Code Excited Linear Prediction: CELP speech production model; Analysis-by-synthesis; Generic CELP encoders and decoders; Excitation codebook search – state-save method, zero-input zero- state method; CELP based on adaptive codebook, Adaptive Codebook search; Low Delay CELP and algebraic CELP. Speech Coding Standards-An overview of ITU-T G.726, G.728 and G.729 standards

Suggested Readings

1. A.M. Kondoz, “Digital Speech”, Second Edition (Wiley Students Edition), 2004.
2. W.C. Chu, “Speech Coding Algorithms: Foundation and Evolution of Standardized Coders”, Wiley Inter science, 2003.
3. L. Rabiner and B-H Juang, “Fundamentals of Speech Recognition”, Pearson.
4. L.R. Rabinu and R.W. Schafer, ‘Digital Processing of Speech Signals’, Pearson.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	L	
CO 2	H	L	M	
CO 3	H		M	L
CO 4	L	H	M	M
CO 5			H	H

ECNT0088 NANOTECHNOLOGY (L-T-P: 3-0-0)

(3 credits-45 hours)

Objective

This course will introduce the students to the field of Nanotechnology. The course is designed to build up a basic understanding of the nano concepts. It will provide the students the knowledge of synthesis of nanomaterials, their characterization techniques as well as touch upon some applications of nanotechnology.

Course Outcomes

1. Recognize the principles underlying the field of Nanotechnology (Remembering)
2. Relate the concepts underlying this disruptive field of new technology (Understanding)
3. Build knowledge on fabrication processes of new materials and devices in the nanoscale (Applying)
4. Analyze nanomaterials for applications in various technologies (Analysis)
5. Assess new materials and devices in the nanoscale using various characterization tools (evaluation)

Module I (11 hours)

Basics of Nanotechnology: Importance of Nanotechnology, History of Nanotechnology, Properties of Nanomaterials, Difference between Bulk and Nanomaterial, Molecular building blocks for nanostructure systems, Forces between atoms and molecules, Size effects – Fraction of Surface Atoms – specific Surface Energy and Surface Stress. Particles and grain boundaries, Strong Intermolecular forces, Electrostatic and Vander Waals forces between surfaces.

Module II (11 hours)

Physics of nanomaterials: Atomic scale structure of nanomaterials; Concept of quantum confinement: 0D, 1D and 2D nanostructures; Electronic and optical characteristic properties of quantum dots, quantum wires etc.; Nanophotonics, Plasmonics – plasmons and surface plasmons, SPR, Core-shell quantum dots.

Module III (12 hours)

Synthesis/fabrication techniques of nanomaterials: Top down approach, Lithography – electron beam and ion beam techniques, Etching – wet and dry etching, Bottom up approach - Solvent based and template based synthesis, other important synthesis methods like CVD, PVD etc.; Doping, Nucleation, Growth and Stability of colloidal nanoparticles, concept of self- assembly.

Module IV (5 hours)

Characterization methods: Transmission electron microscopy (TEM), Scanning electron microscopy (SEM), Atomic force microscopy (AFM), Scanning Tunneling Microscopy (STM).

Module V (6 hours)

Applications: Different application of Nanotechnology, Micro and Nano electromechanical systems.

Suggested Readings

1. G. L. Hornyak, J. Dutta, H. F. Tibbals, A. Rao Introduction to nanoscience CRC Press
2. G. L. Hornyak, J. Dutta, H. F. Tibbals, A.Rao Introduction to nanotechnology CRC Press
3. T. Pradeep, Nano: The Essentials McGraw Hill
4. D. Maclurcan and N. Radywyl (Eds.) Nanotechnology and Global Sustainability CRC Press
5. E. Lichtfouse, J. Shwarzbauer, D. Robert, Environmental Chemistry for a Sustainable World Vol.2 Springer Verlag

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	L			
CO 2	M	H	L		
CO 3	L	M	H		
CO 4	L	L	M	H	
CO 5	L	M	M	L	H

ECCS0089 CONTROL SYSTEM (L-T-P: 3-0-0)

(3 Credits – 45 hrs)

Objective

To introduce different types of systems and identify a set of algebraic equations to represent and model a complicated system into a more simplified form to interpret different physical and mechanical systems in terms of electrical systems to construct equivalent electrical models for analysis.

Course Outcomes

1. Define a system and illustrate its study state behavior (Understanding)
2. Interpret and explain stability of a system using different tests (Understanding)
3. Solve linear, non-linear and optimal control problems (Applying)
4. Design various controllers (Creating)

Module I (5 Hours)
Introduction to control problem: Industrial Control examples, System with dead-time, System response. Control hardware and their models: potentiometers, synchros, LVDT, dc and ac servomotors, tacho-generators, electro hydraulic valves, hydraulic servo motors, electro pneumatic valves, pneumatic actuators. Closed-loop systems. Transfer Function, Block diagram, and signal flow graph analysis.

Module II (7 Hours)
Feedback control systems: Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness. Proportional, integral and derivative systems. Feed-forward and multi-loop control configurations, stability concept, relative stability, Routh stability criterion.

Module III (7 Hours)
Time response of second-order systems, steady-state errors and error constants. Performance specifications in time-domain. Root locus method of design. Lead and lag compensation.

Module IV (11 Hours)
Frequency-response analysis: Polar plots, Bode plot, stability in frequency domain, Nyquist plots. Nyquist stability criterion. Performance specifications in frequency-domain. Frequency domain methods of design, Compensation & their realization in time & frequency domain. Lead and Lag compensation. Op-amp based and digital implementation of compensators. Tuning of process controllers. State variable formulation and solution.

Module V (8 Hours)
State variable Analysis: Concepts of state, state variable, state model, state models for linear continuous time functions, diagonalization of system matrix, solution of state equations, concept of controllability & observability.

Module VI (7 Hours)
Introduction to Optimal control & nonlinear control, Optimal Control problem, Regulator problem, Output regulator, tracking problem. Nonlinear system: Basic concept & analysis.

Suggested Readings
1. Gopal. M., "Control Systems: Principles and Design", Tata McGraw-Hill, 1997.
2. Kuo, B.C., "Automatic Control System", Prentice Hall, sixth edition, 1993.
3. Ogata, K., "Modern Control Engineering", Prentice Hall, second edition, 1991.
4. Nagrath& Gopal, "Modern Control Engineering", New Age International, New Delhi

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M	L		H	
CO 2	L		H	H	M	
CO 3		L	M	M		H
CO 4		H	M	M	L	

ECNT0090 COMPUTER NETWORKS (L-T-P: 3-0-0)
(3 CREDITS – 45 hours)

Objective
The course intended at understanding the principles and practice of designing, building and operating computer networks particularly the internet.

Course Outcomes
1. Describe and discuss the various concepts of networking thoroughly. (Remembering/ Understanding)
2. Evaluate the design of a network for a particular application. (Evaluating)
3. Analyze the performance of the network. (Analyzing)

Module I (11 Hours)
Introduction to computer networks and the Internet: Application layer: Principles of network applications, The Web and Hyper Text Transfer Protocol, File transfer, Electronic mail, Domain name system, Peer-to-Peer file sharing, Socket programming, Layering Concepts.

Module II (16 Hours)
Switching in networks: Classification and requirements of switches, a generic switch, Circuit Switching, Time-division switching, Space-division switching, Crossbar switch and evaluation of blocking probability, 2-stage, 3-stage and n-stage networks, Packet switching, Blocking in packet switches, Three generations of packet switches, switch fabric, Buffering, Multicasting, Statistical Multiplexing. Transport layer: Connectionless transport - User Datagram Protocol, Connection- oriented transport – Transmission Control Protocol, Remote Procedure Call.

Module III (5 Hours)
Transport layer: Connectionless transport - User Datagram Protocol, Connection-oriented transport – Transmission Control Protocol, Remote Procedure Call.

Module IV (5 Hours)
Congestion Control and Resource Allocation: Issues in Resource Allocation, Queuing Disciplines, TCP congestion Control, Congestion Avoidance Mechanisms and Quality of Service.

Module V (8 Hours)
Network layer: Virtual circuit and Datagram networks, Router, Internet Protocol, Routing algorithms, Broadcast and Multicast routing
Link layer: ALOHA, Multiple access protocols, IEEE 802 standards, Local Area Networks, addressing,

Suggested Readings
1. J.F. Kurose and K. W. Ross, "Computer Networking – A top-down approach featuring the Internet", Pearson Education, 5th Edition
2. L. Peterson and B. Davie, "Computer Networks – A Systems Approach" Elsevier Morgan Kaufmann Publisher, 5th Edition.
3. T. Viswanathan, "Telecommunication Switching System and Networks", Prentice Hall
4. S. Keshav, "An Engineering Approach to Computer Networking" , Pearson Education
5. B. A. Forouzan, "Data Communications and Networking", Tata McGraw Hill, 4th Edition
6. Andrew Tanenbaum, "Computer networks", Prentice Hall
7. D. Comer, "Computer Networks and Internet/TCP-IP", Prentice Hall
8. William Stallings, "Data and Computer Communications", Prentice Hall

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	H	M	L	L
CO 2	M	H	L	M	H
CO 3	M	H	H		H

ECEW0091 ELECTROMAGNETIC WAVES (L-T-P: 3-0-0)
(3 credits- 45 hours)

Objective
The course is aimed at introducing the concept of electromagnetic waves which is a prerequisite to understand the theory behind antenna design and microwave engineering. This subject is aimed to provide basic knowledge on wave propagation through transmission line and waveguides.

Course Outcomes
1. Define the fundamentals of transmission line theory, uniform plane wave and radiation characteristics of an antenna. (Remembering)
2. Explain the characteristics and wave propagation on high frequency transmission lines, demonstrate and carry out impedance transformation on transmission lines. (Understanding)
3. Solve related problems using the concepts of wave propagation, waveguides and antennas. (Applying)
4. Analyze different parameters like standing wave, reflection coefficient, and impedance, etc. using Smith chart, and wave propagation on metallic waveguides in modal form. (Analyzing)
5. Compare the basic theories in understanding the working of related structures and wave propagation. (Evaluating)

Module I (12 hours)
Transmission Lines- Equations of Voltage and Current on TX line, Propagation constant and characteristic impedance, and reflection coefficient and VSWR, Impedance Transformation on Loss-less and Low-loss Transmission line, Power transfer on TX

line, Smith Chart, Admittance Smith Chart, Applications of transmission lines: Impedance Matching, use transmission line sections as circuit elements.

Module II (15 hours)
Maxwell's Equations- Basics of Vectors, Vector calculus, Basic laws of Electromagnetics, Maxwell's Equations, Boundary conditions at Media Interface. Uniform Plane Wave- Uniform plane wave, Propagation of wave, Wave polarization, Poincare's Sphere, Wave propagation in conducting medium, phase and group velocity, Power flow and Poynting vector, Surface current and power loss in a conductor. Plane Waves at a Media Interface- Plane wave in arbitrary direction, Reflection and refraction at dielectric interface, Total internal reflection, wave polarization at media interface, Reflection from a conducting boundary.

Module III (8 hours)
Wave propagation in parallel plane waveguide, Analysis of waveguide general approach, Rectangular waveguide, Modal propagation in rectangular waveguide, Surface currents on the waveguide walls, Field visualization, Attenuation in waveguide.

Module IV (10 hours)
Radiation: Solution for potential function, Radiation from the Hertz dipole, Power radiated by hertz dipole, Radiation Parameters of antenna, receiving antenna, Monopole and Dipole antenna.

Suggested Readings

1. R.K. Shevgaonkar, Electromagnetic Waves, Tata McGraw Hill India, 2005
2. E.C. Jordan & K.G. Balmain, Electromagnetic waves & Radiating Systems, Prentice Hall, India
3. NarayanaRao, N: Engineering Electromagnetics, 3rd ed., Prentice Hall, 1997.
4. David Cheng, Electromagnetics, Prentice Hall.
5. Mathew N. O. Sadiku, Elements of Electromagnetics, Oxford University Press, 2001.
6. K. D. Prasad, Antenna & Wave Propagation, SatyaPrakashan, New Delhi, 2009

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	H	M	H
CO 2	H			
CO 3		H	H	H
CO 4	H	L	L	
CO 5	H	M	M	M

ECCD0092 CMOS DESIGN (L-T-P: 3-0-0)
(3 credits-45 hours)

Objective
The objectives of this course are to introduce the concept IC technology and VLSI Design. The course also provides fundamental concepts used in the design of digital systems, the basic tools for the design and implementation of digital circuits, modules subsystems using CMOS technology.

Course Outcomes
1. Define basics of IC technology and MOS transistor. (Remembering)
2. Explain the physical and mathematical concept of MOS transistors and demonstrate CMOS circuits and logic design rules. (Understanding)
3. Apply the logic design rules to design various CMOS circuits and layouts. (Applying)
4. Design different CMOS circuits using various logic families. (Creating)

Module I (12 hours)
Introduction to IC Technology – MOS, PMOS, NMOS, CMOS & BiCMOS Technologies. VLSI Fabrication, Oxidation, Lithography, Diffusion, Ion Implantation, Metallization, MOS Theory Analysis: Basic Electrical Properties of MOS Circuits, Non-ideal behavior of the MOS Transistor, Transistor as a switch, Integrated Resistors and Capacitors. Ids-Vds Relationships, MOS Transistor Threshold Voltage V_{th}, g_m, g_{ds}, Figure of Merit ω_0, Short Channel and Narrow Channel Width Effects. Pass Transistor, Transmission Gate, CMOS Inverter Analysis and Design, Bi-CMOS Inverters, Latch up in CMOS Circuits

Module II (13 hours)

Integrated Circuit Layout- CMOS Circuits and Logic Design Rules: MOS Layers, Stick Diagrams, Design Rules and Layout, 2µm, 1.2 µm Design Rules, Rules for Vias and Contacts, Stick Diagrams and Simple Symbolic Encodings for NMOS, PMOS, CMOS and BiCMOS Logic Gates. Scaling of CMOS Circuits.

Module III (10 hours)
CMOS Circuit Characterization and Performance Estimation- Sheet Resistance RS and its Concept to MOS, Area Capacitance Units, Calculations – RC Delay model, linear delay model, Driving Large Capacitive Loads, logical path efforts. Power, interconnect and Robustness, power dissipation and reliability in CMOS circuit layout.

Module IV (10 hours)
Combinational Circuit Design: CMOS logic families including static, dynamic and dual rail logic. Sequential Circuit Design: Static circuits. Design of latches and Flip-flops.

Suggested Readings

1. N.H.E. Weste and D.M. Harris, CMOS VLSI design: A Circuits and Systems Perspective, 4th Edition, Pearson Education India, 2011.
2. C.Mead and L. Conway, Introduction to VLSI Systems, Addison Wesley, 1979.
3. J. Rabaey, Digital Integrated Circuits: A Design Perspective, Prentice Hall India, 1997.
4. P. Douglas, VHDL: programming by example, McGraw Hill, 2013.
5. L. Glaser and D. Dobberpuhl, The Design and Analysis of VLSI Circuits, Addison Wesley, 1985.

Mapping of COs to Syllabus

Course outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H		M	
CO 2	H		L	
CO 3		H		
CO 4		M		H

ECNE0093 NANOELECTRONICS (L-T-P: 3-0-0)
(3 credits-45 hours)

Objective
This course will introduce the students to electronics or electron behaviour at the nanoscale. The course is designed to build up an understanding of particle behavior at nano dimensions. Students will be able to see the effects of nanoscale dimensions on electronic devices and how CMOS technology is expected to be affected because of this. This will also open to them the technologies that are likely to take over electronic functions due to consistent size reduction or scaling.

Course Outcomes
1. Recognize the principles underlying the field of Nanotechnology (Remembering)
2. Relate the concepts of quantum mechanics to nano dimensions. (Understanding)
3. Develop understanding of the effect of scaling on electronic devices. (Applying)
4. Analyze new materials and devices for nano sized electronics. (Analysis)
5. Assess new materials and devices in the nanoscale for electronic applications. (Evaluation)

Module I (15 hours)
Introduction to nanotechnology, meso structures, Basics of Quantum Mechanics: Schrodinger equation, Density of States, Particle in a box Concepts, Degeneracy, Band Theory of Solids.

Module II (15 Hours)
Kronig-Penny Model. Brillouin Zones. Shrink-down approaches: Introduction, CMOS Scaling, The nanoscale MOSFET, Finfets, Vertical MOSFETs, limits to scaling, system integration limits (interconnect issues etc.).

Module III (15 Hours)
Resonant Tunneling Diode, Coulomb dots, Quantum blockade, Single electron transistors, Carbon nanotube electronics, Band Structure and transport, devices, applications, 2D semiconductors and electronic devices, Graphene, atomistic simulation.

Suggested Readings

1. G.W. Hanson, Fundamentals of Nanoelectronics, Pearson, 2009.
2. W. Ranier, Nanoelectronics and Information Technology (Advanced Electronic Material and Novel Devices), Wiley-VCH, 2003.

3. K.E. Drexler, Nanosystems, Wiley, 1992.
4. J.H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge University Press, 1998.
5. C.P. Poole, F. J. Owens, Introduction to Nanotechnology, Wiley, 2003

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H	M	L
CO 2	H	H	M
CO 3	M	H	H
CO 4	M	H	H
CO 5	M	H	H

ECIC0094 INFORMATION THEORY AND CODING (L-T-P: 3-0-0)
(3 credits-45 hours)

Objective
The objectives of this course are to introduce the mathematical concept required for data communication course. The course also provides concepts error detecting, correcting and controlling techniques used in communication.

Course Outcomes
1. Define the fundamentals of information theory, entropy and various coding & decoding techniques. (Remembering)
2. Illustrate different models of information sources, coding theorems and information channels. (Understanding)
3. Apply the theoretical knowledge gained to implement it in various continuous and discrete channels as well as communication systems. (Applying)
4. Analyze different coding and decoding techniques. (Analyzing)

Module I (11 hours)
Revision of Probability and Random Process, Digital Communication. Information Theory-Introduction, Measure of information, Information content of message, Average Information content of symbols in Long Independent sequences, Markov Statistical Model of Information Sources, Entropy, Markov sources and Information rate of Markov Sources.

Module II (15 hours)
Source Coding theorems- Shannon's noiseless coding theorem; Encoding of discrete sources, Shannon's noisy coding theorem and converse for discrete channels; Information Channels- Communication Channels. Channel Models, Channel Matrix, Joint probability Matrix, Binary Symmetric Channel, System Entropies, Mutual Information, Channel Capacity- Calculation of channel capacity and bounds for discrete channels, Channel Capacity of Binary Symmetric Channel, Binary Erasure Channel, Application to continuous channels.

Module III (19 hours)
Techniques of coding and decoding; Introduction, Examples of Error control coding, methods of Controlling Errors, Types of Errors, Types of Codes, Linear Block Codes- matrix description of Linear Block Codes, Error Detection and Error Correction Capabilities of Linear Block Codes, Single Error Correcting Hamming Codes. Huffman codes and uniquely detectable codes; Cyclic codes, convolutional arithmetic codes.

Suggested Readings
1. N. Abramson, Information and Coding, McGraw Hill, 1963.
2. M. Mansurpur, Introduction to Information Theory, McGraw Hill, 1987.
3. R.B. Ash, Information Theory, Prentice Hall, 1970.
4. Shu Lin and D.J. Costello Jr., Error Control Coding, Prentice Hall, 1983.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	H	M
CO 2	H	H		
CO 3	L	H	M	M
CO 4			H	H

ECRB0095 ROBOTICS (L-T-P: 3-0-0)
(3 credits-45 hours)

Objective
The objective of this course is to impart knowledge about industrial robots for their control and design.

Course Outcomes
1. Define and illustrate the basic knowledge of various robot structures and their workspaces. (Remembering, Understanding)
2. Perform kinematic and dynamic analyses with simulation. (Applying, Analyzing)
3. Design control laws for a robot. (Creating)
4. Integrate mechanical and electrical hardware for a real prototype of robotic device. (Creating)
5. Select a robotic system for a given application. (Evaluating)

Module I (3 Hours)
Introduction to Robotics: Types and components of a robot, Classification of robots, closed-loop and open loop control systems. Kinematics systems; Definition of mechanisms and manipulators, Social issues and safety.

Module II (7 Hours)
Robot Kinematics and Dynamics: Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Jacobian, Singularity, and Statics. Dynamic Modelling: Equations of motion: Euler-Lagrange formulation

Module III (10 Hours)
Sensors and Vision System: Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc. Introduction to Cameras, Camera calibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations. Vision applications in robotics.

Module IV (12 Hours)
Robot Control: Basics of control: Transfer functions, Control laws: P, PD, PID. Non-linear and advanced controls

Module V (3 Hours)
Robot Actuation Systems: Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.

Module VI (10 Hours)
Control Hardware and Interfacing: Embedded systems: Architecture and integration with sensors, actuators, components, Programming for Robot Applications

Suggested Readings
1. Saha, S.K., “Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, NewDelhi, 2014.
2. Ghosal, A., “Robotics”, Oxford, New Delhi, 2006
3. NikuSaeed B., “Introduction to Robotics: Analysis, Systems, Applications”, PHI, NewDelhi.
4. Mittal R.K. and Nagrath I.J., “Robotics and Control”, Tata McGraw Hill.
5. Mukherjee S., “Robotics and Automation”, Khanna Publishing House, Delhi.
6. Craig, J.J., “Introduction to Robotics: Mechanics and Control”, Pearson, New Delhi,2009
7. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, “Robot Modelling and Control”, John Wiley and Sons Inc, 2005
8. Steve Heath, “Embedded System Design”, 2nd Edition, Newnes, Burlington, 2003
9. Merzouki R., Samantaray A.K., Pathak P.M. and Bouamama B. Ould, “Intelligent Mechatronic System: Modeling, Control and Diagnosis”, Springer.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	H	M	L		
CO 2		H		M	L	
CO 3			L	H	M	L
CO 4	L		H	M		M
CO 5		M		L	H	H

ECAI0096 ARTIFICIAL INTELLIGENCE (L-T-P: 3-0-0)
(3 credits- 45 hours)

Objective
The main objective of the course is to familiarize the students with concepts of Artificial Intelligence, search techniques and knowledge representation issues. This course also aims to equip the students with knowledge of fuzzy logic and its uses for artificial intelligence, game playing and natural language processing.

Course Outcomes
1. Define Artificial Intelligence and different techniques of Artificial Intelligence. (Remembering)
2. Relate components of a Planning system, AI in solutions that require problem solving, inference, perception, knowledge representation, learning ANN and Fuzzy logic. (Understanding)
3. Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, learning, ANN and Fuzzy logic (Applying)
4. Analyze the different approaches to AI in solutions that require problem solving, inference, perception, knowledge representation, learning, game playing, ANN and Fuzzy logic (Analyzing)

Module I (10 Hours)
What is AI (Artificial Intelligence)? : The AI Problems, The Underlying Assumption, What are AI Techniques, The Level Of The Model, Criteria For Success, Some General References, One Final Word Problems, State Space Search & Heuristic Search Techniques: Defining The Problems As A State Space Search, Production Systems, Production Characteristics, Production System Characteristics, And Issues In The Design Of Search Programs, Additional Problems. Generate- And-Test, Hill Climbing, Best-First Search, Problem Reduction, Constraint Satisfaction, Means-Ends Analysis.

Module II (10 Hours)
Knowledge Representation Issues: Representations And Mappings, Approaches To Knowledge Representation. Using Predicate Logic: Representation Simple Facts In Logic, Representing Instance And Isa Relationships, Computable Functions And Predicates, Resolution. Representing Knowledge Using Rules: Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning.

Module III (8 Hours)
Symbolic Reasoning Under Uncertainty: Introduction To No monotonic Reasoning, Logics For Non-monotonic Reasoning. Statistical Reasoning: Probability And Bayes' Theorem, Certainty Factors And Rule-Base Systems, Bayesian Networks, Dempster Shafer Theory

Module IV (5 Hours)
Fuzzy Logic, Weak Slot-and-Filler Structures: Semantic Nets, Frames. Strong Slot-and- Filler Structures: Conceptual Dependency, Scripts, CYC.

Module V (7 Hours)
Game Playing: Overview, And Example Domain: Overview, MiniMax, Alpha-Beta Cut-off, Refinements, Iterative deepening, The Blocks World, Components Of A Planning System, Goal Stack Planning, Nonlinear Planning Using Constraint Posting, Hierarchical Planning, Reactive Systems, Other Planning Techniques. Understanding: What is understanding? What makes it hard? As constraint satisfaction.

Module VI (5 Hours)
Natural Language Processing: Introduction, Syntactic Processing, Semantic Analysis, Discourse And Pragmatic Processing, Spell Checking Connectionist Models: Introduction: Hopfield Network, Learning In Neural Network, Application Of Neural Networks, Recurrent Networks, Distributed Representations, Connectionist AI And Symbolic AI.

Suggested Readings
1. Elaine Rich and Kevin Knight "Artificial Intelligence", 2nd Edition, Tata Mcgraw-Hill, 2005.
2. Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Prentice Hall, 2009.

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	M	M	L	L	L	L
CO 2	L	H	H	L	L	L
CO 3		M	H	H	L	L

CO 4	L	M	L	L	M	M

ECVD0096 VLSI DESIGN TECHNOLOGY (L-T-P: 3-1-0)
(4 credits – 60 hours)

Objective
The objective of this course is to deal with the study of the technology and building blocks of integrated circuits including salient features of digital circuits, structured systems and design automation in the field of VLSI. The scope of this course includes an introduction to practical considerations and design of integrated circuits.

Course Outcomes
1. Recall, illustrate and summarize the fabrication process of BJT and MOSFET. (Remembering - Understanding)
2. Analyze the MOS transistors under external bias. (Analyzing)
3. Develop CMOS logic. (Applying)
4. Inspect different PLDs for system design. (Analyzing)
5. Evaluate the performance of CMOS circuits. (Evaluating)

Module I (8 Hours)
Introduction: Historical perspective, Introduction to IC Fabrication Techniques, VLSI design methodologies, VLSI design flow, Design hierarchy, Design Style. Introduction to CAD technology. The Bipolar Technology, Fabrication of BJT. Fabrication of MOSFETS, NMOS fabrication, CMOS n-well process.

Module II (10 Hours)
MOS Transistor: MOS transistor under external bias, Structure and Operation of MOSFET (Threshold Voltage), MOSFET V-I Characteristics (Gradual Channel Approximation, Channel Length Modulation, Substrate bias effect and Measurement of Parameters), MOSFET scaling and small geometry effects. MOSFET capacitances (Oxide Related Capacitance and Junction Capacitance). Modelling of MOS Transistors- Basic concept the SPICE level-1 models, the level –2 and level –3 model equations.

Module III (12 Hours)
MOS Inverters: Static characteristics of MOS Inverter: Voltage transfer characteristics, Noise Immunity and Noise Margins, Power and Area Considerations, Speed of operation, Inverters with resistive load and with n-type MOSFET load, CMOS inverter and characteristics. Switching characteristics and interconnect effects: Delay time definitions and calculation, inverter design with delay constraints, estimation of parasitic switching power dissipation of CMOS inverters.

Module IV (15 Hours)
Logic Design using CMOS
Combinational MOS logic circuits, CMOS logic circuits, state style, Complex logic circuits, pass transistor logic, Sequential logic circuit – introduction, SR latch, clocked latch & flip-flop circuits, CMOS D latch and edge triggered flip-flop. Design considerations (Layer Representation), Design Style (Stick Diagrams), Design Rules.
Dynamics logic circuits: Dynamic logic, basic principles, high performance dynamics CMOS circuits, Dynamic Ram, SRAM, flash memory.

Module V (15 Hours)
System Design
Systems design method, Design strategies, combinational and Sequential module, ROM implementation, PLDs, PLA, PAL, Sequential System design, State Machines (Mealy Circuit and Moore Circuit) Concept of FPGA, Standard cell based design, Design capture tools, Hardware definition languages such as VHDL and packages. Xlinx (introduction),
Introduction to IRSIM and GOSPL (open source packages), Design verification and testing, Simulation at various levels including timing verification, Faults models. Design strategies for testing chip level and system level test techniques.

Suggested Readings
1. S.M. Kang and Y. Leblebici, CMOS Digital integrated Circuits: Analysis and Design, TMH.
2. Perry, VHDL Programming by Example, TMH.
3. Rabeyet. al, Digital Integrated Circuits: A Design Perspective, Pearson.
4. R.A. Geiger, P.E. Allen et al, VLSI Design Techniques for Analog and Digital Circuits, McGraw Hill.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	M	L		
CO 2	L	H	M		
CO 3		L	M	H	
CO 4			L	M	H
CO 5		M	H	L	

ECOT0097 OPTIMIZATION TECHNIQUES (L-T-P: 3-0-0)

(3 credits – 45 hours)

Objective

The objective of the course is to familiarize the students about various optimization methods and algorithms necessary for solving various optimization problems.

Course Outcomes

1. Define single variable, multivariable and constrained and intelligent optimization techniques and also principles of genetic programming. (Remembering)
2. Illustrate the importance of optimization. (Understanding)
3. Apply basic concepts of mathematics to formulate an optimization problem.(Applying)
4. Analyze and appreciate a variety of performance measures for various optimization problems. (Analysing)
5. Evaluate and measure the performance of an optimization algorithm. (Evaluating)
6. Design algorithms, the repetitive use of which will lead reliably to finding an approximate solution. (Creating)

Module I (7 Hours)

Introduction to Classical Methods & Linear Programming Problems Terminology, Design Variables, Constraints, Objective Function, Problem Formulation. Calculus method, Kuhn Tucker conditions, Method of Multipliers.

Module II (5 Hours)

Linear Programming Problem, Simplex method, Two-phase method, Big-M method, duality, Integer linear Programming, Dynamic Programming, Sensitivity analysis.

Module III (8 Hours)

Single Variable Optimization Problems: Optimality Criterion, Bracketing Methods, Region Elimination Methods, Interval Halving Method, Fibonacci Search Method, Golden Section Method. Gradient Based Methods: Newton-Raphson Method, Bisection Method, Secant Method, Cubic search method.

Module IV (10 Hours)

Multi Variable and Constrained Optimization Technique: Optimality criteria , Direct search Method, Simplex search methods, Hooke-Jeeve's pattern search method, Powell's conjugate direction method, Gradient based method, Cauchy's Steepest descent method, Newton's method ,Conjugate gradient method. Kuhn - Tucker conditions, Penalty Function, Concept of Lagrangian multiplier, Complex search method, Random search method.

Module V (8 Hours)

Intelligent Optimization Techniques: Introduction to Intelligent Optimization, Soft Computing, Genetic Algorithm: Types of reproduction operators, crossover & mutation, Simulated Annealing Algorithm, Particle Swarm Optimization (PSO) - Graph Grammer Approach – Example Problems

Module VI (7 Hours)

Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

Suggested Readings

1. S. S. Rao, "Engineering Optimisation: Theory and Practice", Wiley, 2008.
2. K. Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall, 2005.
3. C.J. Ray, "Optimum Design of Mechanical Elements", Wiley, 2007.
4. R. Saravanan, "Manufacturing Optimization through Intelligent Techniques, Taylor & Francis Publications, 2006.
5. D. E. Goldberg, "Genetic algorithms in Search, Optimization, and Machine learning", Addison-Wesley Longman Publishing, 1989.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H		H	L		
CO 2		L	H	H	M	
CO 3	H		L	M	M	L
CO 4	L		H	M		M
CO 5		M		M	H	H
CO 6		L		H	M	H

ECRS0098 REMOTE SENSING (L-T-P: 3-0-0)
(3 credits- 45 hours)

Objective
This course is intended to introduce the students to the concepts of remote sensing. The course starts with the physics used in remote sensing and then gives an idea about the types of platforms and satellites. It also deals with advanced topics such as microwave scatterometry, thermal and hyper spectral remote sensing etc.

Course Outcomes
1. Define the concepts behind the physics of remote sensing. (Remembering)
2. Outline concepts of data acquisition and different platforms such as LANDSAT, SPOT etc. (Understanding)
3. Make use of optical sensors and different types of scanners. (Applying)
4. Analyse different types of RADAR, characteristics of microwave images etc. (Analyzing)
5. Evaluate thermal and hyper spectral remote sensing etc. (Evaluating)
6. Discuss data analysis and data processing techniques. (Creating)

Module I (10 Hours)
Physics Of Remote Sensing: Electro Magnetic Spectrum, Physics of Remote Sensing, Effects of Atmosphere Scattering, Different types, Absorption, Atmospheric window, Energy interaction with surface features, Spectral reflectance of vegetation, soil and water atmospheric influence on spectral response patterns-multi concept in Remote sensing.

Module II (5 Hours)
Data Acquisition: Types of Platforms, Different types of aircrafts, Manned and Unmanned space crafts, sun synchronous and geosynchronous satellites.
Types and characteristics of different platforms: LANDSAT, SPOT, IRS, INSAT, IKONOS, QUICKBIRD etc.

Module III (10 Hours)
Photographic products, B/W color, color IR film and their characteristics, resolving power of lens and film, Optomechanical electro optical sensors, across track and along track scanners, multispectral scanners and thermal scanners, geometric characteristics of scanner imagery, calibration of thermal scanners.

Module IV (10 Hours)
Scattering System: Microwave scatterometry, types of RADAR, SLAR, resolution, range and azimuth, real aperture and synthetic aperture RADAR. Characteristics of Microwave images: topographic effect, different types of Remote Sensing platforms, airborne and space borne sensors, ERS, JERS, RADARSAT, RISAT, Scatterometer, Altimeter, LiDAR remote sensing, principles, applications.

Module V (5 Hours)
Thermal and Hyper Spectral Remote Sensing: Sensors characteristics, principle of spectroscopy, imaging spectroscopy, field conditions, compound spectral curve, Spectral library, radiative models, processing procedures, derivative spectrometry, thermal remote sensing, thermal sensors, principles, thermal data processing, applications.

Module VI (5 Hours)
Data Analysis: Resolution, Spatial, Spectral, Radiometric and temporal resolution, signal to noise ratio, data products and their characteristics, visual and digital interpretation, Basic principles of data processing, Radiometric correction, Image enhancement, Image classification, Aerial Laser Terrain Mapping.

Suggested Readings
1. Lillesand.T.M. and Kiefer.R.W ,"Remote Sensing and Image interpretation", 6th Edition, John Wiley & Sons, 2000.
2. John R. Jensen, "Introductory Digital Image Processing: A Remote Sensing Perspective", 2nd Edition, PrenticeHall,1995.

3. Richards, John A., Jia, Xiuping, “Remote Sensing Digital Image Analysis”,5th Edition, Springer-Verlag Berlin Heidelberg, 2013.
4. Paul Curran P.J. Principles of Remote Sensing, 1st Edition, Longman Publishing Group, 1984.
5. Charles Elachi, Jakob J. van Zyl, “Introduction to ThePhysicsand Techniques of Remote Sensing”, 2nd Edition, Wiley Serie,2006.
6. Sabins, F.F.Jr, “Remote Sensing Principles and Image Interpretation”, 3rd Edition, W. H. Freeman & Co,1978.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	L				
CO 2		H	M			
CO 3			H	H		
CO 4			M	H	H	
CO 5					H	H
CO 6						H

ECNN0099 NANOTECHNOLOGY AND NANOELECTRONICS (L-T-P: 3-0-0)
(3 credits – 45 hours)

Objective

This course will introduce the students to Nanotechnology. The course is designed to build up a basic understanding of the nano concepts. It will provide the students the knowledge of synthesis of nanomaterials, their characterization techniques as well as touch upon some applications of nanotechnology. This course will also introduce the students to nano and molecular

Course Outcomes

1. Recognize the concepts underlying this disruptive field of new technology (Remembering)
2. Illustrate the processes involved in making nano components and material. (Understanding)
3. Apply this knowledge for fabrication of new materials and devices in the nanoscale (Application)
4. Analyze new materials and devices in the nanoscale using various characterization tools (Analysis)
5. Evaluate materials for their various properties (Evaluating)
6. Creating solutions for practical problems with appropriate use of nano-materials. (Creating)

Module I (8 Hours)

Basics of Nanotechnology: History, Properties of Nanomaterials, Difference between Bulk and Nanomaterial, Molecular building blocks for nanostructure systems, Forces between atoms and molecules - Particles and grain boundaries – strong Intermolecular forces – Electrostatic and Vander Waals forces between surfaces, Properties of nanomaterials.

Module II (8 Hours)

Physics of nanomaterials: Atomic scale structure of nanoparticles, nanotubes, nanowires, nanodots etc.; electronic and optical characteristic properties of quantum dots, quantum wires and quantum wells; concept of quantum confinement: 0D, 1D and 2D nanostructures; Size effects – Fraction of Surface Atoms – specific Surface Energy and Surface Stress. Nanophotonics, Nanofluidics, Nanothermodynamics, Plasmonics – plasmons and surface plasmons, SPR, Core-shell quantum dots and quantum-dot-quantum wells.

Module III (10 Hours)

Synthesis and Characterization of nanomaterials: Top down approach, Lithography – electron beam and ion beam techniques, Etching – wet and dry etching, Bottom up approach - Solvent based and template based synthesis, other important synthesis methods like CVD, PVD etc.; Doping, Nucleation, Growth and Stability of colloidal nanoparticles, concept of self-assembly. Characterization methods: Transmission electron microscopy (TEM), Scanning electron microscopy (SEM), Atomic force microscopy (AFM), X-ray diffraction spectroscopy (XRD), Optical characterization.

Module IV (12 Hours)

Fundamentals of Nanoelectronics: Quantum particles, Quantum mechanics of electrons, Free and confined electrons, Band theory of solids, Single electron/few electron devices, Coulomb blockade, Semiconductor quantum wells, quantum wires and quantum dots, Nanosensors, Micro and Nano electromechanical systems, Photonic crystals, Nanopiezotronics.

Module V (7 Hours)
Molecular Electronics: Electronic and optoelectronic properties of molecular materials - Electrodes and contacts – functions – molecular electronic devices - elementary circuits using organic molecules- Organic materials based rectifying diode switches – TFTs- OLEDs- OTFTs – logic switches.

Suggested Readings
1. G. L. Hornyak, J. Dutta, H. F. Tibbals, A. Rao Introduction to nanoscience, CRC Press
2. G. L. Hornyak, J. Dutta, H. F. Tibbals, A.Rao Introduction to nanotechnology CRC Press
3. T. Pradeep, Nano: The Essentials McGraw Hill
4. G. W. Hanson, Fundamentals of Nanoelectronics, Pearson
5. D. Maclurcan and N. Radywyl (Eds.) Nanotechnology and Global Sustainability CRC Press
6. E. Lichtfouse, J. Shwarzbauer, D. Robert, Environmental Chemistry for a Sustainable World, Vol.2 Springer Verlag

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	M	M	L	L
CO 2		M	H		
CO 3		L	M	H	
CO 4		M	H	M	
CO 5	L	M	H		H
CO 6			M	M	H

ECSD0100 SOC DESIGN (L-T-P: 3-0-0)
(3 credits- 45 hours)

Objective
This course will cover the basics of system-on-chip (SoC) design, hardware-software co-specification, co-synthesis, network-on-chip (NoC) systems and system-on-programmable-chip technologies. It provides the advanced knowledge required for system-on-chip design and development, multi-core architectures and embedded systems on a chip. It also involves projects based on FPGA prototyping platform using state-of- the-art synthesis and verification tools and design flows.

Course Outcomes
1. Define System on Chip (SoC) and SoC design methodologies. Also Relate the algorithms used for ASIC construction. (Remembering)
2. Explain the issues involved in ASIC design, including technology choice, design management, tool-flow, verification, debug and test, as well as the impact of technology scaling on ASIC design. (Understanding)
3. Model and specify embedded systems at high levels of abstraction. (Applying)
4. Develop HDL coding techniques for minimization of power consumption, Fault tolerant designs. (Applying)
5. Examine high performance algorithms available for ASICs. (Analysing)
6. Develop examples of applications and systems developed using a co-design approach. (Creating)

Module I (7 Hours)
ASIC: Overview of ASIC types, design strategies, CISC, RISC and NISC approaches for SOC architectural issues and its impact on SoC design methodologies, Application Specific Instruction Processor (ASIP) concepts.

Module II (8 Hours)
NISC: NISC Control Words methodology, NISC Applications and Advantages, Architecture Description Languages (ADL) for design and verification of Application Specific Instruction set Processors (ASIP), No-Instruction-Set-computer (NISC)- design flow, modeling NISC architectures and systems, use of Generic Netlist Representation - A formal language for specification, compilation and synthesis of embedded processors.

Module III (8 Hours)
Simulation: Different simulation modes, behavioural, functional, static timing, gate level, switch level, transistor/circuit simulation, design of verification vectors, Low power FPGA, Reconfigurable systems, SoC related modeling of data path design and control logic, Minimization of interconnects impact, clock tree design issues.

Module IV (7 Hours)
Low power SoC design / Digital system: Design synergy, Low power system perspective- power gating, clock gating, adaptive voltage scaling (AVS), Static voltage scaling, Dynamic clock frequency and voltage scaling (DCFS), building block optimization, building block memory, power down techniques, power consumption verification.

Module V (10 Hours)
Synthesis: Role and Concept of graph theory and its relevance to synthesizable constructs, Walks, trails paths, connectivity, components, mapping/visualization, nodal and admittance graph. Technology independent and technology dependent approaches for synthesis, optimization constraints, Synthesis report analysis Single core and Multi core systems, dark silicon issues, HDL coding techniques for minimization of power consumption, Fault tolerant designs

Module VI (5 Hours)
Case study for overview of cellular phone design with emphasis on area optimization, speed improvement and power minimization.

Suggested Readings
1. Hubert Kaeslin, “Digital Integrated Circuit Design: From VLSI Architectures to CMOS Fabrication”, Cambridge University Press, 2008.
2. B. Al Hashimi, “System on chip-Next generation electronics”, The IET, 2006
3. RochitRajsuman, “System-on- a-chip: Design and test”, Advantest America R & D Center, 2000
4. P Mishra and N Dutt, “Processor Description Languages”, Morgan Kaufmann, 2008
5. Michael J. Flynn and Wayne Luk, “Computer System Design: System-on-Chip”, Wiley, 2011

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H		H	M	L	
CO 2	H	M		L		
CO 3		M		H	L	H
CO 4		H	M		H	
CO 5	H		M	L		H
CO 6	M	H		M		H

ECWP0102: ANTENNAS and WAVE PROPAGATION (L-T-P: 3-0-0)
(3 credits – 45 hours)

Objective
This subject is aimed at providing basic knowledge on the theory of radiation of antenna, types of antenna and propagation characteristics and their applications in communication engineering.

Course Outcomes
1. Define various antenna functions and parameters. (Remembering)
2. Identify different types of antennas and arrays along with their application (Understanding)
3. Develop various antennas and arrays using specific design principles (Applying)
4. Analyse the properties of different types of antennas and their design. (Analysing)
5. Design antennas of required specifications in antenna design software tools. (Creating)

Module I (10 hours)
Fundamental Concepts- Physical concept of radiation, Radiation pattern, near-and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions.

Module II (13 Hours)
Radiation from Wires and Loops- Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop. Aperture and Reflector Antennas- Huygens' principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts, prime-focus parabolic reflector and cassegrain antennas. Broadband Antennas- Log-periodic and Yagi-Uda antennas, frequency independent antennas, broadcast antennas. Micro strip Antennas- Basic characteristics of micro strip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas.

Module III (12 Hours)
Antenna Arrays- Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays, synthesis of antenna arrays using Schelkunoff polynomial method, Woodward-Lawson method.

Module IV (10 Hours)
Basic Concepts of Smart Antennas- Concept and benefits of smart antennas, fixed-weight beam forming basics, Adaptive beam forming. Different modes of Radio Wave propagation used in current practice.

Suggested Readings
1. J.D. Kraus, Antennas, McGraw Hill, 1988.
2. C.A. Balanis, Antenna Theory - Analysis and Design, John Wiley, 1982.
3. R.E. Collin, Antennas and Radio Wave Propagation, McGraw Hill, 1985.
4. R.C. Johnson and H. Jasik, Antenna Engineering Handbook, McGraw ill, 1984.
5. I.J. Bahl and P. Bhartia, Micro Strip Antennas, Artech House, 1980.
6. R.K. Shevgaonkar, Electromagnetic Waves, Tata McGraw Hill, 2005
7. R.E. Crompton, Adaptive Antennas, John Wiley

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			M
CO 2		H	H	H
CO 3		H	H	L
CO 4		H	M	
CO 5	H	M	M	

ECES0103: EMBEDDED SYSTEM (L-T-P: 3-0-0)
(3 credits – 45 hours)

Objective
To provide students with basic knowledge and skills in embedded systems design.

Course Outcomes
1. Select design approach using advanced controllers to real-life situations. (Remembering)
2. Develop systems using interfacing with other data handling / processing systems. (Applying)
3. Assess engineering constraints like energy dissipation, data exchange speeds etc. (Evaluating)

Module I (10 hours)
Concept of embedded systems design, embedded microcontroller cores, embedded memories. Examples of embedded systems

Module II (20 hours)
Technological aspects of embedded systems: interfacing between analog and digital blocks, signal conditioning, digital signal processing. Sub-system interfacing, interfacing with external systems, user interfacing.

Module III (15 hours)
Design trade-offs due to process compatibility, thermal considerations, etc., Software aspects of embedded systems: real time programming languages and operating systems for embedded systems.

Suggested Readings
1. J.W. Valvano, "Embedded Microcomputer System: Real Time Interfacing", Brooks/Cole,
2. Jack Ganssle, "The Art of Designing Embedded Systems", Newness, 1999.
3. V.K. Madisetti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.
4. David Simon, "An Embedded Software Primer", Addison Wesley, 2000.
5. K.J. Ayala, "The 8051 Microcontroller: Architecture, Programming, and Applications", Penram Intl, 1996.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H	M	
CO 2		H	L
CO 3		L	H

ECMN0104: MOBILE COMMUNICATION and NETWORKS (L-T-P: 3-0-0)

(3 credits – 45 hours)

Objective

The course introduces the principles of mobile systems and its most important technical aspects and services and emphasizes on both public and professional mobile telephony standards, spread spectrum technology, wireless networks while migrating from wired to wireless applications.

Course Outcomes

1. Define the working principles of the cellular communication systems. (Remembering)
2. Explain the features and underlying technology. (Understanding)
3. Compare different techniques used to in mobile communication system. (Analysing)

Module I (12 hours)

Cellular concepts-Cell structure, frequency reuse, cell splitting, channel assignment, handoff, interference, capacity, improving the capacity in cellular system- cell splitting, sectoring, power control; Wireless Standards: Overview of 2G and 3G cellular standards.

Module II (15 Hours)

Signal propagation-Propagation mechanism- reflection, refraction, diffraction and scattering, large scale signal propagation and lognormal shadowing. Fading channels-Multipath and small scale fading- Doppler shift, statistical multipath channel models, narrowband and wideband fading models, power delay profile, average and rms delay spread, coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate. Capacity of flat and frequency selective channels.

Module III (10 Hours)

Antennas-Antennas for mobile terminal- monopole antennas, PIFA, base station antennas and arrays.

Multiple access schemes-FDMA, TDMA, CDMA and SDMA. Modulation schemes- BPSK, QPSK and variants, QAM, MSK and GMSK, multicarrier modulation, OFDM. Receiver structure- Diversity receivers- selection and MRC receivers, RAKE receiver, equalization: linear-ZFE and adaptive, DFE. Transmit diversity-Altamonte scheme.

Module IV (8 Hours)

MIMO and space time signal processing, spatial multiplexing, diversity/multiplexing trade off. Performance measures- Outage, average snr, average symbol/bit error rate. System examples- GSM, EDGE, GPRS, IS-95, CDMA 2000 and WCDMA.

Suggested Readings

1. T. S. Rappaport, Wireless Communication, Pearson, 2001.
2. WCY Lee, Mobile Cellular Telecommunications Systems, McGraw Hill, 1990.
3. WCY Lee, Mobile Communications Design Fundamentals, Prentice Hall, 1993.
4. Raymond Steele, Mobile Radio Communications, IEEE Press, New York, 1992.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	H	M	L
CO 2		H	M	
CO 3			M	H

ECWN105: WIRELESS SENSOR NETWORK (L-T-P: 3-0-0)

(3 credits – 45 hours)

Objective

This course introduces the different modules in a wireless sensor node and design of wireless sensor networks for different applications

Course Outcomes

1. Recall the Concepts, Network Architecture and Applications of Wireless Sensor Networks (Remembering).
2. Outline emerging research areas in the field of sensor networks (Understanding).
3. Develop the Concepts and Architecture of ad-hoc and sensor networks and MAC layer protocols (Applying).
4. Interpret and Analyze the protocol design issues for different communication standards used in WSN (Understanding, Analyzing).

5. Evaluate the QOS related performance measurements of ad-hoc and sensor networks (Evaluating).

Module I (5 Hours)
Introduction: Introduction to Sensor Networks and its architecture; Unique constraints and challenges of Sensor Networks; Advantage of Sensor Networks; Applications of Sensor Networks; Types of wireless sensor networks; Sensor node architecture with hardware and software details.

Module II (5 Hours)
Mobile Ad-hoc Networks: Mobile Ad-hoc Networks (MANETs) and Wireless Sensor Network; Enabling technologies for Wireless Sensor Networks.

Module III (12 Hours)
Overview of Sensor Network Protocols: Routing protocols, MAC protocols: Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and ZigBee; Dissemination protocol for large sensor network: Data dissemination, data gathering, and data fusion; Quality of a sensor network; Real-time traffic support and security protocols.

Module IV (5 Hours)
Design Principles: Design Principles for WSNs, Gateway Concepts Need for gateway, WSN to Internet Communication, and Internet to WSN Communication.

Module V (12 Hours)
Hardware and Software: Single-node architecture, Hardware components & design constraints, Examples like mica2, micaZ, telosB, cricket, Imote2, tmote, btnode, and Sun SPOT.
Operating systems and execution environments, introduction to TinyOS, nesC, MANTIS, Contiki, and RetOS.

Module VI (6 Hours)
Specialized features: Energy preservation and efficiency; Security challenges; Fault tolerance, Issues related to Localization, connectivity and topology; Sensor deployment mechanisms; Coverage issues; sensor Web; Sensor Grid.

Suggested Readings
1. Waltenegus Dargie, Christian Poellabauer, “Fundamentals Of Wireless Sensor Networks Theory And Practice”, By John Wiley & Sons Publications ,2011
2. H. Karl and A. Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley & Sons, India, 2012.
3. Philip Levis, And David Gay "TinyOS Programming” by Cambridge University Press 200
4. F. Zhao and L. Guibas, “Wireless Sensor Networks: An Information Processing Approach”, Morgan Kaufmann, 1st Indian reprint, 2013.
5. KazemSohrby, Daniel Minoli, “Wireless Sensor Networks”: Technology, Protocols and Applications, Wiley-Inter science
6. SabrieSoloman, “Sensors Handbook" by McGraw Hill publication. 2009

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M				L
CO 2		L	M	M	H	H
CO 3		H	L	M	M	M
CO 4	L		H	H		M
CO 5			M	L	M	H

ECSC0106: SATELLITE COMMUNICATION (L-T-P: 3-0-0)
(3 credits – 45 hours)

Objective
This course introduces the basic satellite system, Geostationary satellite, satellite link budget, Multiple access, satellite Earth station etc.

Course Outcomes
1. Relate the architecture of satellite systems as a means of high speed, high range communication system. (Remembering)
2. Infer the basic laws, terminologies and orbital parameters related to satellite communication. (Understanding)
3. Explain various aspects related to satellite systems such as types of satellites, satellite orbits, orbital parameters and the process of launching them in orbits. (Applying)

4. Analyze the subsystems of satellite communication. (Analysing)
5. Compare the various multiple access techniques and assess their importance in satellite communication. (Evaluating)

Module I (6 hours)
Introduction to Satellite Communication: Principles and architecture of satellite communication, Brief history of satellite systems, advantages, disadvantages, applications and frequency bands used for satellite communication.

Module II (8 hours)
Orbital Mechanics: Orbital equations, Kepler's laws, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc. of a satellite, concepts of Solar day and Sidereal day.

Module III (8 hours)
Satellite sub-systems: Study of Architecture and Roles of various sub-systems of a satellite system such as Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication sub-system, power sub-systems etc.

Module IV (8 hours)
Typical Phenomena in Satellite Communication: Solar Eclipse on satellite, its effects, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift phenomena and expression for Doppler shift.

Module V (8 hours)
Power Calculations: Satellite link budget. Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions.

Module VI (7 hours)
Modulation and Multiple Access Schemes: Modulation schemes used in satellite communication, Multiple access schemes - TDMA, FDMA and CDMA.

Suggested Readings

1. Timothy Pratt Charles W. Bostian, Jeremy E. Allnutt: Satellite Communications: Wiley India. 2nd edition 2002.
2. Tri T. Ha: Digital Satellite Communications: Tata McGraw Hill, 2009.
3. Dennis Roddy: Satellite Communication: 4th Edition, McGraw Hill, 2009.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module5	Module6
CO 1	H	M	L			
CO 2	M	H	L			
CO 3		M	H	L		
CO 4	L	L	M	H		
CO 5	L	L	L	M	H	L

ECAM0107: INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING (L-T-P: 3-0-0)
(3 credits – 45 hours)

Objective
This course will help students to acquire knowledge on intelligent systems and agents, formalization of knowledge, reasoning with and without uncertainty, machine learning and applications at a basic level

Course Outcomes
1. Interpret mathematical principles used in learning algorithms and relate them to learning principles. (Understanding)
2. Demonstrate fundamental understanding of artificial intelligence (AI) and its foundations. (Applying)
3. Construct and classify learning algorithms used in different problems (Applying)
4. Contrast what and how to perform pre-processing to make dataset ready for learning algorithms. (Analysing)
5. Choose and compare the different approaches To Knowledge Representation. (Evaluate)

Module I (10 Hours)
Artificial Intelligence: What is AI (Artificial Intelligence)? : The AI Problems, The Underlying Assumption, What are AI Techniques, The Level Of The Model, Criteria For Success, Some General References, One Final Word Problems, State Space Search & Heuristic Search Techniques: Defining The Problems As A State Space Search, Production Systems, Production

Characteristics, Production System Characteristics, And Issues In The Design Of Search Programs, Additional Problems. Generate- And-Test, Hill Climbing, Best-First Search, Problem Reduction, Constraint Satisfaction, Means-Ends Analysis.

Module II (10 Hours)
Mathematical Foundations: Linear Algebra-Linear equations & vector spaces, matrix decomposition: determinant, Eigen values, singular value decomposition, matrix approximation, Calculus: Differentiation & partial differentiation, gradientvector, Probability & Distributions: Discrete and Continuous random variables, Gaussian distribution, Continuous optimization: Gradient descent, Lagrange Multiplier.

Module III (8 Hours)
Knowledge Representation Issues: Representations and Mappings, approaches to knowledge Representation; Using Predicate Logic: Representation Simple Facts In Logic, Representing Instance And Isa Relationships, Computable Functions And Predicates, Resolution; Representing Knowledge Using Rules: Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning.

Module IV (7 Hours)
Learning: Supervised, unsupervised and reinforcement learning, types of unsupervised learning, KNN, regression models, Naive Bayes' classifier, decision trees, random forest classifier, SVM: linear, non-linear.

Module V (5Hours)
Data pre-processing& Scaling: Different kinds of pre-processing, Data transformations, Scaling: training data & testing data, dimensionality reduction, clustering: k-Means, Fuzzy C -Means, DBSCAN.

Module VI (5 Hours)
Deep learning: Introduction to neural Network: Perceptron model, Multilayer feed forward neural networkand back propagation, Convolutional Neural Network(CNN): Basic architecture and training of CNN. Introduction to Deep learning, RNN: Training a RNN, deep RNN, LSTM cell, Autoencoders: stacked autoencoders, sparse autoencoder.

Suggested Readings

1. Elaine Rich and Kevin Knight "Artificial Intelligence", 2nd Edition, Tata Mcgraw-Hill, 2005.
2. Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Prentice Hall, 2009.
3. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer (India) Private Limited, 2013
4. AurelienGeron, Hands-On Machine Learning with Scikit-Learn &TensorFLow. Second edition, 2017, O' Reilly Media.
5. Stephen Marshland,Machine Learning-An Algorithmic Perspective, second edition, ,2015, CRC Press.
6. John D. Kelleher, Deep Learning,2019, Massachusetts Institute of Technology(MIT).

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1		H		M	L	
CO 2	H		M	L		L
CO 3		L		H	M	H
CO 4			L	M	H	M
CO 5			H	L	M	

ECOC0108: FIBER OPTIC COMMUNICATION (L-T-P: 3-0-0)
(3 credits – 45 hours)

Objective
This course aims at providing a comprehensive introduction to communication systems which include fiber-optic communication technology, satellite communication and multiple access. The course is designed for the students to develop a good understanding of the physical aspect of the technology necessary for them to evaluate and design communication systems.

Course Outcomes
1. Define the fundamental concepts of light transmission. (*Remembering*)
2. Define different types of optical fibers and other components of Fiber Optic Communication such as optical sources, detectors amplifiers and connectors etc. (*Remembering*)
3. Explain various components of optical networking and networking systems. (Understanding)
4. Solve for various parameters related to optical fibre and fibre optic link design. (*Applicatio*n)

5. Analyze optical fibers in terms of various nonlinear effects. (*Analysis*)

Module I (10 Hours)
Introduction: Introduction to vector nature of light, propagation of light, propagation of light in a cylindrical dielectric rod, Ray model, wave model.

Module II (7 Hours)
Different types of optical fibers, Modal analysis of a step index fiber. Signal degradation on optical fiber due to dispersion and attenuation. Fabrication of fibers and measurement techniques like OTDR.

Module III (6 Hours)
Optical sources and receivers: LEDs and Lasers, Photo-detectors - pin-diodes, APDs, detector responsivity, noise, optical receivers.

Module IV (7 Hours)
Optical Networking: Optical switches, Couplers, coupled mode analysis of directional couplers, electro-optic switches. Optical amplifiers - EDFA, Raman amplifier. WDM and DWDM systems. Principles of WDM networks.

Module V (5 Hours)
Optical link design - BER calculation, quantum limit, power penalties.

Module VI (10 Hours)
Nonlinear Effects: Nonlinear effects in fiber optic links. Concept of self-phase modulation, group velocity dispersion and soliton based communication.

Suggested Readings

1. J. Keiser, Fibre Optic communication, McGraw-Hill, 5th Ed. 2013 (Indian Edition).
2. T. Tamir, Integrated optics, (Topics in Applied Physics Vol.7), Springer-Verlag, 1975.
3. J. Gowar, Optical communication systems, Prentice Hall India, 1987.
4. S.E. Miller and A.G. Chynoweth, eds., Optical fibres telecommunications, Academic Press, 1979.
5. G. Agrawal, Nonlinear fibre optics, Academic Press, 2nd Ed. 1994.
6. G. Agrawal, Fiber optic Communication Systems, John Wiley and sons, New York, 1997.
7. F.C. Allard, Fiber Optics Handbook for engineers and scientists, McGraw Hill, New York (1990).

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module5	Module6
CO 1	H	M	L			
CO 2	M	H	L			M
CO 3	L	M	H			
CO 4	L	L	M	H		H
CO 5	L	L	L	M	H	L

ECAS0109: ADAPTIVE SIGNAL PROCESSING (L-T-P: 3-0-0)
(3 credits – 45 hours)

Objective
This course introduces some practical aspects of signal processing, and in particular adaptive systems.

Course Outcomes
1. Identify various algorithms to design filters and adaptive filters. (Remembering)
2. Explain the characteristics and properties of Adaptive systems. (Understanding)
3. Inspect concepts of signal and vector space and its applicability in various systems. (Analysing)
4. Discuss application of recursive least squares in filters and adaptive filters. (Creating)

Module I (10 Hrs)
Adaptive Systems - Definition and characteristics – Properties - Applications and examples of an adaptive system. Stochastic Processes and Models: Characterization - Mean ergodic theorem - Correlation matrix - Power spectral density, Properties of power spectral Density, Response of a linear system to random signals; Stochastic models

Module II (10 Hrs)

Wiener filters - Linear optimum filtering - Minimum mean-square error - Wiener- Hopf equations - Multiple linear regression model - Linear prediction - Forward linear prediction, Levinson-Durbin algorithm. Recursive updating of forward and backward prediction errors, Stochastic lattice filters, joint process estimator, gradient adaptive lattice.Kalman filter - Extended Kalman filter

Module III (7 Hrs)
Steepest-descent algorithm, Least-Mean-Square (LMS) adaptive filters - LMS algorithm, LMS adaptation algorithm - applications. Method of Least Squares - Data windowing, Normal equations and linear least square filters, Recursive least squares algorithm.

Module IV (8 Hrs)
Introduction to recursive least squares (RLS), vector space formulation of RLS estimation, pseudo-inverse of a matrix, time updating of inner products, development of RLS lattice filters, RLS transversal adaptive filters.

Suggested Readings

1. Todd K. Moon, Wynn C. Stirling, “Mathematical Methods and Algorithms for Signal Processing” Prentice Hall, First edition, 1999.
2. John. R. Triechler, C. Richard Johnson (Jr), Michael. G. Larimore, “Theory and Design of Adaptive Filters”, Prentice Hall India Private Limited, 2004
3. Bernard Widrow and Samuel. D. Stearns, “Adaptive Signal Processing”, Pearson Education, 2001.
4. S. Haykin, Adaptive filter theory, Prentice Hall, 1986.
5. C.Widrow and S.D. Stearns, Adaptive signal processing, Prentice Hall, 1984.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					
CO 2	L	H	H			
CO 3				H	H	
CO 4						H

ECMT0110: MICROWAVE THEORY & TECHNIQUE (L-T-P: 3-0-0)
(3 credits – 45 hours)

Objective
The course provides an introduction to microwave theory and techniques, including network theory, transmission lines, passive devices and active devices. The course also describes the microwave sources, propagation and measurement.

Course Outcomes

1. Define the fundamentals of microwave systems, components and their properties (Remembering)
2. Illustrate the mathematical concepts during analysis/ synthesis of microwave systems, and circuit parameters (Understanding)
3. To apply the knowledge of transmission line theory and design principles to compute measurement parameters and solve related problems (Applying)
4. Design microwave systems for different practical application (Creating)

Module I (5 hours)
Introduction to Microwaves-History of Microwaves, Microwave Frequency bands; Applications of Microwaves: Civil and Military, Medical, EMI/ EMC. Mathematical Model of Microwave Transmission-Concept of Mode, Features of TEM, TE and TM Modes, Losses associated with microwave transmission, Concept of Impedance in Microwave transmission.

Module II (11 hours)
Analysis of RF and Microwave Transmission Lines- Coaxial line, Rectangular waveguide, Circular waveguide, Strip line, Microstrip line. Microwave Network Analysis- Equivalent voltages and currents for non-TEM lines, Network parameters for microwave circuits, Scattering Parameters.

Module III (9 hours)
Passive and Active Microwave Devices- Microwave passive components: Directional Coupler, Power Divider, Magic Tee, Attenuator, Resonator. Microwave active components: Diodes, Transistors, Oscillators, Mixers. Microwave Semiconductor Devices: Gunn Diodes, IMPATT diodes, Schottky Barrier diodes, PIN diodes. Microwave Tubes: Klystron, TWT, Magnetron.

Module IV (12 hours)
Microwave Design Principles- Impedance transformation, Impedance Matching, Microwave Filter Design, RF and Microwave Amplifier Design, Microwave Power Amplifier Design, Low Noise Amplifier Design, Microwave Mixer Design, Microwave Oscillator Design. Microwave Antennas- Antenna parameters, Antenna for ground based systems, Antennas for airborne and satellite borne systems, Planar Antennas.

Module V (4 hours)
Microwave Measurements- Power, Frequency and impedance measurement at microwave frequency, Network Analyzer and measurement of scattering parameters, Spectrum Analyzer and measurement of spectrum of a microwave signal, Noise at microwave frequency and measurement of noise figure. Measurement of Microwave antenna parameters.

Module VI (4 hours)
Microwave Systems- Radar, Terrestrial and Satellite Communication, Radio Aidsto Navigation, RFID, GPS. Modern Trends in Microwaves Engineering- Effect of Microwaves on human body, Medical and Civil applications of microwaves, Electromagnetic interference and Electromagnetic Compatibility (EMI & EMC), Monolithic Microwave ICs, RF MEMS for microwave components, Microwave Imaging.

Suggested Readings
1. R.E. Collins, Microwave Circuits, McGraw Hill
2. K.C. Gupta and I.J. Bahl, Microwave Circuits, Artech
3. Samual Y. Liao, Microwave Devices & circuits, Pearson

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H		H	L		H
CO 2	H	H	L	M		
CO 3	M	H		L	H	
CO 4		L		H		

ECDV0111: DIGITAL IMAGE and VIDEO PROCESSING (L-T-P: 3-0-0)
(3 credits – 45 hours)

Objective
This course's objectives are to introduce the fundamentals of digital image and video processing, analyze operations on images and videos such as image enhancement, image restoration, Image Segmentation, image compression, colour Image Processing etc.

Course Outcomes
1. Define key stages of image processing (Remembering)
2. Explain key stages of image processing (Understanding)
3. Implement image enhancement, restoration, data compression techniques (Apply)
4. Choose image enhancement technique and object recognition tool for specific image and video application (Evaluate)

Module I (15hours)
Digital Image Fundamentals-Elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels – neighborhood, adjacency, connectivity, distance measures. Image Enhancements and Filtering-Gray level transformations, histogram equalization and specifications, pixel-domain smoothing filters – linear and order-statistics, pixel-domain sharpening filters – first and second derivative, two-dimensional DFT and its inverse, frequency domain filters – low-pass and high-pass.

Module II (15hours)
Color Image Processing-Color models–RGB, YUV, HSI; Color transformations– formulation, color complements, color slicing, tone and color corrections; Color image smoothing and sharpening; Color Segmentation. Image Segmentation-Detection of discontinuities, edge linking and boundary detection, thresholding – global and adaptive, region-based segmentation. Wavelets and Multi-resolution image processing- Uncertainty principles of Fourier Transform, Time frequency localization, continuous wavelet transforms, wavelet bases and multi-resolution analysis, wavelets and Sub band filter banks, wavelet packets.

Module III (15hours)

Image Compression-Redundancy–inter-pixel and psycho-visual; Lossless compression – predictive, entropy; Lossy compression-predictive and transform coding; Discrete Cosine Transform; Still image compression standards–JPEG and JPEG-2000. Fundamentals of Video Coding-Inter-frame redundancy, motion estimation techniques – full-search, fast search strategies, forward and backward motion prediction, frame classification – I, P and B; Video sequence hierarchy–Group of pictures, frames, slices, macro-blocks and blocks; Elements of a video encoder and decoder. Video Segmentation.

Suggested Readings

1. Digital Image Processing, 3rd edition, R.C. Gonzalez and R.E. Woods, 2008, Pearson Education.
2. Fundamentals of Digital Image Processing, 2nd edition, Anil Kumar Jain, 2004, Prentice Hall of India.
3. Digital Video Processing, 2nd edition, Murat Tekalp , 2015,Prentice Hall.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	M	M	M
CO 2	M	M	M
CO 3	H	L	H
CO 4	L	H	H

ECIT0112: INTERNET OF THINGS (L-T-P: 3-0-0)

(3 credits – 45 hours)

Objective

This course introduces the definition and significance of the Internet of Things and discusses the architecture, operation, and benefits of IoT.

Course Outcomes

1. Recall the fundamental concepts of Internet of Things (IoT) (Remembering)
2. Explain the transition from M2Mto IoT (Understanding)
3. Evaluate the various applications of IoT (Evaluating)
4. Describe the importance of privacy and security in IoT (Understanding)

Module I (12 hours)

Introduction to IoT: History and evolution of IoT, Sensing, Actuation, Networking basics, Communication Protocols, Sensor Networks, Machine-to-Machine Communications, IoT Definition, Characteristics. IoT Functional Blocks, Physical design of IoT, Logical design of IoT.

Module II (8 Hours)

M2M to IoT: Introduction, From M2M to IoT, M2M towards IoT-the global context, Role of M2M in IoT, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT.

Module III (8 Hours)

Domain specific applications of IoT: Home automation, Industry applications, Surveillance applications, Other IoT application.

Module IV (7 Hours)

Privacy and Security in IoT: Internet of Things Privacy, Security and Governance Introduction, Overview of Governance, Privacy and Security Issues.

Suggested Readings

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1 st Edition, Academic Press, 2014.
2. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on Approach)”, 1 st Edition, VPT, 2014.
3. Bernd Scholz-Reiter, Florian Michahelles, “Architecting the Internet of Things”, ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer
4. Francis da Costa, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1stEdition, Apress Publications, 2013.
5. E- Resource: http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L		

CO 2		H	L	
CO 3		M	H	M
CO 4				H

ECBI0113: BIOINFORMATICS (L-T-P: 3-0-0)
(3 credits – 45 hours)

Objective
The objective of the course is to introduce students to the rapidly evolving field of bioinformatics and to analyze and evaluate bioinformatics data to discover patterns, critically evaluate conclusions and generate predictions for subsequent experiments

Course Outcomes
1. Recall the biological concepts. (Remembering)
2. Explain the fundamentals of bioinformatics. (Understanding)
3. Apply various techniques used in bioinformatics. (Applying)
4. Analyse and compare various aspects of bioinformatics. (Analysing)
5. Predict protein structure that helps in drug discovery. (Creating)

Module I (10 hours)
Introduction to bioinformatics and computational biology, Scope of bioinformatics, relation of bioinformatics with molecular biology, Fundamental concepts of biology such as nucleotide, amino acids, proteins, different structure of proteins, DNA, DNA Sequences, Cell, Chromosomes, Gene, Mutation, Genetic Polymorphism

Module II (15 hours)
The form of biological information, Introduction to Biological Databases: Nucleic Acid Databases (NCBI, EMBL, DDBJ,), Protein databases (Primary, Composite and Secondary), Specialized Genome Databases (SGD, TIGR), Structure Databases (CATH, SCOPE and PDBsum), Tools: FASTA, BLAST, BLAT, RASMOL

Module III (10 hours)
DNA sequence analysis, Sequence Based Parameters, DNA sequencing as a diagnostic tool

Module IV (10 hours)
Protein Structure and Function, Sequence Alignment, Protein Sequence Analysis, Protein Secondary Structure Prediction, Recent advancement in bioinformatics

Suggested Readings:
1. Arthur M. Lesk, Introduction to Bioinformatics, Oxford
2. JinXiong, Essential Bioinformatics, Cambridge
3. David W. Mount, Bioinformatics: Sequence and Genome Analysis, CBS Relevant e resources

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L		
CO 2		H		
CO 3		M	H	
CO 4			M	H
CO 5			L	H

ECST0114: SENSOR TECHNOLOGY (L-T-P: 3-1-0)
(4 credit – 60 hours)

Objective
This course introduces the concepts of Sensors. The course provides different measurement techniques of physical parameters and to convert it into convenient form and transmit the signals to the control room to have a reliable product.

Course Outcomes
1. Recall the fundamental characteristics of sensors (Remembering)
2. Explain the working of different types of sensors (Understanding)

3. Apply the sensors/transducers to measure the physical quantities in the field of science, engineering and technology (Applying)
4. Analyse the different signal conditioning techniques (Analysing)

Module I (10 hours)
Basics of Sensors, Sensor Classification; Units of Measurements; Performance and Types, Sensor Characteristics, Error Analysis characteristics

Module II (18 hours)
Displacement, position and proximity sensors, Velocity and motion sensors, Strain gauge, load cell, Fluid pressure sensors, Piezoelectric sensors, Liquid flow and level sensors, Ultrasonic sensors, Temperature sensors, Smart sensors

Module III (17 hours)
Electronic and Optical properties of semiconductor as sensors, LED, Semiconductor lasers, Fiber optic sensors, photoconductive detectors, Photo diodes, Avalanche photodiodes, Basics of biomedical sensors: ECG sensor, EEG sensor, PPG sensor, GSR sensor

Module IV (15 hours)
Signal conditioning and processing, Data acquisition systems, block diagram of DAQ, signal conditioning, Digital to Analog converters, Analog to digital converters

Suggested Readings
1. D. Patranabis, Sensors and Transducers, PHI Publication, New Delhi, 2013
2. Ernest O.Doebelin, Measurement systems Application and Design, International Student Edition, IV Edition, McGraw Hill Book Company, 1998.
3. R.K.Jain, Mechanical and Industrial Measurements, Khanna Publishers, New Delhi, 1999.
4. D.Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill Publishing Ltd., New Delhi, 1999.
5. A.K.Sawhney, A course in Electrical and Electronic Measurement and Instrumentation – Dhanpat Rai and Sons, New Delhi, 1999.
6. Leslie Cromwell, Biomedical Instrumentation and measurement, 2nd edition, Prentice hall of India, New Delhi, 2015.

E- Resource
7. https://nptel.ac.in/courses/108/108/108108147/
8. https://nptel.ac.in/courses/108/105/108105064/
9. https://nptel.ac.in/content/storage2/courses/112103174/pdf/mod2.pdf

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M		
CO 2		H	H	
CO 3		H	H	M
CO 4		L	L	H

ECBA0115: IOT Basics and Architecture (L-T-P: 4-0-0)
(4 credits – 60 hours)

Objective
This course introduces the definition and significance of the Internet of Things and discusses the architecture, operation, and benefits of IoT.

Course Outcomes:
1. Recall the fundamental concepts of Internet of Things (IoT) (Understanding/ Remembering)
2. Explain the transition from M2M IoT (Understanding)
3. Analyze various M2M and IoT architectures (Analysing)
4. Evaluate design issues related to IoT architecture (Evaluating)

Module I (15 hours)
Introduction to IoT: History and evolution of IoT, Networking basics, Communication Protocols, Sensor Networks, Machine-to-Machine Communications, IoT Definition, Characteristics. IoT Functional Blocks, Physical design of IoT, Logical design of IoT.

Applications of IoT and IoT privacy and security.

Module II (10 Hours)
M2M to IoT: Introduction, From M2M to IoT, M2M towards IoT-the global context, Role of M2M in IoT, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT.

Module III (10 Hours)
Overview of Architecture: An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking.

Module IV (15 hours)
Reference Architecture: IoT Architecture-State of the Art – Introduction, State of the art, Reference Model and architecture, IoT reference Model - IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Introduction to protocols.

Suggested Readings
1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1 st Edition, Academic Press, 2014.
2. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on Approach)”, 1 st Edition, VPT, 2014.
3. Bernd Scholz-Reiter, Florian Michahelles, “Architecting the Internet of Things”, ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer
4. Francis da Costa, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1stEdition, Apress Publications, 2013.
5. E- Resource: http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L		
CO 2		H	L	
CO 3		M	H	M
CO 4		L	L	H

ECWT0116: WEB TECHNOLOGY (L-T-P: 4-0-0)
(4 credits – 60 hours)

Objective
The main objective of the course is to focus on fundamental key concepts required for developing web applications. The course will encompass key components like HTTP communication protocol, the markup languages HTML, XHTML, PHP and XML, the CSS XSLT standards for formatting and transforming web content, interactive graphics and multimedia content on the web, client-side programming using Javascript, JSP and AJAX.

Course Outcomes
1. Define basics terminologies like HTML, PHP, JAVA, XML, AJAX etc. necessary in web technology. (Remembering)
2. Explain the HTML and CSS syntaxes and semantics required to build web pages. (Understanding)
3. Apply different tags, tables, forms, frames and style sheets supported by HTML to design web pages. (Applying)
4. Evaluate particular software problem using Java programs, comprising more than one class. (Evaluating)
5. Design applets as per the requirements with event handling facility. (Creating)

Module I (12 hrs)
Web Basics: Introduction, History and Protocols of Internet, World Wide Web, Web Server and Browser, HTML, Structure of HTML document, Dynamic HTML.
PHP: Introduction to PHP, Declaring variables, data types, arrays, strings, operations, expressions, control structures, functions, etc. File Handling in PHP: File operations like opening, closing, reading, writing, appending, deleting etc. on text and binary files, listing directories.

Module II (10 hrs)
JAVA: Introduction to JAVA, Client side scripting with JavaScript, variables, functions, conditions, loops and repetition, Pop up boxes, JavaScript Objects, The Document Object Model (DOM), JavaScript Events, Forms.

Module III (13 hrs)
XML: Introduction to XML, uses of XML, simple XML, Defining XML tags, their attributes and values, Document type definition, XML Schemas, XML key components, DTD and Schemas, Using XML with application, XHTML Parsing XML Data - DOM and SAX parsers in java, Transforming XML using XSL and XSLT.

Module IV (15 hrs)
Servlets: Introduction to Servlets, Common Gateway Interface (CGI), Lifecycle of a Servlets, deploying a Servlets, The Servlets API, Reading Servlets parameters, Reading initialization parameters, Handling Http Request & Responses.
JSP: Introduction to JSP, The Anatomy of a JSP Page, JSP Processing, Declarations, Directives, Expressions, Code Snippets, implicit objects, Using Beans in JSP Pages, Using Cookies and session tracking, connecting to database in JSP.

Module V (10 hrs)
AJAX: Introduction AJAX, AJAX Components, Handling Dynamic HTML with AJAX, AJAX using PHP, AJAX PHP Database form, AJAX PHP MySQL select Query, AJAX using XML.

Suggested Readings
1. Randy Connolly, Ricardo Hoar, "Fundamentals of Web Development", 1 st Edition, Pearson Education India. (ISBN:978-9332575271)
2. Ralph Moseley and M.T Savaliya, "Developing Web Applications", 2nd edition, Wiley-India, 2015 (ISBN: 9788126538676)
3. Robin Nixon, "Learning PHP, MySQL &JavaScript with jQuery, CSS and HTML5", 4 thEdition, O'Reilly Publications, 2015. (ISBN:978-9352130153)
4. Nicholas C Zakas, "Professional JavaScript for Web Developers", 3rd Edition, Wrox/Wiley India, 2012. (ISBN:978-8126535088)
5. Zak Ruvalcaba Anne Boehm, "Murach's HTML5 and CSS3", 3rdEdition, Murachs/Shroff Publishers & Distributors Pvt Ltd, 2016. (ISBN: 978-9352133246)
6. B. M Harwani, "Developing Web Applications in PHP and AJAX", 1st Edition, McGraw Hill India, 2010 (ISBN: 978-0070144521)

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	M	L		
CO 2		H	M	L	
CO 3	M	L	H		
CO 4		M	H		L
CO 5	L	M		M	H

ECML0117: Machine Learning (L-T-P: 4-0-0)
(4 credits – 60 hours)

Objective
The main objective of this course is to introduce the students with the concept of artificial intelligence and machine learning.

Course Outcomes
1. Define various terminologies used in probability theory and statistics, function approximation and models of classification (Remembering)
2. Explain various terminologies used in probability theory and statistics, function approximation and models of classification (Understanding)
3. Implement various function approximation techniques and models of classification (Applying)
4. Compare various function approximation techniques and models of classification (Analyzing)
5. Choose models of classification for specific application (Evaluating)

Module I (20 hours)
Basics of Linear Algebra and Probability Theory: Vector space, Inner product, Inverse of a matrix, Eigen analysis, Singular value decomposition, Probability distributions – Discrete distributions and Continuous distributions; Independence of events, Conditional probability distribution and Joint probability distribution, Bayes theorem, Normal (Gaussian) distribution.
Methods for Function Approximation: Linear models for regression, Parameter estimation methods - Maximum likelihood method and Maximum *aposteriori* probability method; Regularization, Ridge regression, Lasso, Bias-Variance decomposition, Bayesian linear regression.

Module II (20 hours)
Classification: Bayesian decision theory, Bayes classifier, Minimum error-rate classification,– Discriminant functions, Decision surfaces, Maximum-Likelihood, maximum a posteriori probability decision; Gaussian mixture models -- Expectation-Maximization method for classification; Naive Bayes classifier: Non-parametric techniques for density estimation -- Parzen-window method, K-nearest neighbors method, Hidden Markov models (HMMs)

Module III (20hours)
Dimensionality Reduction Techniques: Principal component analysis, Fisher discriminant analysis, Multiple discriminant analysis.
Discriminative Learning based Models for Classification: Logistic regression, Perceptron, Multilayer feed forward neural network – Gradient descent method, Error back propagation method; Support vector machine.
Swap Pattern Recognition with Intro to AI

Suggested Readings
1. Pattern Recognition and Machine Learning, C.M.Bishop, , 2006, Springer.
2. Pattern Classification ,2nd Edition, R.O.Duda, P.E.Hart and D.G.Stork, 2001, John Wiley.
3. Pattern Recognition , 3rd Edition, S. Theodoridis and K. Koutroumbas, 2009 , Academic Press.
4. Introduction to Machine Learning, 4thEdition , E. Alpaydin, 2010 , Prentice-Hall of India.
5. Introduction to Statistical Learning, G. James, D. Witten, T. Hastie and R. Tibshirani, 2013.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H	H	L
CO 2	H	H	L
CO 3	L	M	M
CO 4	L	M	M
CO 5	L	M	H

ECET0118: EMBEDDED SYSTEMS & IOT (L-T-P: 4-0-0)
(4 credits – 60 hours)

Objective
The main objective of this course is to introduce the students with the concept of embedded system and IoT and its applications in various fields. In this course they will study IoT architecture designing of IoT based embedded system with the security and privacy issues.

Course Outcomes
1. Define various terminologies related to embedded system and IoT. (Remembering)
2. Illustrate the concept of IoT. (Understanding)
3. Apply the concept of IOT architecture to design embedded systems in various domains. (Applying)
4. Analyze IOT architecture and applications in various fields. (Analyzing)
5. Create IoT based embedded systems. (Evaluating-Creating)

Module I (10 Hours)
Embedded System Basics: Introduction to Embedded Systems, Components of Embedded Systems, Features of Embedded System, Challenges in designing Embedded Systems, Categories of Embedded Systems, Importance of Microcontroller in Embedded System based system design

Module II (15 Hours)
IoT Basics: Definition, History, Features, Working, Applications, Challenges, Advantages and Disadvantages, Best Practices of IoT, Embedded devices and system using IoT, IoT decision framework, IoT Ecosystem

Module III (10 Hours)
a. Architecture: Components of IoT Architecture, Stages of IoT Architecture, IoT Platform
b. IoT Communication Protocols: Data Link, Network Layer, Session Layer

Module IV (15 Hours)
a. Applications of IoT: Smart Objects, IoT Devices, Basic and Advance IoT Boards
b. Domain of IoT: Energy, Biometric, Security and Surveillance, Smart City, Healthcare, Agriculture, Transportation, Transforming Businesses

Module V (10 Hours)
IoT based System Design: IoT based Home Light Control, IoT based Ultra Sonic Sensor Distance Calculation, Temperature, Pressure and Altitude Measurement System using IoT

Suggested Readings

1. Arsheep Bahga, Vijay Madisetti, Internet of Things: A Hands-On Approach Book, R.K. Books.
2. Cuno Pfister, Getting Started with the Internet of Things, O'Reilly Media.
3. Simone Cirani, Gianluigi Ferrari, Marco Picone, and Luca Veltri, Internet of Things: Architectures, Protocols and Standards, Willey.
4. Samuel Greengard, The Internet of Things, MIT Press.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	M			
CO 2		H	M		
CO 3		L	H	M	
CO 4			M	H	L
CO 5				M	H

ECSV0119: SIGNAL PROCESSING FOR VLSI (L-T-P: 3-1-0)
(4 credits – 60 hours)

Objective
This course aims at providing a comprehensive coverage of some of the important techniques for designing efficient VLSI architectures for DSP.

Course Outcomes
1. Explain pipelining and parallel processing concepts. (Understanding)
2. Inspect various algorithms and architecture for designing FIR and IIR filters. (Applying)
3. Inspect concepts of scaling and round off noise in digital filters (Analyzing)
4. Discuss various bit level arithmetic architectures. (Creating)

Module I (8 Hrs)
Introduction to DSP Systems: Introduction to DSP systems, Typical DSP algorithms, Data flow and Dependence graphs, critical path, Loop bound, iteration bound, longest path matrix algorithm, Pipelining and Parallel processing of FIR filters, Pipelining and Parallel processing for low power.

Module II (8 Hrs)
Retiming: Retiming and Unfolding: Retiming, definitions and properties, Unfolding, an algorithm for unfolding, properties of unfolding, sample period reduction and parallel processing application.

Module III (7 Hrs)
Algorithmic Strength Reduction: Algorithmic strength reduction in filters and transforms, 2-parallel FIR filter, 2-parallel fast FIR filter, DCT architecture, rank-order filters, Odd-Even merge-sort architecture, parallel rank order filters.

Module IV (7 Hrs)
Fast Convolution & Pipelining and Parallel Processing Of IIR Filters: Fast Convolution - Fast convolution, Cook-Toom algorithm, modified Cook-Toom algorithm.
Pipelining and Parallel Processing of IIR Filters - Pipelined and parallel recursive filters, Look-Ahead pipelining in first-order IIRfilters, Look-Ahead pipelining with power-of-2 decomposition, Clustered look-ahead pipelining, parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters.

Module V (7 Hrs)
Scaling and Round-Off Noise: Scaling and round-off noise, scaling operation, round-off noise, state variable description of digital filters, scaling and round-off noise computation, round-off noise in pipelined IIR filters.

Module VI (8 Hrs)
Bit-Level Arithmetic Architectures: Bit-level arithmetic architectures, parallel multipliers with sign extension, parallel carry ripple and carry-save multipliers, Design of Lyon's bit-serial multipliers using Horner's rule, bit-serial FIR filter, CSD

representation, CSD multiplication using Horner's rule for precision improvement, Distributed Arithmetic fundamentals and FIR filters

Suggested Readings

1. Keshab K.Parhi, "VLSI Digital Signal Processing systems, Design and implementation", Wiley, Inter Science, 1999.
2. V.K. Madisetti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.
3. Gary Yeap, "Practical Low Power Digital VLSI Design", Kluwer Academic Publishers, 1998.
4. Mohammed Ismail and Terri Fiez, "Analog VLSI Signal and Information Processing", Mc Graw-Hill, 1994.
5. S.Y. Kung, H.J. White House, T. Kailath, "VLSI and Modern Signal Processing", Prentice Hall, 1985. 5. Jose E. France, Yannis Tsividis, "Design of Analog & Digital VLSI Circuits for Telecommunication and Signal Processing ", Prentice Hall, 1994.
6. U.Meyer, Baese, Digital Signal Processing with Field Programmable Gate Arrays, Springer, Second Edition, 2004.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H					
CO 2	L	H	H	H		
CO 3	L			M	H	
CO 4					L	H

EDDS0120: ADVANCED DIGITAL SIGNAL PROCESSING (L-T-P: 3-1-0)

(4 credits – 60 hours)

Objective

This course is intended to make the students learn the essential advanced topics in digital signal processing. The course includes linear constant-coefficient system properties which will be required for study of any further advance courses. The course also introduces the students to adaptive signal processing and applications of DSP and multirate DSP.

Course Outcomes

1. Recall, illustrate and summarize the theories DSAP and multirate DSP for different filters and algorithms. (Remembering - Understanding)
2. Choose best algorithm for adaptive filter design. (Applying)
3. Solve different problems related to finite word length effect. (Applying - Creating)
4. Analyze the theory of prediction and solution of normal equations. (Analyzing)
5. Examine applications of DSP at block level. (Analyzing)
6. Interpret the utilization of advanced algorithms like LMS, MMSE etc., for designing of adaptive filters. (Evaluating)

Module I (9 Hours)

DSP: Discrete time signals and Systems and its classifications; Time and frequency domain analysis of LTI System; Z-transform, DTFT, DFT, FFT Algorithms; IIR and FIR digital filter design and structural realization; Butterworth, Chebyshev and Eliptic Approximations; All pass filter.

Module II (9 Hours)

Multirate DSP: Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, poly phase filters, QMF, digital filter banks, Applications in sub-band coding.Introduction to wavelets, Multi-resolution analysis.

Module III (8 hours)

Introduction; Representation of numbers- fixed point, floating point; Rounding and Truncation Errors; Quantization Effects in ADC and DAC processes; Noise power from a digital system; Coefficient quantization effects in direct form realization of IIR and FIR systems; Round off effects in Digital filter structures.

Module IV (8 Hours)

Stationary random processes, Minimum mean square error and linear minimum mean square error criteria, forward-backward linear prediction filters, solution of normal equations – Levinson Durbin Algorithm, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction.

Module V (10 Hours)

Adaptive Filters, FIR adaptive filters: steepest descent algorithm, LMS algorithmand variance, Gradient Adaptive Lattice, Recursive Least Square algorithm, Applications: noise cancellation, channel equalization.
Introduction to Kalman Filter.

Module VI (10 Hours)
Nonparametric Methods for Power Spectrum Estimation, Parametric Methods for Power Spectrum Estimation, Minimum Variance Spectral Estimation, Eigen analysis, Algorithms for Spectrum Estimation.

Module VII: Applications (6 Hours)
Application to Radar signal processing, image processing and speech processing.

Suggested Readings

1. J. G. Proakis and D. G. Manolakis "Digital signal processing: Principles, Algorithm and Applications", 4th Edition, Prentice Hall, 2007.
2. N. J. Fliege, "Multirate Digital Signal Processing: Multirate Systems-Filter Banks– Wavelets", 1st Edition, John Wiley and Sons Ltd, 1999.
3. Bruce W. Suter, "Multirate and Wavelet Signal Processing", 1st Edition, Academic Press, 1997.
4. M. H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley & Sons Inc., 2002.
5. S. Haykin, "Adaptive Filter Theory", 4th Edition, Prentice Hall, 2001.
6. D. G. Manolakis, V.K. Ingle an and S. M. Kogon, "Statistical and Adaptive Signal Processing", McGraw Hill, 2000.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H		M	L		
CO 2			M	H	L	
CO 3		H		L	M	L
CO 4			H	M	L	
CO 5	M		L			H
CO 6			M	L	H	

ECCV0121: FUNDAMENTALS OF COMPUTER VISION (L-T-P: 3-1-0)
(4 credits – 60 hours)

Objective
The course is intended to make an insight into different aspects of Computer Vision and Machine learning, working principles, systems associated and applications.

Course Outcomes
1. Recall the working of camera and explain behavior of various sources, surfaces, shadows, human visual systems etc. (Remembering - Understanding)
2. Illustrate the image formation models and feature extraction for computer vision. (Understanding)
3. Apply various image analysis operations on the images and videos such as segmentation, counting objects, shape determination, feature extraction etc. (Applying)
4. Analyze algorithms for high level vision analysis such as object detection and classifications using input features and classifiers. (Analyzing)
5. Evaluate the segmentation and motion detection and estimation techniques. (Evaluating)
6. Develop small applications and detect the objects in various applications. (Creating)

Module I (12 Hours)
Human Visual system, Colour representation and colour Models; Camera: Pinhole and Lens Types, geometric Camera model and Camera calibration; Monocular imaging system, Orthographic & Perspective Projection, Binocular imaging systems, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Radiometry, Projections.
Transforms: 2 dimensional discrete Fourier transform, Hough transforms for line detection and Radon transform and tomographic reconstruction.

Module II: Feature Extraction (10 Hours)
Edge detection, Edge linking, corner detection, texture, binary shape analysis, boundary pattern analysis, circle and ellipse detection,

Module III (5 Hours)
Surface Illumination; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo, Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges.

Module IV (20 Hours)
Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation. Deformable curves and surfaces, active contours, Level set representations, Fourier and wavelet descriptors, B-Splines, Least Squares and Eigen Vector Line Fitting
Statistical Decision Theory; Pattern Recognition Principles; Clustering Approach- K- Means Clustering; Parametric Approach- Bayes' Classifier; Relaxation Approach; Shape Similarity Based Recognition; Expert System and applications;
Shape correspondence and shape matching, Principal component analysis, Shape priors for recognition, Geometric templates from spatial relations, Probabilistic and inferential methods- neural networks, support vector machines; Introduction to convolutional neural network

Module V (8 Hours)
Regularization theory, Optical computation, Stereo Vision, Motion estimation, Background Subtraction and Modeling, Optical Flow, Spatio Temporal Analysis, Dynamic Stereo; Motion parameter estimation, Structure from motion, Motion Tracking in Video.

Module VI (5 Hours)
Automated Visual Inspection, Inspection of Cereal Grains, Surveillance, In-Vehicle Vision Systems, CBIR, CBVR, Activity Recognition, computational photography, Biometrics, stitching and document processing.

Suggested Readings

1. Ballard and Brown, "Computer Vision",PRENTICEHALL, INC., 1982.
2. D. Forsyth and J. Ponce, "Computer Vision - A modern approach", 2nd Edition, Pearson Prentice Hall, 2012
3. Szeliski, Richard, "Computer Vision: Algorithms and Applications", 1st Edition, SpringerVerlag London Limited, 2011.
4. Richard Hartley and Andrew Zisserman, "Multiple View Geometry in Computer Vision", 2nd Edition, Cambridge University Press, 2004.
5. Rafael C. Gonzalez and Richard E. Woods," Digital Image Processing", 3rd Edition, Prentice Hall, 2008.
6. K. Fukunaga,"Introduction to Statistical Pattern Recognition",2nd Edition, Morgan Kaufmann, 1990.
7. B. K. P. Horn, "Robot Vision", 1st Edition, McGraw-Hill, 1986.
8. E. R. Davies "Computer and Machine Vision: Theory, Algorithms, Practicalities", 4th Edition, Elsevier Inc, 2012.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H			L	M	M
CO 2		H	L			M
CO 3		M	H		L	L
CO 4	L			M	H	M
CO 5				H	M	L
CO 6	M	L	M	M	M	H

ECDC0122: DIGITAL CIRCUITS (L-T-P: 3-1-0)
(4 credits – 60 hours)

Objective
The objectives of this course are to introduce the concept of digital and binary systems and give students the concept of digital electronics. The course also provides fundamental concepts used in the design of digital systems, the basic tools for the design and implementation of digital circuits and systems.

Course Outcomes
1. Define the fundamentals of digital systems, logic gates, Boolean algebra, logic families and memories (Remembering)
2. Classify and compare between different types of number systems, their conversions and different types of combinational and sequential circuits (Understanding)
3. Apply Boolean formulas, K-map and Quine-McClusky methods for minimizing logic functions (Applying)
4. Analyse various combinational, sequential and other digital circuits and systems. (Analyzing)
5. Design various combinational and sequential circuits and determine their outputs (Creating)

Module I (10 Hours)
Introduction to Digital Systems-Difference between analog and digital systems, advantages of digital systems, Number System-Decimal, Binary, Octal and Hexadecimal number system, addition, subtraction, multiplication and division of different number

systems, conversion from one number system to another, Codes-Binary codes, BCD codes, Excess-3, Gray codes, Parity and Hamming codes. Logic Gates-NOT, AND, OR, NAND, NOR, XOR, XNOR, Universal gates, realization of basic gates using universal gates, Difference between Positive and negative logic systems, TTL 74XX series.

Module II (8 Hours)
Boolean Algebra-Boolean rules, laws and axioms, SOP, POS forms, standard SOP and standard POS forms, conversion from SOP to POS forms, minimization of Boolean expressions, Karnaugh Map, Quine Mc-Clusky method.

Module III (10 Hours)
Combinational Circuits-Difference between combinational and sequential circuits, half adder, full adder, half subtractor, full subtractor, Parallel adder, Look-Ahead Carry adder, Serial adder, BCD adder, encoder, decoder, multiplexers and demultiplexers, comparator, parity generator and checker, priority encoder, code converters.

Module IV (13 Hours)
Sequential Circuits-Latches, concept of clock, level-triggered and edge-triggered clocks, flip-flops-S-R, J-K, D and T flip-flop, conversion from one flip-flop to another, Race-around condition, Master-Slave J-K flip-flop, Registers-Shift registers- right shift and left shift registers, SISO, SIPO, PISO and PIPO, bi-directional shift registers, universal shift registers, ring and twisted-ring counters, Counters-Difference between synchronous and asynchronous counters, ripple counter design, synchronous counter design, decade counter

Module V (8 Hours)
Introduction to Analog-to-Digital Converters-Successive Approximation type ADC, Dual-Slope type ADC, Flash type ADC, Counter type ADC, Introduction to Digital-to-Analog Converters- Parameters of DAC, R-2R Ladder type DAC, Weighted Resistor DAC, Switched Current –Source type DAC, Switched –Capacitor type DAC

Module VI (11 Hours)
Introduction to different Logic Families- RTL, DCTL, DTL, HTL, TTL, ECL, CMOS, BiCMOS, IC specification Terminology-Threshold voltage, Propagation Delay, Fan-in, Fan-out, Noise margin, power dissipation, characteristics of different logic families, CMOS inverter, CMOS NAND and NOR gates, design of basic gates using CMOS. Introduction to memories-memory types and terminology, RAMs, ROMs and PROMs, DRAMs and SRAMs, Volatile and Non-Volatile memory, magnetic memories, optical disk memory, charged coupled devices.

Suggested Readings
1. William Gothmann, "Digital Electronics: An Introduction to Theory and Practice", 2nd Edition, Prentice Hall
2. John Morris, "Digital Electronics" 1st Edition, Butterworth-Heinemann
3. Anand Kumar, "Fundamentals of Digital Circuits", 2nd Revised Edition, Motilal UK Books of India.
4. R. P. Jain, "Modern Digital Electronics", 4th Edition, Mc-Graw Hill.
5. M. Morris Mano, "Digital Design", 3rd Edition, Pearson.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	L	M	M	M	H
CO 2	H		H	H	M	
CO 3		H	L	L		
CO 4			H	H	M	
CO 5			H	H	L	L

ECSC0123: SEMICONDUCTOR DEVICES AND CIRCUITS (L-T-P: 3-1-0)
(4 credits – 60 hours)

Objective
The objective of the course is to introduce basic semiconductor devices, their characteristics and application. The course will also help in analysis and design of circuits using simple devices such as p-n junctions and also more complex devices such as Bipolar Junction Transistors (BJTs) and Field Effect Transistors (FETs).

Course Outcomes
1. Define semiconductors and their applications (Remembering)
2. Identify the behavior PN junctions and special purpose diodes (Applying)
3. Design and analyze simple BJT and MOSFET circuits (Analysing, Creating)

4. Illustrate the advantages of feedback in amplifiers (Understanding)

Module I (15 Hours)

a. Semiconductors: Energy band theory of Solids, Conductors, Semiconductors and Insulators. Types of semiconductors, mobility, conductivity, concept of holes, majority and minority carriers, drift current and diffusion current
b. PN Junction diodes: PN junction as a diode, drift and diffusion currents in PN junction diode, V-I characteristics, Diode equation. Diode resistance, Transition capacitance and diffusion capacitance, loadline analysis. Applications of Diode: Half-wave and full-wave rectifiers, voltage multipliers, clipper, clamper; Special purpose diodes: Construction, Principle of operation, application and characteristics of Zener diode, Schottky diode, Varactor diode, Tunnel diode, PIN diode, LED, photo diode, Photo diode.

Module II (20 Hours)

Bipolar Junction Transistors: Transistor– construction, operation and configuration, V-I characteristics, Q- point and Biasing in BJTs: Fixed bias, Potential-divider bias. Collector feedback Bias etc., loadline analysis, Transistor as an inverter and amplifier, Small signal modeling and analysis: Hybrid model and analysis. Parameter conversion for three transistor configurations. Compound configurations: Darlington pair, cascade and cascode connection; Frequency Response of an amplifier, Phototransitors: construction and application of phototransistors

Module III (15 Hours)

Field Effect Transistors (FET): Construction and V-I characteristics of JFET, differnt types of Biasing in JFETs, Application of JFET as an amplifier, Small signal modeling and analysis of JFETs, Types of MOSFETS: EMOSFET and DMOSFET, construction and V-I characteristics, Biasing in MOSFETs, MOSFETs as an amplifier and small signal modelling and analysis of MOSFETs, CMOS: Construction and advantages of CMOS, application of CMOS as an inverter

Module IV (10 Hours)

Feedback amplifiers: Concept of feedback, advantages of negative feedback; Topological classification (Voltage series; Voltage shunt, Current series, Current shunt), Effect of feedback on input and output resistances, Bandwidth of amplifier.

Suggested Readings

1. S Salivahanan, N Suresh Kumar and A Vallavaraj, Electronic Devices and Circuits, 2 ed., Tata McGraw-Hill, 2008
2. Robert L. Boylestad and Lowis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education, New Delhi
3. David A. Bell, Electronic Devices and Circuits, 4th Edition, Oxford University Press
4. Streetman and Banerjee, Solid State Electronic Devices, Prentice Hall, New Delhi
5. Jacob Millman, Christos C Halkias, Integrated Electronics, McGraw Hill Int. students Edition.
6. R. S. Sedha, Applied Electronics, Multicolor Illustrative Edition, SChand, New Delhi.
7. Donald A. Neamen, Semiconductor Physics and Devices, 3rd Edition, Tata McGraw Hill
8. P. Ramesh Babu, Electronic Devices and Circuits, Scitech Publications Pvt. Ltd.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	
CO 2	H	L	L	
CO 3		H	H	M

ECFC0124: FUNDAMENTALS OF ANALOG ELECTRONIC CIRCUIT (L-T-P: 3-1-0)

(4 credits – 60 hours)

Objective

The course introduces to basic analog electronic circuit design. The student will develop the ability to apply basic engineering sciences to the design, analysis and operation of electronics devices and circuits and problem solving skills of electronic circuits.

Course Outcomes

1. Define the fundamental concepts of semiconductor devices. (Remembering)
2. Explain the working principle of different circuits based on BJT and Op-amp. (Understanding)
3. Apply the methods learned in class to design and implement practical projects. (Applying)
4. Analyse modern analog circuits using integrated circuits. (Analyzing)
5. Evaluate the operation and behaviour of various analog integrated circuits by using the analog circuit analysis techniques. (Evaluating)
6. Design analog circuits. (Creating)

Module I (10 Hours)
Amplifiers: Introduction and classification of Power Amplifiers, Class A, Class B, Complementary symmetry push pull amplifier, Class C, Distortion in power amplifiers.
Introduction and classification of Tuned Amplifiers, Capacitance coupled tuned amplifier, stagger tuned amplifier.

Module II (15 Hours)
Oscillators: Review of the basic concept, Barkhausen criterion, RC oscillators (phase shift, Wien bridge etc.), LC oscillators (Hartley, Colpitt, Clapp etc.), non-sinusoidal oscillators.
Current mirror: Basic topology and its variants, V-I characteristics, output resistance and minimum sustainable voltage (VON), maximum usable load. Differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR.

Module III (20 Hours)
Op-Amp: Internal structure of an Op-amp, Ideal op-amp, Non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product).
Op-amp as inverting and non-inverting amplifier, Differential amplifier, Instrumentation amplifier, Integrator, P, PI and PID controllers and lead/lag compensator using an op-amp, Voltage regulator, Zero crossing detector, Square wave and triangular wave generators, Precision rectifier.

Module IV (15 Hours)
Active filters: Transfer functions- LPF, HPF, BPF, BRF and All Pass Filter, Approximation methods- Butterworth, Chebyshev filter, I and II filter orders.
555 Timer: Block diagram, Monostable operation, Astable operation, Voltage controlled oscillator, Ramp generator.
A/D and D/A Converter: DAC- Weighted resistor, R-2R ladder, ADC- Single slope, dual slope, successive approximation and flash type.

Suggested Readings:
1. R.S Sedha, A Textbook of Applied Electronics, S. Chand & Company Ltd.
2. T.R. Ganesh Babu and B. Suseela, Linear Integrated Circuits, Scitech Publications (India) Pvt. Ltd.
3. S. Salivahanan, V.S.K. Bhaaskaran, Linear Integrated Circuits, Tata McGraw Hill.
4. J.V. Wait, L.P. Huelsman and GA Korn, Introduction to Operational, Amplifier theory and applications, McGraw Hill,1992.
5. J. Millman and A. Grabel, Microelectronics, 2nd edition, McGraw Hill,1988.
6. P. Horowitz and W. Hill, The Art of Electronics, 2nd edition, Cambridge University Press,1989.
7. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder'sCollege11 Publishing, EditionIV.
8. Paul R. Gray and Robert G.Meyer, Analysis and Design of Analog Integrated Circuits, John Wiley, 3rdEdition.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	M	L
CO 2	L	H	H	M
CO 3		L	M	H
CO 4	L	M	H	H
CO 5		L	M	H
CO 6			M	H

ECIM0125: INTRODUCTION TO MICROPROCESSOR AND MICROCONTROLLER (L-T-P: 3-1-0)
(4 credits – 60 hours)

Objective
This course provides an in-depth understanding of the architecture and operation of microprocessors and microcontroller, assembly language programming and microcontroller interfacing techniques. The students will be able to design and implement microcontroller-based systems in both hardware and software and can apply this knowledge to more advanced structures.

Course Outcomes
1. Develop an ALP in 8085 microprocessor using the internal organization for the given specification. (Creating)
2. Analyze assembly language programs; select appropriate assemble into machine a cross assembler utility of a microprocessor and microcontroller. (Analysing)

3. Demonstrate the architecture and functional block of 8085 and 8086 microprocessor and 8051 Microcontroller. (Understanding)
4. Develop an embedded C and ALP in 8051 microcontroller using the internal functional blocks for the given specification. (Creating)
5. Explain various peripherals devices such as 8255, 8279, 8251, 8253, 8259 and 8237. (Understanding)
6. Design electrical circuitry to the Microprocessor I/O ports in order to interface the Processor to external devices. (Creating)

Module I (5 Hours)
Microprocessor Architecture: Introduction to microprocessor and microcomputer architecture; History and Evolution; Pins and signals; Register organization, ALU, control unit, Timing and control module; Architecture of 8085 Microprocessor, pin out configuration of 8085 microprocessor.

Module II (15 Hours)
Instruction set and assembly language programming of 8085: Instruction Fetch, Instruction cycle, machine cycles, T-states; Programming model of 8085 microprocessor; instruction and data formats; Memory and I/O Addressing; Addressing modes of 8085; Instruction set of 8085 Microprocessor; Assembly language programming using 8085 microprocessor; State transition diagram, use of stack and subroutine.

Module III (12 Hours)
Interfacing: Memory and their interfacing; I/O Interfacing, Addressing the I/O devices, I/O data transfer schemes; I/O interfacing devices and special purpose supporting chips like 8255, 8279, 8259, 8257; Interfacing a keyboard, interfacing a LED and seven segment displays, interfacing A/D converter, D/A converter; Serial I/O techniques.

Module IV (6 Hours)
Interrupts: Interrupt in 8085; RST Instructions; Issues in implementing interrupt, multiple interrupts and priorities, Daisy Chaining, Interrupt handling in 8085, Enabling, Disabling and masking of interrupts.

Module V (7 Hours)
16-bit Microprocessor: Functional block diagram of 8086 microprocessor; Addressing modes of 8086 microprocessor; Software model of 8086 microprocessor; Instruction sets of 8086 microprocessor; Interrupts of 8086 microprocessor.

Module VI (15 hours)
Microcontroller (Architecture and Programming): Introduction to 8051 Microcontrollers, Assembly level language programming on 8051; I/O port programming; 8051 interrupt; Interfacing to 8255, 80851 interfacing examples; 16-bit microcontroller-MCS-96 series; Trends and development in Microcontroller.

Suggested Readings

1. R.S. Goankar, Microprocessor Architecture, Programming and Application with 8085, Pengram
2. Mazidi J Gillispie and Mazidi M Ali, The 8051 Microcontroller and Embedded Systems, Pearson/ PHI
3. P.K. Ghosh and P.R. Sridhar, 0000 to 8085 - Introduction to Microprocessor for Scientists and Engineers, PHI
4. A.V. Deshmukh, Microcontroller, TMH
5. YU-Cheng Liu and Glenn A Gibson, Microprocessor System, Architecture, Programming and Design
6. Barry B Brey, The Intel Microprocessor, Architecture, Programming and interfacing

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	M	H	M	L	L	
CO 2		H	H	M	L	M
CO 3	H		M	L	H	
CO 4	L	M		M		H
CO 5		L	H	M	M	
CO 6	L		M	H	M	L

ECIC0126: SEMICONDUCTOR IC TECHNOLOGY (L-T-P: 3-1-0)
(4 credits – 60 hours)

Objective
This course is intended to make the Students learn the essential concepts of advanced semiconducting materials and IC Technology. The course includes a review of the CMOS logic design, IC fabrication steps as well as study of various advanced semiconducting materials, analog VLSI circuit design and MEMS technology.

Course Outcomes
1. Illustrate and summarize the fabrication techniques and design of digital circuits using CMOS, advanced semiconducting materials, analog VLSI circuits, MEMS (Remembering - Understanding)
2. Understand and analyze MEMS technology, advanced semiconducting materials and various analog VLSI circuit design. Understanding - Analyzing)
3. Develop various CMOS logic circuit, analog VLSI circuits, MEMS. (Applying)
4. Inspect CMOS logic circuits, analog VLSI circuits, MEMS (Analyzing)
5. Evaluate the performance of CMOS logic circuits, analog VLSI circuits, MEMS. (Evaluating)

Module I (16 hours)
Review of IC Fabrication Techniques: Crystal growth, Oxidation, Diffusion and Ion-implantation, Epitaxy, Etching, Lithography, Metallization.
Review of digital circuits using CMOS: Logic gates, Combinational MOS logic circuits, CMOS logic circuits.

Module II (12 hours)
Advanced semiconducting materials:
Gallium Nitride: Band structure, Carrier concentration, Temperature dependencies, Effective masses, Donors and acceptors.
Aluminum Nitride: Band structure, Carrier concentration, Temperature dependencies, Effective masses, Donors and acceptors.
Boron Nitride: Band structure, Carrier concentration, Temperature dependencies, Effective masses, Donors and acceptors.

Module III (12 hours)
Analog VLSI Circuit Design: Single stage amplifier, Differential amplifier, Current mirror, Operational amplifiers.

Module IV (20 hours)
MEMS Technology: An overview of micro-electromechanical devices and technologies, Physics in microscopic world, scaling issues, Micromachining technologies, Basics of micro-fabrication technologies, Bulk micromachining, Surface micromachining, Materials encountered in micromachining processes and their properties.

Suggested Readings
1. S. K Gandhi, VLSI Fabrication Principles: Silicon and Gallium Arsenide, John Wiley and Sons.
2. S. M. Kang and Y. Leblebici, CMOS Digital integrated Circuits: Analysis and Design, TMH.
3. E. M. Levinshtein, S. L. Rumyantsev and M. S. Shur, Properties of Advanced Semiconductor Materials: GaN, AIN, InN, BN, SiC, SiGe. John Wiley & Sons.
4. B. Razavi, Design of Analog CMOS Integrated Circuits, Mc Graw Hill.
5. T. R. Hsu, MEMS & Microsystems, Design and Manufacturing, TMH.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	M	M	M	M	M
CO 2	L	M	M	M	M
CO 3	L		M	M	M
CO 4	L		M	M	M
CO 5	L	L	M	M	M

ECMC0127: MICROELECTRONICS: DEVICES TO CIRCUITS (L-T-P: 3-1-0)
(4 credits – 60 hours)

Objective
The objective of this course is to develop the ability to understand, analyse and design microelectronic circuits. The course starts with the basics of the devices mostly used for various designs and applications like BJT, FET, MOS transistors and then goes on to do various circuit analysis. The course also includes complex electronic circuits like the differential amplifier and

introduction of feedback for various operations and applications. It also introduces students to designing concepts for analog and digital microelectronic circuits.

Course Outcomes
1. Define and explain the basic principles of various electronic devices and their operation. (Remembering)
2. Understand and explain how various electronic devices are used as electronic circuit components and their behavior. (Understanding)
3. Apply certain electronic devices, components and circuits for various applications. (Applying)
4. Analyze how electronic circuits work under various conditions. (Analyzing)
5. Evaluate and/or design electronic circuits for specific performance/applications. (Evaluating)

Module I (13 Hours)
Device Basics: *Bipolar Junction Transistor*: physical structure, modes of operation, circuit symbols and conventions, operation in active mode, BJT as an Amplifier, BJT as a switch.
Field Effect Transistor: JFET, structure and operation, MOS Transistor, types; I-V characteristics, CMOS inverter.

Module II (12 Hours)
Circuit Basics: Ebers Moll Model, BJT biasing; bias stability, Biasing of MOS Amplifier, CMOS Amplifier.General Feedback structure and properties of negative feedback, feedback topologies,.
Operational Amplifer: Basic structure and principle of operation, Open loop and closed loop concept, virtual ground, equivalent circuit, characteristics, transfer curve.

Module III (10 Hours)
Op amp applications: Inverting and non-inverting amplifiers, integrator and differentiator, summing amplifier, difference amplifier, precision rectifier, comparator, zero crossing detector, Schmitt trigger, active filters, DAC and ADC.

Module IV (10 Hours)
Circuit Analysis: Small signal analysis, frequency response of amplifiers, low frequency transistor models and analysis, High frequency transistor models and analysis, multistage amplifiers, differential amplifier.
MOS differential amplifier, power analysis, high frequency modelling.

Module V (15 Hours)
Circuit Design: Design of feedback amplifier, 1st and 2nd order filters: Low pass, High pass, Band Pass and Band Stop, design considerations, practical filter design.
Logic Design: Sequential logic design, combinational logic design.

Suggested Readings
1. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder’s College11 Publishing, Edition IV.
2. David A. Bell, “Electronic Devices and Circuits”, Oxford.
3. Robert L. Boylestad, “Electronic Devices and Circuit Theory”, Pearson.
4. Jacob Millman, Christos C Halkias and Satyabrata Jit, Millman’s Electronic Devices and Circuits, Tata McGraw Hill.
5. P. Ramesh Babu, Electronic Devices and Circuits, Scitech Publications Pvt. Ltd.
6. J. Millman and A. Grabel, Microelectronics, 2nd edition, McGraw Hill, 1988.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	M	L	M	L
CO 2	M	H	L	M	L
CO 3	L	L	H	L	M
CO 4	M	L	M	H	L
CO 5	L	M	M	M	H

ECES0128 EMBEDDED SYSTEMS (L-T-P: 3-0-0)
(3 credits – 45 hours)

Objective
To provide students with basic knowledge and skills in embedded systems design.

Course Outcomes
1. Define the fundamental concepts related to embedded systems. (Remembering)

2. Explain the internal organization of various microcontrollers. (Understanding)
3. Select various microcontrollers for different applications. (Applying)
4. Design and develop embedded systems. (Creating)

Module I (8 hours)
Introduction to Embedded Systems, Components of Embedded Systems, Features of Embedded System, Challenges in designing Embedded Systems, Categories of Embedded Systems, Importance of Microcontroller in Embedded System based system design

Module II (20 hours)
Fundamentals of Microcontrollers, Ingredients of microcontroller, Criteria for choosing microcontrollers, History of MCS51 family, Various versions of 8051 microcontroller, Architecture of 8051 microcontroller, Instruction Set of 8051 microcontroller, Programming of 8051 microcontroller, Interfacing of 8051 microcontroller with various peripheral devices, Timers, Serial Communication and Interrupt of 8051 microcontroller

Module III (12 hours)
Introduction to PIC Microcontroller, Comparison of various PIC families, Internal Organization of PIC16C61 microcontroller, Introduction to AVR Microcontrollers, Internal Organization of ATMega8 Microcontroller

Module IV (5 hours)
Introduction to advanced microcontrollers, recent technologies related to embedded system design, Design of embedded system

Suggested Readings
1. Shibu K V, Introduction to Embedded Systems, McGraw Hill
2. Muhammad Ali Mazidi. Janice Gillispie Mazidi. Rolin D. McKinlay., The 8051 Microcontroller And Embedded Systems Using Assembly And C, Pearson
3. A V Deshmukh, Microcontrollers : Theory and Applications, Tata McGraw-Hill Education
4. Muhammad Ali Mazidi, Rolin D. McKinlay, Danny Causey, PIC Microcontroller And Embedded Systems Using Assembly And C, Pearson
5. Steven F Barett, Daniel J. Pack, Atmel AVR Microcontroller Primer: Programming and Interfacing, Morgan and Claypool
6. E resources and relevant datasheets

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	L
CO 2	L	H	H	H
CO 3	L	H	H	H
CO 4	L	M	M	H

ECBI0129 BIOINFORMATICS
(L:T:P: 3:0:0) (3 credit – 45 hours)

Objective
The objective of the course is to introduce students to the rapidly evolving field of bioinformatics. It will help the students to gain knowledge about various biological databases that provides information about biomolecules. It will also give in depth understanding of various techniques used in bioinformatics.

Course Outcomes
1. Recall the biological concepts. (Remembering)
2. Explain the fundamentals of bioinformatics. (Understanding)
3. Apply various techniques used in bioinformatics. (Applying)
4. Analyse and compare various aspects of bioinformatics. (Analysing)
5. Predict protein structure that helps in drug discovery. (Creating)

Module I (10 hours)
Introduction to bioinformatics and computational biology, Scope of bioinformatics, relation of bioinformatics with molecular biology, Fundamental concepts of biology such as nucleotide, amino acids, proteins, different structure of proteins, DNA, DNA Sequences, Cell, Chromosomes, Gene, Mutation, Genetic Polymorphism

Module II (15 hours)
The form of biological information, Introduction to Biological Databases: Nucleic Acid Databases (NCBI, EMBL, DDBJ,), Protein databases (Primary, Composite and Secondary), Specialized Genome Databases (SGD, TIGR), Structure Databases (CATH, SCOPE and PDBsum), Tools: FASTA, BLAST, BLAT, RASMOL

Module III (10 hours)
DNA sequence analysis, Sequence Based Parameters, DNA sequencing as a diagnostic tool

Module IV (10 hours)
a. Protein Structure and Function, Sequence Alignment, Protein Sequence Analysis, Protein Secondary Structure Prediction, Recent advancement in bioinformatics
b. Introduction to various bioinformatics Softwares: Acua, INCA, Anaconda, PAST3, CodonW
c. DNA Computing

Suggested Readings
1. Arthur M. Lesk, Introduction to Bioinformatics, Fifth Edition, Oxford
2. Jin Xiong, Essential Bioinformatics, First Edition, Cambridge University Press
3. David W. Mount, Bioinformatics: Sequence and Genome Analysis, First Edition, CBS
4. Relevant e resources

Mapping of COs to Syllabus

Course Outcomes	**Module 1**	**Module 2**	**Module 3**	**Module 4**
CO 1	H	L		
CO 2		H		
CO 3		M	H	
CO 4			M	H
CO 5			L	H

ECMD0130: MIXED SIGNAL DESIGN

Objective: The objective of the course is to enlighten the students with design methodology of mixed signal IC design, switch capacitors, concepts of data converter fundamentals, A/D converter, PLL, over sampling converters and continuous time filters. Further the course will facilitate the students to implement product level design blocks for VLSI applications.

CO 1: Explain the concept of mixed signal design system and its performance measure. (Understanding)
CO 2: Identify various analog to digital and digital to analog converters. (Applying)
CO 3: Inspect concepts of mixed signal design in PLL.
(Analyzing)
CO 4: Evaluate mixed signal design performances in converters and filters. (Creating)

Unit I Basic Concepts & Switched Capacitor Circuits **8 hrs**
Concepts of Mixed-Signal Design and Performance Measures, Design methodology for mixed signal IC design using gm/Id concept.
Introduction to Switched Capacitor circuits basic building blocks, Operation and Analysis, Non-ideal effects in switched capacitor circuits, Switched capacitor integrators first order filters, Switch sharing, Biquad filters.

UNIT-II: Data Converter Fundamentals **7 hrs**
DC and dynamic specifications, Quantization noise, Nyquist rate D/A converters- Decoder based converters, Binary-Scaled converters, Thermometer-code converters, Hybrid converters.

UNIT-III: Nyquist Rate A/D Converters **8 hrs**
Successive approximation converters, Flash converter, Two-step A/D converters, Interpolating A/D converters, Folding A/D converters, Pipelined A/D converters, Time-interleaved converters. Electronics & Communication Engineering**.**

UNIT-IV: Phased Lock Loop (PLL) **7 hrs**
Basic PLL topology, Dynamics of simple PLL, Charge pump PLLs Lock acquisition, Phase/Frequency detector and charge pump, Basic charge pump PLL, Non-ideal effects in PLLs-PFD/CP non idealities, Jitter in PLLs, Delay locked loops, applications.

UNIT-V: Oversampling Converters **8 hrs**
Noise shaping modulators, Decimating filters and Interpolating filters, Higher order modulators, Delta sigma modulators with multi-bit quantizers, Delta sigma D/A.

UNIT-VI: Continuous-Time Filters **7 hrs**

Introduction to Gm-C Filters, Bipolar Trans conductors, CMOS trans-conductors Using Triode and Active Transistors, Bi CMOS Tran conductors, MOSFET-C Filters.

Suggested Readings:

1. R. Jacob Baker, CMOS: Mixed Signal Circuit Design, Wiley (2008)
2. R. Jacob Baker, Harry W. Li, David E. Boyce, CMOS, Circuit Design, Layout, and Simulation, Wiley-IEEE Press, 1998
3. David A. Johns and Ken Martin, Analog Integrated Circuit Design, John Wiley and Sons,1997
4. Philip E-Allen, Dougles R.Holberg, CMOS analog circuit design, second edition Oxford University press 2002.
5. Behzad Razavi, Design of analog CMOS integrated circuits, Tata McGraw Hill edition 2002.

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
1	H					
2	L	H	H			
3	L			H		
4	L				H	H

LABORATORY COURSES

ECED6034: ELECTRONIC DEVICES LAB
(L-T-P: 0-0-2) (1 Credit)

Course Outcomes
1. Label and demonstrate the working of electronic devices and tools used in the lab. (Remembering - Understanding)
2. Build simple electronic circuits and analyze their outputs. (Applying - Analysing)
3. Construct electronic circuits using different devices and components to assess certain operations. (Evaluating - Creating)

List of Experiments:
1. Study the Characteristics of PN junction Diodes.
2. Study the Characteristics of Zener Diodes.
3. Design half wave and full wave rectifiers using diodes and study various parameters.
4. Design various multiplier circuits using diodes and capacitors.
5. Design wave forming circuits or clippers using diodes.
6. Study Static Characteristics of a Bipolar Junction Transistor (CE Mode)
7. Study the Characteristics of JFET.
8. Series voltage Regulator.
9. Study of BJT as a switch.
10. Design of CE amplifiers using voltage divider biasing and plot and understand its response curve.

ECDS6035: DIGITAL SYSTEM DESIGN LAB
(L-T-P: 0-0-2) (1 credit)

Course Outcomes
1. List and recognize the various logic gate ICs and other components and instruments used in DLD lab. (Remembering)
2. Demonstrate the working and operation of hardware involved in designing and building of digital circuits. (Understanding)
3. Analyze practically different types of combinational and sequential circuits. (Analyzing)
4. Construct digital electronic circuits using different devices and components to assess certain operations. (Evaluating - Creating)

List of Experiments:
1. To study and verify the truth table of logic gates.
2. To realize half/full adder and half/full subtractor.
3. To convert a given binary number to gray code and given gray code to its equivalent binary number.
4. To verify the truth table of MUX and DEMUX.
5. To verify the truth table of one bit and four bit comparator using logic gates.
6. To study shift register in all its modes i.e. SIPO/SISO, PISO/PIPO.
7. Realization of 3-bit asynchronous counter and Mod-N counter design.
8. Realization of 3-bit synchronous counter design.
9. Truth table verification of flip-flops: (i) RS-Type, (ii) D-Type, (iii) T-Type, (iv) JK-Type.
10. Realization of 2:4 decoder and 4:2 encoder design.
11. Design and testing of Ring counter/ Johnson counter.

ECAC6036: ANALOG CIRCUITS LAB
(L-T-P: 0-0-2) (1 credit)

Course Outcomes
1. Define the various terminologies and parameters related to operational amplifiers (741) and IC555. (Remembering))
2. Extend the theoretical knowledge to practical one. (Understanding)
3. Experiment with different types of circuits based on operational amplifiers and some specialized ICs. (Applying)

List of Experiments:

Any ten or more experiments from the following are to be performed depending on the no of laboratory classes.
1. Inverting, Non-Inverting amplifier using op-amp
2. Adder – Subtractor using op-amp

3. Integrator – Differentiator using op-amp
4. Comparator – Zero crossing detector using op-amp
5. Schmitt trigger using op-amp
6. Triangular wave generator using op-amp
7. Monostable or Astable multivibrator using op-amp
8. Active Filters– LPF 1st and 2nd order using op-amp
9. Active Filters- HPF 1st and 2nd order using op-amp
10. Digital to analog converter using op-amp
11. Analog to Digital converter using op-amp.
12. 555 Timer application as monostable or astable multivibrator
13. Instrumentation amplifier
14. RC phase shift oscillator using op-amp
15. Wein Bridge oscillator using op-amp

ECEL6037: ELECTRONIC MEASUREMENTS LAB
(L-T-P: 0-0-2) (1 credit)

Course Outcomes
1. List various measuring instruments used for measurement of electrical quantities. (Remembering)
2. Explain the correct procedure of using a C.R.O. (Understanding)
3. Apply different electronic measuring instruments for different measurement Applications. (Applying)
4. Compare performances of different type of measuring instruments to be applied for measurement of electrical quantities. (Analysing)
5. Choose and justify the proper measurement devices. (Evaluating)
6. Elaborate the different components involved in measurement. (Creating)

List of Experiments:
1. Extension of range of Ammeter.
2. Extension of range of Voltmeter.
3. Measurement of frequency using Lissajous Pattern.
4. Measurement of phase-angle using Lissajous Pattern.
5. Measurement of resistance by Wheatstone bridge method.
6. Study of Maxwell bridge circuit.
7. Measurement of frequency by Wien Bridge using Oscilloscope.
8. Measurement of Inductance by Anderson Bridge.
9. Study of Schering bridge circuit.
10. Study of LCR meter.
11. Study of Spectrum Analyser
12. Study the characteristics of transducers (RTD/Thermistor/Thermocouple).
13. Study the characteristics of (a) LDR and (b) Photodiode

ECDP6038: DIGITAL SIGNAL PROCESSING LAB
(L-T-P: 0-0-2) (1 credit)

Course Outcomes
1. Identify the different MATLAB functions useful for DSP. (Remembering)
2. Classify a system design problem in various parts to be solved/ simulated in MATLAB. (Understanding)
3. Describe the various components/modules of the MATLAB program of a particular problem. (Understanding)
4. Apply mathematical skills and how these skills are important in writing MATLAB programs for DSP. (Applying)
5. Improve skill to simulate, design and analysis of different discrete time signals and signal processing techniques. (Creating)
6. Evaluate the simulated results. (Evaluating) CO 16: Justify the results with proper mathematical relationships. (Evaluating)

List of Experiments:
1. MATLAB code to generate different unitary discrete time signals.
2. MATLAB code for verification of sampling theorem, Demonstrate the effects of aliasing arising from improper sampling

3. MATLAB code to demonstrate the folding , time scaling and shifting with any k samples towards the right or left of any signal x[n].
4. MATLAB code to determine the Linear Convolution of any input signal x[n] with the impulse response h[n] i.e, y[n]=x[n]*h[n].
5. MATLAB code to determine the N-point DFT X(k) for any signal x[n] for N=L, N<L, and N>L, where L is the length of the signal also demonstrates the effect of the three different cases.
6. MATLAB code to determine the IDFT of complex DFT X(k).
7. MATLAB code to determine the Circular Convolution of any two signals x1[n] and x2[n] using matrix method and also using DFT and IDFT.
8. MATLAB program to determine the linear convolution using circular convolution of any two signals.
9. MATLAB program to demonstrate a simple FIR (Butterworth LPF, HPF, BPF and BSF) filter using different windows.
10. MATLAB program to demonstrate a simple FIR low-pass and high-pass filter using frequency sampling method.
11. MATLAB program to demonstrate a simple IIR (Butterworth LPF, HPF, BPF and BSF) filter.
12. MATLAB program to determine the autocorrelation of x[n] then the power spectral density (PSD) using DFT.
13. MATLAB program to determine the time response (unit impulse and unit step response) and frequency response of any recursive system.
14. Introduction to DSP (TMS3207613) board

ECEC6039: ANALOG ELECTRONIC CIRCUITS LAB

(L-T-P: 0-0-2) (1 credit)

Course Outcomes

1. Define PN junction diode and their properties and uses. (Remembering)
2. Explain the working of basic electronic circuits such as transistors, diodes and amplifiers. (Understanding)
3. Build different circuits using diodes, transistors and OPAMPs. (Applying)
4. Analyse various amplifier and filter circuits. (Analysing)
5. Evaluate the performance of the 555 timer as a monostable and astable vibrator. (Evaluating)
6. Design amplifiers, integrators, oscillators and filter circuits using OPAMPs. (Creating)

List of Experiments:

1. To Study the Characteristics of Zener Diodes.
2. Study of the Half-wave and Full-wave rectifier circuits with and without capacitor filter
3. To Study the characteristics of a Bipolar Junction Transistor (CE Mode)
4. To design of CE amplifier and analyse the frequency response of the amplifier
5. To Study the Characteristics of JFET
6. Inverting and non-inverting op-amp amplifiers
7. Op-amp linear applications: adders, sub-tractors
8. Op-amp based active filters: Low Pass and High Pass
9. Instrumentation Amplifier
10. 555 timer applications: Monostable and Astable

ECBE6040: BASIC ELECTRONICS LAB

(L-T-P: 0-0-2) (1 credit)

Course Outcomes

1. Classify and compare different passive and active electronic components and devices. (Understanding)
2. Apply the theoretical knowledge in developing different electronic circuits. (Applying)
3. Analyse the characteristics of different components like diodes, transistors, amplifiers and oscillators. (Analysing)
4. Evaluate and estimate the behavior of logic gates. (Evaluating)
5. Create and test electronic circuits using the components and devices studied in the course. (Creating)

List of Experiments:

1. Identification, Specifications, Testing of R, L, C Components; Bread Boards and Printed Circuit Boards (PCBs); Identification, Specifications, Testing of Active Devices – Diodes, BJTs, JFETs, MOSFETs, LEDs; Study and Operation of Digital MultiMeter, Function / Signal Generator, Regulated Power Supply (RPS)

2. Study of Cathode Ray Oscilloscopes – Displaying and Determining Amplitude, Phase and Frequency of Sinusoidal Signals in CRO
3. To study the characteristics of a P-N Junction diode
4. To design a full wave bridge rectifier circuit with and without filter
5. To study the static characteristics of a BJT in CE mode
6. To study the static characteristics of a BJT in CB mode
7. To design an Inverting and Non Inverting amplifier using op-amp
8. To design a monostable and an astable multivibrator using 555 timer IC
9. To verify different logic gates
10. Realisation of simple logical expression using logic gates

ECAP6041: ADVANCED DIGITAL SIGNAL PROCESSING LAB

(L-T-P: 0-0-4) (2 credits)

Course Outcomes

1. Find and demonstrate the particular methodology to be adopted for writing the various programs in MATLAB. (Remembering - Understanding)
2. Apply important mathematical skills in writing MATLAB programs for DSP. (Applying)
3. Examine the advance topics of digital signal processing in MATLAB. (Analyzing)

List of Experiments:

1. Basic Signal Representation
2. Different operations on discrete time signals
3. Linear and Circular convolution
4. Correlation Auto And Cross
5. Stability Using Hurwitz Routh Criteria
6. Sampling FFT Of Input Sequence
7. Butterworth Low pass And High pass Filter Design
8. Chebychev Type I, II Filter
9. State Space Matrix from Differential Equation
10. Normal Equation Using Levinson Durbin
11. Decimation And Interpolation Using Rational Factors
12. Maximally Decimated Analysis DFT Filter
13. Cascade Digital IIR Filter Realization
14. Convolution And M Fold Decimation & PSD Estimator
15. Estimation Of PSD
16. Inverse Z Transform
17. Group Delay Calculation
18. Separation Of T/F
19. Parallel Realization of IIR filter

ECDV6042: DIGITAL IMAGE AND VIDEO PROCESSING LAB

(L-T-P: 0-0-4) (2 credits)

Course Outcomes

1. Perform basic gray and colour image processing operations as well as various image procession algorithms. (Applying)
2. Perform basic video processing algorithm and to calculate various features of image. (Applying)

List of Experiments:

1. Perform basic operations on images like addition, subtraction etc.
2. Plot the histogram of an image and perform histogram equalization
3. Implement segmentation algorithms
4. Perform video enhancement
5. Perform video segmentation
6. Perform image compression using lossy technique
7. Perform image compression using lossless technique

8. Perform image restoration
9. Convert a colour model into another
10. Calculate boundary features of an image
11. Calculate regional features of an image
12. Detect an object in an image/video using template matching/Bayes classifier

ECWM6043: WIRELESS AND MOBILE COMMUNICATION LAB

(L-T-P: 0-0-4) (2 credits)

Course Outcomes

1. Define the fundamental concepts of cellular communication like frequency reuse, cell splitting etc. (Remembering)
2. Outline concepts of GSM and CDMA architecture, network concepts etc. (Understanding)
3. Utilize GSM handset for various signalling techniques. (Applying)
4. Analyse transmitter and receiver sections in mobile handset, different modulation techniques etc. (Analysing)
5. Evaluate AT commands in 3G network. (Evaluating)
6. Discuss features of 3G communication systems such as transmission of voice and video calls, SMS etc. (Creating)

List of Experiments:

1. Understanding Cellular Fundamentals like Frequency Reuse, Interference, cell splitting, multipath environment, Coverage and Capacity issues using communication software.
2. Knowing GSM and CDMA architecture, network concepts, call management, call setup, call release, Security and Power Control, Handoff Process and types, Rake Receiver etc.
3. Study of GSM handset for various signaling and fault insertion techniques (Major GSM handset sections: clock, SIM card, charging, LCD module, Keyboard, User interface).
4. To study transmitters and receiver sections in mobile handsets and measure frequency band signal and GMSK modulating signal.
5. To study various GSM AT Commands their use and developing new applications using it.
6. Understating of 3G Communication System with features like; transmission of voice and video calls, SMS, MMS, TCP/IP, HTTP, GPS and File system by AT Commands in 3G network.
7. Study of DSSS technique for CDMA, observe effect of variation of types of PN codes, chip rate, spreading factor, processing gain on performance.
8. To learn and develop concepts of Software Radio in a real time environment by studying the building blocks like Baseband and RF section, convolution encoder, Interleaver and De- Interleaver.
9. To study and Analyse different modulation techniques in time and frequency domain using SDR kit.

ECMA6044: MICROCONTROLLER AND APPLICATIONS LAB

(L-T-P: 0-0-4) (2 credits)

Course Outcomes

1. Apply the concept of 8051 microcontroller to write program using assembly language and embedded C language. (Applying)
2. Design systems using 8051 microcontroller. (Creating)

List of Experiments:

1. Introduction to various simulators used for 8051 microcontroller
2. Assembly language programming of 8051 microcontroller for arithmetic operations
3. Assembly language programming of 8051 microcontroller for logical operations
4. Introduction to development board of 8051 microcontroller
5. Interfacing of LED with 8051 microcontroller
6. Interfacing of Seven segment display with 8051 microcontroller
7. Interfacing of LCD interfacing with 8051 microcontroller
8. Interfacing of Keyboard with 8051 microcontroller
9. Interfacing of ADC with 8051 microcontroller
10. Assignment based on above mentioned experiments.

ECPM6045: PATTERN RECOGNITION & MACHINE LEARNING LAB

(L-T-P: 0-0-4) (2 credits)

Course Outcome

1. Implement various tools such as maximum likelihood algorithm, Bayes classifier, linear regression, deep learning algorithm, linear discriminant algorithm,unsupervised learning. (Applying)
2. Design classifier using perceptron rule, feed forward back-propagation and delta rule, SVM. (Creating)

List of Experiments:

1. Implement maximum likelihood algorithm
2. Implement Bayes classifier
3. Implement linear regression
4. Design a classifier using perceptron rule
5. Design a classifier using feed-forward back-propagation and delta rule algorithms
6. Implement deep learning algorithm
7. Implement linear discriminant algorithm
8. Design a two class classifier using SVM
9. Design a multiclass classifier using SVM
10. Perform unsupervised learning

ECDE6046: DETECTION AND ESTIMATION THEORY LAB

(L-T-P: 0-0-4) (2 credits)

Course Outcomes

1. Identify methods for detection and estimation of signals in white and non-white Gaussian noise. (Applying)
2. Analyse Signals and noise models. (Analysing)
3. Design optimal and suboptimal detection and estimation algorithms under realistic conditions. (Creating)

List of Experiments:

1. Simulate signal and noise models models.
2. Simulate spatially separated target Signal in the presence of Additive Correlated White Noise
3. Simulate spatially separated target Signal in the presence of Additive Uncorrelated White Noise
4. Simulate spatially separated target Signal in the presence of Additive Correlated Colored Noise
5. Detect Constant amplitude Signal in AWGN
6. Detect Time varying Known Signals in AWGN
7. Detect Unknown Signals in AWGN
8. Compare performance comparison of the Estimation techniques - MLE, MMSE, Bayes Estimator, MAP Estimator, Expectation Maximization (EM) algorithm
9. Performance comparison of conventional Energy Detectors and Coherent Matched Filter Techniques

ECRS6047: ANTENNAS AND RADIATING SYSTEMS LAB

(L-T-P: 0-0-4) (2 credits)

Course Outcome

1. Definition of basic taxonomy and terminology of the computer networking area. (Remembering)
2. Understand and build the skills of subnetting and routing mechanisms. (Understanding)
3. Understand basic protocols of computer networks, and how they can be used to assist in network design and implementation. (Understanding)
4. Apply mathematical foundations to solve computational problems in computer networking. (Applying)
5. Analyse performance of various communication protocols. (Analysing)
6. Compare routing algorithms. (Evaluating)
7. Design and develop protocols for Communication Networks and practice packet/file transmission between nodes. (Creating)

List of Experiments:

1. Simulation of half wave dipole antenna.
2. Simulation of change of the radius and length of dipole wire on frequency of resonance of antenna.
3. Simulation of quarter wave, full wave antenna and comparison of their parameters.

4. Simulation of monopole antenna with and without ground plane.
5. Study the effect of the height of the monopole antenna on the radiation characteristics of the antenna.
6. Simulation of a half wave dipole antenna array.
7. Study the effect of change in distance between elements of array on radiation pattern of dipole array.
8. Study the effect of the variation of phase difference 'beta' between the elements of the array on the radiation pattern of the dipole array.
9. Case study.

ECCN6048: ADVANCED COMMUNICATION NETWORKS LAB

(L-T-P: 0-0-4) (2 credits)

Course Outcomes

1. Definition of basic taxonomy and terminology of the computer networking area. (Remembering)
2. Understand and build the skills of subnetting and routing mechanisms. (Understanding)
3. Understand basic protocols of computer networks, and how they can be used to assist in network design and implementation. (Understanding)
4. Apply mathematical foundations to solve computational problems in computer networking. (Applying)
5. Analyse performance of various communication protocols. (Analysing)
6. Compare routing algorithms. (Evaluating)
7. Design and develop protocols for Communication Networks and practice packet/file transmission between nodes. (Creating)

List of Experiments:

1. Study of Networking Commands (Ping, Tracert, TELNET, nslookup, netstat, ARP, RARP) and Network Configuration Files.
2. Linux Network Configuration.
3. Configuring NIC's IP Address.
4. Determining IP Address and MAC Address using if-config command.
5. Changing IP Address using if-config.
6. Static IP Address and Configuration by Editing.
7. Determining IP Address using DHCP.
8. Configuring Hostname in /etc/hosts file.
9. Design TCP iterative Client and Server application to reverse the given input sentence.
10. Design a TCP concurrent Server to convert a given text into upper case using a multiplexing system called "select".
11. Design UDP Client Server to transfer a file.
12. Configure a DHCP Server to serve contiguous IP addresses to a pool of four IP devices with a default gateway and a default DNS address. Integrate the DHCP server with a BOOTP demon to automatically serve Windows and Linux OS Binaries based on client MAC address.
13. Configure DNS: Make a caching DNS client, and a DNS Proxy; implement reverse DNS and forward DNS, using TCP dump/Wireshark characterise traffic when the DNS server is up and when it is down.
14. Configure a mail server for IMAP/POP protocols and write a simple SMTP client in C/C++/Java client to send and receive mails.
15. Configure FTP Server on a Linux/Windows machine using a FTP client/SFTP client characterise file transfer rate for a cluster of small files 100k each and a video file of 700mb.Use a TFTP client and repeat the experiment.
16. Signaling and QoS of labeled paths using RSVP in MPLS.
17. Find shortest paths through the provider network for RSVP and BGP.
18. Understand configuration, forwarding tables, and debugging of MPLS.

ECDS6049: DSP ARCHITECTURE LAB

(L-T-P:0-0-4) (2 credits)

Course Outcomes

1. Recall and demonstrate the Code Composer Studio. (1-Remembering, 2-Understanding)
2. Develop the interfacing between MATLAB and Code Composer Studio (3-Applying, 6-Creating)
3. Simplify and explain the real time DSP problems with the help of DSP processor. (4-Analyzing, 5-Evaluating)

List of Experiments:

1. Introduction to Code Composer Studio-I
2. Introduction to Code Composer Studio-II
3. Introduction to the Addressing Modes
4. FFT and Bit Reversal Operation
5. FFT and its Applications
6. Audio Codec and its Applications
7. Real Time Data Exchange
8. FIR filtering by interfacing Matlab with Code Composer Studio
9. Introduction to Interrupts
10. Digital communication using Binary Phase Shift Keying

ECSA6050: EMBEDDED SYSTEMS AND APPLICATIONS LAB

(L-T-P: 0-0-4) (2 credits)

Course Outcomes

1. Perform various experiments using PIC and AVR microcontroller. (Applying)
2. Relate different peripheral devices with PIC and AVR microcontroller. (Analysing)
3. Evaluate the performance of various microcontroller based embedded systems (Evaluating)

List of Experiments:

1. Introduction to MPLAB and Embedded C.
2. LED interfacing with PIC Microcontroller
3. 7 Segment display interfacing with PIC Microcontroller
4. LCD interfacing with PIC Microcontroller
5. Keyboard interfacing with PIC Microcontroller
6. ADC and DAC interfacing with PIC Microcontroller
7. Serial Communication using PIC Microcontroller
8. Timer using PIC Microcontroller
9. Interrupt using PIC Microcontroller
10. Basic programming using AVR Microcontroller
11. Data Acquisition using LabView
12. Interfacing of Microcontroller with LabVIEW

ECMI6051: MINI PROJECT

(L-T-P: 0-0-4) (2 credits)

Objective

The Mini Project work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution. Seminars should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. Tech. The examination shall consist of the preparation of a report consisting of a detailed problem statement and a literature review. The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiners panel set by the Head and PG coordinator. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.

Course Outcomes

1. Choose various topics for self-learning (Remembering)
2. Explain different problems and recent trends related to the topic (Understanding)
3. Apply the knowledge to find out the solution of the problems related to the topic (Applying)
4. Compare various real life problems related to the topic (Analysing)
5. Evaluate various design problems related to the topic (Evaluating)
6. Develop oral and written communication skills to present and defend their work in front of technically qualified audience (Creating)

ECAC6052: ANALOG AND DIGITAL COMMUNICATION LAB

(L-T-P: 0-0-2) (1 Credit)

Course Outcomes

1. Design various carrier generation circuits as well as pulse modulation circuits. (Applying - Creating)
2. Design various analog modulation circuits and measure noise figure. (Applying - Creating)
3. Design various digital modulation circuits and PN Sequence Generator. (Applying - Creating)

List of Experiments:

1. Realization of Colpitt Oscillator using BJT.
2. Realization of Hartley Oscillator using BJT.
3. Realization of Amplitude Modulation Circuit.
4. Realization of Envelope Detector Circuit for AM demodulation.
5. Design and study of a sample and hold circuit.
6. To study and implement PPM using IC555 Timer.
7. Generation of ASK Modulation and Demodulation.
8. Generation of FSK Modulation and Demodulation.
9. Generation of PSK and DPSK Signals.
10. Study of QPSK Modulation and Demodulation.
11. Design of a PN Sequence Generator.
12. To Study the Measurement of Noise Figure.

ECMM6053: MICROPROCESSORS AND MICROCONTROLLERS LAB

(L-T-P: 0-0-2) (1 credit)

Course Outcomes

1. Explain the concepts of microprocessor-kits, development boards and assemblers of 8085, 8086 microprocessors and 8051 microcontroller. (Understanding)
2. Apply the knowledge of programming to develop various systems. (Applying)
3. Compare programming techniques of various microprocessors and microcontrollers. (Analysing)
4. Assess various I/O devices for interfacing with microprocessors and microcontrollers. (Evaluating)
5. Elaborate the performance of 8085, 8086 microprocessors and 8051 microcontroller. (Creating)

List of Experiments:

1. Perform Arithmetic (Addition, Subtraction, Multiplication and Division) and Logical (AND, OR, XOR and Complement) operation using 8085.
2. Perform Data sorting in an Array of numbers using 8085.
3. Binary to Gray and Gray to Binary Conversion using 8085.
4. ALP based on 8085 for delay subroutine.
5. ALP to add, subtracts, multiply and divide of one byte and two byte nos. using 8086.
6. ALP to perform AND, OR, NOT of one byte and two byte numbers using 8086.
7. Find two’s complement of a number using 8086.
8. ALP to display a message without an array and using an array using 8086.
9. ALP to read a character and display the character using 8086.
10. ALP to find some mathematical expression using 8051.
11. ALP to find some logical expression using 8051.
12. Interfacing with Traffic Light controller and Stepper motor Controller using 8085.
13. ALP to interface LEDs, 7 Segment display and LCD using 8051/ AVR microcontroller.

ECMI6054: MINI PROJECT

(L-T-P: 0-0-2) (1 Credit)

Objective

The objective of this course is to train the students to design, simulate or study mini electronic systems which will give them hands on experience in re-creating the principles they have studied in their engineering classes. This is electronic product design work with a focus on electronic circuit design.

Guideline:
1. The mini-project is a team activity having 3-4 students in a team.
2. After interactions with the course coordinator and based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of the mini-project.
3. Students are expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within the first week of the semester.
4. Mini Project should cater to a small system required in laboratory or real life.
5. The mini project may be a complete hardware or a combination of hardware and software. The software part in the mini project should be less than 50% of the total work.
6. It should encompass components, devices, analog or digital ICs, micro controllers with which functional familiarity is introduced.
7. Completed mini project and documentation in the form of mini project report is to be submitted at the end of semester.

Course Outcomes
1. Choose a problem statement either from rigorous literature survey or from the requirements raised from need analysis. (Remembering)
2. Construct the prototype/algorithm in order to solve the conceived problem. (Applying)
3. Analyse the performance of the electronic system. (Analysing)
4. Evaluate the prototype/algorithm. (Evaluating)
5. Compile report on mini project work. (Creating)

ECEW6057: ELECTROMAGNETICS WAVES LAB
(L-T-P: 0-0-2) (1 credit)

Course Outcomes
1. Apply the theoretical knowledge for measuring different parameters experimentally. (Applying)
2. Analyze and test the characteristics and performances of different components, devices and circuits using standard test bench. (Analysing)
3. Model electromagnetic structures, waveguides and antennas in associated software. (Creating)

List of Experiments:
1. To determine an unknown impedance using VSWR/Smith chart.
2. Determine the frequency and wavelength in a rectangular waveguide working on TE10 mode
3. To study the characteristics of wave propagation in a waveguide by studying standing wave patterns for (a) Short circuit, (b) Open circuit and (c) Matched termination.
4. Determine the SWR and reflection co-efficient in a rectangular waveguide
5. Study of the reciprocity theorem for antennas, the variation in the radiation strength at a given distance from the antenna and to perform polarization test
6. Write a MATLAB code to find the following: (a) Vector R_{MN}, (b) Dot product of R_{MN} and R_{PM}, (c) projection of R_{MN} on R_{PM}, (d) angle between R_{MN} and $R_{PM.}$ Given the points M(0.1, -0.2, -0.1), N(-0.2, 0.1, 0.3), P(0.4, 0, 0.1).
7. Two perfect dielectrics have relative permittivities ε_{r1}=3 and ε_{r2}=6. The planar interface between them is the surface x+y+2z =1. The origin lies in region 1. If E1=24.0a_x + 36.0a_y + 42.0a_z V/m, write a MATLAB code to find field E_2.
8. A point charge Q=0.1μC is located at the origin. Write a MATLAB program to plot the electric flux lines in the three dimensional space.
9. Create a default open ended rectangular waveguide. Vary its properties and display it. Plot the E and H field distribution of this waveguide at 2.1GHz.
10. Create and view a default circular waveguide. Plot the s-parameters and impedance of the waveguide.
11. Create a dipole antenna of length 3m and width 0.5m and then plot its radiation pattern in both polar and rectangular coordinate systems. Visualize 2D slices from 3D data. Also calculate the HPBW and FNBW from the plot.
12. Create and view a monopole of 1 m length, 0.02 m width and ground plane of dimensions 2.8m x 2.8m. Plot the radiation pattern for a frequency of 75MHz.

ECDI6059: DISSERTATION PHASE–I

(L-T-P: 0-0-20) (10 credits)

Objectives

During this phase the student will start a research project applying the knowledge acquired during the first two semesters and also incorporating the recent trends in the chosen area. It should include phases of design, implementation and reporting. This project is to be executed individually within or outside the campus. The mode and components of evaluation and the weightages attached to them shall be published by the Department/Institute at the beginning of the semester

Course Outcomes

1. Select a project of interest. (Remembering)
2. Defend the topic of interest for continuing work, by doing initial studies on it. (Understanding)
3. Prepare a working methodology for the project for its successful completion.(Applying)
4. Design and experiment on the selected project. (Analysing)
5. Devise tools and methods for experimenting and troubleshooting for getting expected outcomes. (Evaluating)
6. Explain, justify and defend the project work by presenting the work and writing a report. (Creating)

ECDI6060: DISSERTATION PHASE–II

(L-T-P: 0-0-32) (16 credits)

Objective

During this phase the student will carry forward and complete the work that they have started in Phase I. It is expected that the student will publish at least one research paper in a well-known journal to augment their work during this phase. Published papers will carry extra weightage during evaluation. The mode and components of evaluation and the weightages attached to them shall be published by the Department at the beginning of the semester.

Course Outcomes

1. Define the problem encountered in Phase-I. (Remembering)
2. Explain the working model of the proposed work. (Understanding)
3. Apply mathematical skills and how these skills are important in engineering. (Applying)
4. Contrast different problems encountered in designing a system. (Analysing)
5. Interpret knowhow on the topic selected for the project. (Evaluating)
6. Contrast on limitations of the system designed. (Creating)

ECPR6061: PROJECT-I

(L-T-P: 0-0-2) (1 credits)

Objective

During the last year of their study, B. Tech. students are required to take up a major project. This may be an individual project or a group project. The Major Project is an integral learning experience that encourages students to break away from the compartmentalization of the different courses they have studied during the three years of their study and aims to provide opportunities to explore the inter-relationships and interconnectedness of the various courses and gather them together into a single learning experience.

The major project focuses upon the following:

- Interdisciplinary: The major project provides a platform for students to apply the knowledge and skills acquired from different courses.
- Collaboration: It encourages students to work in groups over an extended period of time. They clarify the task, plan their work, share the responsibilities and work towards the successful completion of the project.
- Process and Product: Project work focuses on both process and product. The process would include collaboration, gathering and processing of information. The product may take the form of a working model, a complete software package, etc.
- Written and Oral presentation: Project work provides students with opportunities to present their findings as a written thesis in a prescribed format and orally with an intended audience and purpose in mind.

During the first phase in the seventh semester, students are expected to choose the project, prepare a synopsis under the guidance of a project supervisor appointed by the department, present the synopsis to the committee set up for the purpose, get approval for the synopsis and start the project work. Students are expected to submit weekly activity reports and present a progress seminar during this phase. They will also undergo a viva voce examination, in which they will be examined on all the basic areas of the discipline in which they have chosen their project.

Course Outcomes

1. Define the problem statement for the project work. (Remembering)
2. Classify the whole project work in various modules. (Understanding)
3. Construct software implementation skills and design skills. (Applying)
4. Simplify different problems encountered in designing a system. (Analysing)
5. Recommend a model for the second phase of the project. (Evaluating)
6. Test for the results with proper mathematical modelling. (Creating)

ECTS6062: TRAINING SEMINAR

(0-0-4)

ECPR6063: PROJECT-II

(L-T-P: 0-0-9) (3 credits)

During the second phase students are expected to focus on the process and completion of the projects and prepare project reports under the guidance of the Supervisors. The internal assessments shall be evaluated by the Departmental Project Evaluation Committee (DPEC) and the external assessment shall be done by the external examiner(s) assisted by the DPEC and the supervisor. The modality and components of the internal assessment and their weightages shall be notified at the beginning of each semester. The External assessment shall have the following components:

- Project Implementation: 40 marks
- Seminar presentation: 20 marks
- Viva voce examination: 20 marks
- Project documentation: 20 marks

Course Outcomes

1. Define the problem encountered in Phase-I. (Remembering)
2. Demonstrate the various components/modules of the project. (Understanding)
3. Analyse different problems encountered in designing a system (Analysing)
4. Develop technical writing and communication skills. (Applying)
5. Design and evaluate the performance of electronic system (Evaluating - Creating)

ECNT6058: COMPUTER NETWORKS LAB

(L-T-P: 0-0-2)(1 credit)

Course Outcomes

1. Choose suitable tools to model a network and understand the protocols at various OSI reference levels.(Applying)
2. Design a suitable network and simulate using a Network simulator tool.(Creating)
3. Model the networks for different configurations and analyze the results.(Evaluating - Creating)

List of Experiments:

1. Study of Network Devices in detail.
2. Familiarization of network environment, understanding and using network utilities: ipconfig, ifconfig, netstat, ping, arp, telnet, ftp, finger, traceroute.
3. Connect the computers in local area network.
4. Configure a network topology using packet tracer software.
5. Implementation of concurrent server using connection-oriented socket system calls.
6. Implementation of concurrent server using connection less socket system calls.
7. Implementation of iterative server using connection-oriented socket system calls.
8. Implementation of iterative server using connection less socket system calls.
9. Implementation of Linked State Routing Algorithm.
10. Implementation of Distance Vector Routing Algorithm.
11. Introduction to Wireshark.
12. Wireshark as a network protocol analyser.

ECSL0200 SERVICE LEARNING

(2 credits – 30 hours)

Objective

Service Learning is an experience-based approach to education. It is a course-based service experience that produces the best outcomes when meaningful service activities are related to the course material through reflection and critical inquiry. It deepens and enriches the theoretical and conceptual side of learning. Service Learning combines – Academic Instruction, Meaningful Service and Critical and Reflective thinking.

Module I (15 Hours)

Introduction to service learning-Its philosophy, historical background, purpose, value& theoretical framework; Locating Service Learning within the University context, elements of service learning, Historical context of University Community Partnership; Understanding Community &Community Partnership; Ethical understanding of partnership; Understanding the agency of the Community – as co-educators; Community barriers; Understanding of society & social issues; Culture and Power Dynamics; Power & Privilege; social responsibility and community engagement

Module II (15 Hours)

Introduction to applicability of Electronics & Communication in various fields; Identification and use of electronic components, concepts of voltage and currents, use of different instruments: digital multimeter, soldering iron, PCB, tester, etc., designing electronic circuits: power supply, Solar-LED lamps, water level indicator system, smoke detector, agricultural monitoring and controlling circuit, experiments using drones, IoT, Utility of Nanotechnology etc.

VALUE ADDED COURSES

ECES6064: ELECTRONIC DISPLAY SYSTEM

(L-T-P: 2-0-0) (2 credits – 30 hours)

Objective

The objective of this course is to introduce the students to opto-electronic devices that are used to make advance display units. This course will also provide an exposure to interfacing of these display devices based on LED.

Course Outcomes

1. Explain and experiment with LED based display system. (Understanding - Applying)
2. Make use of Embedded Systems and its related applications. (Applying)
3. Design electronic displays. (Creating)

Module I (10 hours)

Fundamentals of LED: Introduction to PN Junction Diode, Construction and working of LED, Types of LED, Advantage, Disadvantage and Applications, 7 segment display, LED Dot Matrix Display, Tricolor LED – Construction and Working, LCD. Fundamentals of Microcontroller: 8051 Microcontroller, Basic and Advanced Microcontroller Boards.

Module II (20 hours)

Glowing of various patterns in LED using microcontroller, Microcontroller based up counter and down counter design using LED and 7 segment displays, Displaying of Names in different format using LCD, designing of rolling display using LED and LCD. Implementation of display devices in projects.

Suggested Readings

1. Electronic Devices and Circuits Theory, Boylestead and Nashelsky, 9th Edition, Prentice Hall India, 2007.
2. Electronic Devices and Circuits, Salivahanan et al., 2nd Edition, Tata McGraw Hill, New Delhi, 2008.
3. The 8051 Microcontroller And Embedded Systems Using Assembly And C, Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay,Pearson
4. Microcontrollers : Theory and Applications, A V Deshmukh, Tata McGraw-Hill Education

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2
CO 1	H	M
CO 2	H	H
CO 3	H	H

ECNA6065: NANOTECHNOLOGY and APPLICATIONS

(L-T-P: 2-0-0) (2 credits – 30 hours)

Objective

This course will introduce the students to Nanotechnology. The course is designed to build up a basic understanding of the nano concepts. It will provide the students the knowledge of synthesis of nanomaterials, their characterization techniques as well as touch upon some applications of nanotechnology.

Course Outcomes

1. Define various terms such as nanotechnology, nanoelectronics, nanoscience etc. (Remembering)
2. Explain the operations of various characterization tools. (Understanding)
3. Apply the synthesis process to fabricate various nanostructures. (Applying)
4. Analyze various nanostructures. (Analysing)
5. Evaluate nanomaterials using characterization techniques. (Evaluating)

Module I (17 hours)

Introduction to Nanotechnology, Basics of Material science and Nanoscience, Poor Man's Nanotechnology, Introduction to Characterization Techniques-I, Synthesis of nanomaterials, ImageJ, Origin and Lab Rules, Nano electronics: Novel device fabrication and characterization.

Module II (13 hours)

Introduction to Characterization Techniques – II, Optical properties of nanomaterials, Nano Bioscience, Issues of Nanotechnology, Characterization results, Applications of Nanotechnology.

Suggested Readings

1. G. L. Hornyak, J. Dutta, H. F. Tibbals, A. Rao Introduction to nanoscience, CRC Press

2. G. L. Hornyak, J. Dutta, H. F. Tibbals, A.Rao Introduction to nanotechnology CRC Press
3. T. Pradeep, Nano: The Essentials McGraw Hill
4. G. W. Hanson, Fundamentals of Nanoelectronics, Pearson
5. D. Maclurcan and N. Radywyl (Eds.) Nanotechnology and Global Sustainability CRC Press
6. E. Lichtfouse, J. Shwarzbauer, D. Robert, Environmental Chemistry for a Sustainable World, Vol.2 Springer Verlag

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2
CO 1	H	M
CO 2	H	M
CO 3	H	M
CO 4	M	H
CO 5	M	H

DEPARTMENT OF MECHANICAL ENGINEERING

PROGRAMME: BACHELOR OF TECHNOLOGY (BTECH) MECHANICAL ENGINEERING

VISION
To establish the department as a hub of quality technical education and research for aiding the industry and to strive for the upliftment of the North East Region and nation as a whole.

MISSION
- To train the youth to be intellectually competent with strong fundamentals in Mechanical engineering.
- To create an environment for carrying out fundamentals and interdisciplinary research to address the future needs and challenges of a society and the industry.
- To cultivate strong moral values and professional ethics to build them as responsible and environmentally conscious citizens.
- To motivate, nourish and mould the students to be dynamic leaders and entrepreneurs.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)
1. To develop the ability to design a system, component or process to meet the social and industrial requirements within realistic constraints.
2. To achieve a high level of technical expertise through extensive project work, experiments, industrial visits and regular symposiums.
3. To inculcate professional ethics, leadership qualities and inherent creative instincts in students.
4. To encourage lifelong learning and to foster the ability to function on multi-disciplinary teams.

PROGRAM SPECIFIC OUTCOMES (PSOS)
1. To develop the ability to apply the concept of Mechanical engineering for design, development, manufacturing, analysis and maintenance of mechanical systems and processes.
2. To understand and demonstrate the key concepts related to entrepreneurship, professionalism, effective communication, shop floor management, project management and economics.

MAPPING OF PO, PSO'S VS COURSES

Course	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CHCE0027	M	L		L		M	M		M	M		L	H	M
MACL0012	L	H	M		M	M		M	H	M	M	M		M
EEBE0038	M	M	L						M				M	
MNWM6023					H				M			H	L	H
PSPT0040	H	M	L										M	
MAIN0013	L	H	M		M	M		M	H	M	M	M		M
LSEH0017								L		H		L		
CSPS0079	M	H	M							M	L	L	M	
CSPL6069	M	M	M		M				L	M	L	M	M	
PSEG6017	H	M	M									L	M	L
CVED6024	M		L	L	L				L	H	L		M	L
LSOC6004								L		M		L		
PSW00052	H	M	L							L			M	
MACP0029	L	H	M		M	M		M	H	M	M	M		M
BOBE0002	L		M	M	L	M	H	L	M		H	M		M
ECEE0052	H	M	M		L							H	M	
MNEM0034	H	M										L	H	
MNBT0035	M	M	L									M	M	

MNMD6024	M					M				M		M		M
BTIA8		L	L			M	L	L	M					
MNAP0036	H	M	M				M					L	H	L
MNFM0037	M	L	L										H	
MNSM0038	M	L	L									L	H	
MNSE0039	H	M	L			L						M	L	L
MNIC0040	H	M	M			L	L					L	H	M
CHES0029		M	H	L		M	H	L	L		H			M
MNMF6025	H	M	L						M				M	
MNHT0041	H	M	L									M	M	
MNDM0042	H	M	H	H					M		H		H	
MNMP0043	M	M	M		M	L							M	M
MNKT0044	H	M	M									M	M	M
MTEC0074			L	H			L				M			
MNFT6026	H	M					M						M	
MNMI6027	H	H	M	M	M	L	L	H	H	H	M	L	H	M
MNMT0045	H	H	H	M	M								M	M
MNDD0046	H	H	H				M		M			L	H	L
MNHM0047	M	M	M		M	L	L						M	M
MNMP0048	M						M					H	M	M
MNCM0049	M		M			M	L						M	
MNIC0050	M		L			L	M						M	
MTFP0070			L	H			L				M			
MNDS6028	H	L	L				M		L				M	
MNAM0051	M	M	H		H		L						M	M
MNRC0052	M	L	L				L						M	
MNSE0053	M	L				M	M						M	
MNSN0054	H	M	L	L									H	M
MNER0055	H	L	M				M						M	
MNAE0056	H	M	M		M	L	M						M	M
MNPE0057	H	L	M				L						M	
MNQM0058	L	L	L	M							L		M	
MNCA0059	H				M							H	M	H
MNSG0060	H	M	L									M	M	
MNWT0061	M	L	L										M	L
MNGT0062	L	L	M			M							M	L
MNMO0063	H	H	H	M		L								M
MNRA0064	M	M	M				L						M	
MNMP6029 & MNMP6031	H	H	M	H	M	L	M	H	H	H	M	M	H	H

DETAILED SYLLABUS

MNEM0034: ENGINEERING MECHANICS

(4 Credits-60 hours)(L-T-P: 3-1-0)

Objective

To develop the ability of the engineering students to Analyse physical engineering problems in a simple and logical manner; to apply the basic principles and concepts of mechanics to obtain a feasible solution and reach a conclusion. To understand the kinetics and dynamics of motion and concept of vibration and its effect on a system.

Course/Learning Outcomes

After completing the course successfully the students will be able to-

1. Define various principles, definitions, theorems related to mechanics.
2. Compare and identify the various types of beams, frames and the effect of different loading on them
3. Apply the concept of virtual work for relevant problem solving
4. Analyse the different truss and frames for its suitability considering various given constraints.
5. Appreciate the importance of the knowledge of vibration and its effect on a system
6. Solve various simple day to day life problems within the applicable constraints and communicate the solution effectively.

Module I (9 hours)

a. Force Systems Basic concepts, Particle equilibrium in 2-D and 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy.
b. Friction: Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack and differential screw jack.

Module II (8 hours)

Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams and types of beams; Frames and Machines.

Module III (8 hours)

Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.

Module IV (8 hours)

Virtual displacements, principle of virtual work for particles and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy(elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.

Module V (9 hours)

a. Particle dynamics- Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique).
b. Introduction to Kinetics of Rigid Bodies- Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation.

Module VI (8 hours)

Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums

Suggested Readings

1. Mariam and Craig, Engineering Mechanics, Wiley.
2. S. Timoshenko and D.H. Young, Engineering Mechanics McGraw Hill Int

3. R.K. Bansal, Engineering Mechanics, Laxmi Publication (P) Ltd.
4. K.L. Kumar, Engineering Mechanics, McGraw Publishing Co.
5. Irving H. Shames , Engineering Mechanics, 4th Edition, Prentice Hall (2006)
6. F. P. Beer and E. R. Johnston , Vector Mechanics for Engineers, Vol I - Statics, Vol II, Dynamics, 9th Ed, Tata McGraw Hill (2011).
7. Shanes and Rao , Engineering Mechanics, Pearson Education (2006).
8. Hibler and Gupta , Engineering Mechanics (Statics, Dynamics) by Pearson Education (2010).
9. Khurmi R.S. , Engineering Mechanics, S. Chand and Co (2010).
10. NPTEL LINK: https://nptel.ac.in/courses/112/105/112105164/
11. NPTEL LINK: https://nptel.ac.in/courses/112/106/112106286/
12. NPTEL LINK: https://nptel.ac.in/courses/112/103/112103109/

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO1	H		M		L	
CO2		H				
CO3				H		
CO4		H				
CO5						H
CO6	L	M	H		M	

MNBT0035: BASIC THERMODYNAMICS

(4 Credits-60 hours)(L-T-P: 3-1-0)

Objectives:

- To learn about work and heat interactions, and balance of energy between system and its surroundings
- To learn about application of I law to various energy conversion devices.
- To evaluate the changes in properties of substances in various processes.
- To understand the working of petrol and diesel engines.

Course /Learning Outcomes:

After completing the course successfully the students will be able to

1. define thermodynamic system, properties, processes and various terms related to properties of pure substances
2. apply the concept of 1st and 2nd law to a wide range of systems.
3. evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations
4. classify and compare various types of IC engines

Module I (15 hours)

Fundamentals - System and Control volume; Property, State and Process; Exact and Inexact differentials; Work - Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work. Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers. Definition of heat; examples of heat/work interaction in systems. First Law for Cyclic and Non-cyclic processes; Concept of total energy E; Demonstration that E is a property; various modes of energy, Internal energy and Enthalpy.

Module II (15 hours)

a. First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume.
b. Second law : Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Carnot's theorem, Corollary of Carnot theorem, Absolute thermodynamic temperature scale, Clausius theorem; Definition of entropy S ; Demonstration that entropy S is a property; Inequality of Clausius, Principle of increase of entropy; Illustration of processes in T-s coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles. Irreversibility and

Availability, Availability functions for systems and Control volumes undergoing different processes, Lost work. Second law efficiency.

Module III (10 hours)
Definition of Pure substance, p-v diagram, p-T diagram, p-v-T diagram, T-s diagram for a Pure Substance, h-s diagram or Mollier diagram, Dryness Fraction, Charts of Thermodynamic Properties. Equation of State of a Gas, Ideal Gas, Specific Heats, Internal Energy, Enthalpy and Entropy of an Ideal Gas, Equations of State, Compressibility Charts, Properties of Mixtures of Gases-Dalton's law of Partial Pressures, Internal Energy, Enthalpy and Specific Heats of Gas Mixtures.

Module IV (10 hours)
Definition of Engine, classification of IC Engines, Performance Parameters, Working principle of 4-stroke and 2-stroke engine, Petrol Engine, Diesel Engine, Comparison between Petrol and Diesel Engine.

Suggested Readings
1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., Fundamentals of Thermodynamics, John Wiley and Sons, 6th Edition, 2003.
2. Jones, J. B. and Duggan, R. E., Engineering Thermodynamics, Prentice-Hall of India,1996.
3. Moran, M. J. and Shapiro, H. N., Fundamentals of Engineering Thermodynamics, John Wiley and Sons, 1999.
4. Nag, P.K, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd, 1995.
5. https://nptel.ac.in/courses/112/105/112105266/ Concepts of thermodynamics [IIT KGP}
6. https://nptel.ac.in/courses/112/105/112105220/ Laws of Thermodynamics [IIT KGP}
7. https://nptel.ac.in/courses/112/105/112105123/ Basics Thermodynamics {IIT KGP}

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H	M	H	L
CO2	H	H	M	
CO3		H		
CO4				H

MNAP0036: APPLIED THERMODYNAMICS
(4 Credits-60 hours)(L-T-P: 3-1-0)

Objectives:
- To learn about the operating parameters of vapour power cycles.
- To understand about the properties of dry and wet air and the principles of psychrometry.
- To learn about gas dynamics of air flow and steam through nozzles.
- To learn about reciprocating compressors with and without intercooling.
- To Analyse the performance of steam turbines.

COURSE/ LEARNING OUTCOMES
After completing the course successfully the students will be able to-
1. Define the thermodynamic processes of Rankine cycle.
2. Illustrate the mathematical equations to solve thermodynamics problems.
3. Compute the performance and characteristics of reversible thermodynamic cycles.
4. Analyze thermodynamic problems with application to steam power plant and refrigeration systems.

Module I (10 hours)
a. Simple Steam Power Cycle, Rankine Cycle, Actual Vapour Cycle Processes, Comparison of Rankine and Carnot Cycles, Mean Temperature of Heat Addition, Reheat Cycle, Regeneration- Open Feedwater Heater, Reheat-Regenerative Cycle, Characteristics of an Ideal Working Fluid, Binary Vapour Cycles.
b. Gas power cycles, Air standard Cycles- Otto, Diesel and Dual cycles, Comparison of Otto, Diesel and Dual Cycles, Brayton cycle, effect of reheat, regeneration and intercooling.

Module II (10 hours)
Reversed Carnot Cycle, Unit of Refrigeration, Limitation of Reversed Carnot Cycle, Gas Refrigeration Cycle, Vapor compression refrigeration cycles, p-h diagram. Properties of Atmospheric Air, Psychrometric Properties of Air, Pyschrometric Chart.

Module III (10 hours)
Velocity of Pressure Pulse in Fluid, Stagnation properties, Mach Number, Property Relations for Isentropic Flow through a Duct, One Dimensional Steady Isentropic Flow, Critical Properties- Choking in Isentropic Flow, Normal Shocks, use of ideal gas tables for isentropic flow and normal shock flow, Flow through Actual Nozzles and Diffusers, Effect of Irreversibilities on Nozzle Efficiency.

Module IV (10 hours)
a. Classification, Reciprocating Compressor Terminology, Work of Compression, Single stage Reciprocating Air Compressor, Volumetric Efficiency, Limitations of Single Stage Compression, Multistage Compression.
b. Classification of Steam Turbines, Simple Impulse Turbine, Optimum Operating Conditions from Blade-Velocity Diagram, Effect of Blade Friction on Velocity Diagram, Compounding of Impulse Turbine, Reaction Turbine, Comparison between Impulse and Reaction Turbines, Losses in Steam Turbines.

Module V (10 hours)
Characteristics of an Ideal Fuel, Liquid Fuel, Gaseous Fuel, Combustion, Amount of Air Required for Combustion, Air-Fuel Ratio, Air-Fuel Ratio from Analysis of Flue Gases, Heat Generated by Combustion, Standard Reference State, Enthalpy of Formation, Enthalpy of Reaction, Calorific value of Fuel.

Suggested Readings

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., Fundamentals of Thermodynamics, John Wiley and Sons,6th Edition, 2003..
2. Jones, J. B. and Duggan, R. E., Engineering Thermodynamics, Prentice-Hall of India, 1996.
3. Moran, M. J. and Shapiro, H. N., Fundamentals of Engineering Thermodynamics, John Wiley and Sons,1999.
4. Nag, P.K, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd., 1995.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO1	H			L	
CO2	H	H	M	H	L
CO3	H	H	L		
CO4		H		H	

MNFM0037: FLUID MECHANICS
(4 Credits-60 hours)(L-T-P: 3-1-0)

Objective
This is an introduction in mechanics of fluid motion. It is designed to establish fundamental knowledge of basic fluids mechanics and hydraulic machines. It addresses specific topics relevant to simple applications in the field of fluids as well hydraulics machines.

Course/Learning Outcomes
At the end of the course students will be able to:
1. CO1: Define types of fluid and flow, the properties of fluids, basic law of fluid mechanics, basic fundamental theories of fluid mechanics, types of turbines, pumps and various hydraulic equipment, function and characteristic of hydraulics machines. (Remembering)
2. CO2: Explain different types of fluids, types of fluid flow, fundamental law of fluid mechanics, basic fundamental theories of fluid mechanics, various fluid mechanic equipment and hydraulics machines (Understanding)
3. CO3: Apply fundamental concepts of fluid mechanics and hydraulic system to engineering application. (Applying)
4. CO4: Solve problems of fundamental law of fluid mechanics and work done and various efficiencies of turbines, pumps and hydraulic machines. (Applying)
5. CO5: Analyze fluid flow problems by fundamental fluid mechanics laws, dimensional analysis and model analysis. (Analyzing)

Module I (6 hours)
Definition of fluid, Units and dimensions-Properties of fluids, Pascal law, Pressure measurement manometer, types of manometer and its application, Newton's law of viscosity, Forces on submerged plane and curved surfaces, buoyant force, metacentre, centre of buoyancy, equilibrium of floating and submerged body.

Module II (11 hours)
Types of fluid flow: steady, unsteady, uniform, non uniform, laminar, turbulent, compressible, incompressible, rotational, irrotational, one, two, three dimensional flows, velocity, acceleration, Velocity potential function, Stream function. Control volume- application of continuity equation and momentum equation, flow net, Vortex flow Bernoulli's equation and its applications to Venturimeter, Orificemeter and Pitot tube and Notches.

Module III (15 hours)
Exact flow solutions in channels and ducts, Laminar flow, Velocity distribution, mean velocity, velocity profile Kinetic energy factor and momentum Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli. Turbulent flow: Reynold's experiment, laws of fluid friction, shear stress, types of boundary, Prandtl length concept, velocity distribution, mean velocity, velocity profile, resistance to flow in smooth and rough pipes, Darcy Weisbach equation, friction factor, Moody's diagram.

Module IV (7 hours)
Concept of boundary layer, laminar boundary layer, turbulent boundary layer, Laminar sub layer, Boundary layer thickness, displacement thickness, momentum thickness, energy thickness. Flow around submerged bodies- Introduction to concept and expression of drag and lift, pressure drag and friction drag, Streamlined and Bluff bodies.

Module V (4 hours)
Need for dimensional analysis, Buckingham's pi theorem and its application. Similitude – types of similitude Dimensionless parameters – application of dimensionless parameters – Model analysis.

Module VI (9 hours)
Euler's equation – theory of Rotodymanic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps-Reciprocating pump – working principle.

Module VII (8 hours)
Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines.

Suggested Readings

1. Sukumar Pati, Fluid Mechanics and Hydraulic Machines, Tata McGraw Hill.
2. Dr. R.K. Bansal, Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications.
3. R.K Rajput, Textbook on Fluid Mechanics and Hydraulic Machines, S. Chand.
4. Y. A. Cengel, Fluid Mechanics Fundamentals and Applications, Tata McGraw Hill.
5. P.N. Modi and S.M. Seth, Hydraulics and fluid Mechanics including hydraulics machines, Standard Book House.
6. NPTEL course: Introduction to Fluid Mechanics By Prof. Suman Chakraborty https://nptel.ac.in/courses/112/105/112105269/
7. NPTEL course: Fluid Mechanics By Prof. S.K. Som https://nptel.ac.in/courses/112/105/112105171/

Mapping of COs to Syllabus

Course Outcomes	Module1	Module2	Module3	Module4	Module5	Module6	Module7
CO1	H	M	L	H	M	M	M
CO2	M	H	M	L	L	M	M
CO3	M	M	L	L	M	H	H
CO4	L	L	M	M	H	M	M
CO5	L	H	H	M	M	H	H

MNSM0038: STRENGTH OF MATERIALS
(4 Credits-60 hours)(L-T-P: 3-1-0)

Objectives:
- To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads
- To calculate the elastic deformation occurring in various simple geometries for different types of loading

Course/Learning Outcomes
1. Define and relate basic definitions of important terminologies used to characterize solid mechanics problems. (Remembering)
2. Explain various loading conditions and stress regimes prevalent under various loading and boundary conditions. (Understanding)
3. Solve various problems related to stresses in beams, cylinders, columns and prismatic bodies subjected to combinations loading. (Applying)
4. Analyse various stress states using both analytical and graphical techniques. (Analysing)

Module I (8 Hours)
Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses- elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle.

Module II (8 Hours)
Beams and types transverse loading on beams- shear force and bend moment diagrams-Types of beam supports, simply supported and overhanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.

Module III (8 Hours)
Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.

Module IV (8 Hours)
Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs.

Module V (8 Hours)
Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure

Suggested Readings
1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
3. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw Hill Publishing Co. Ltd., New Delhi 2005.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO1	H	M	L		L
CO2		H	M	L	M
CO3		H	H	M	H
CO4		H	L	H	H

MNSE0039: MATERIAL SCIENCE AND ENGINEERING
(3 Credits-45 hours)(L-T-P: 3-0-0)

Objectives:
- Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.
- To provide a detailed interpretation of equilibrium phase diagrams
- Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

Course/ Learning Outcomes
At the end of the course students will be able to:
1. Understand the basic concepts and crystal properties of material.
2. Evaluate the different properties of material by studying different tests.
3. To quantify mechanical integrity and failure in materials.
4. To understand variation in structure of different metallic System with variation in composition and heat treatment procedures.

5. Study the alloying and high temperature behaviour of superalloys.

Module I (6 hours)
Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress.

Module II (6 hours)
Mechanical Property measurement: Tensile, Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength.

Module III (8 hours)
Static failure theories: Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture mechanics: Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress- life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Introduction to nondestructive testing (NDT)

Module IV (6 hours)
Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstructural aspects of ledeburite, austenite, ferrite and cementite, cast iron.

Module V (6 hours)
Heat treatment of Steel: Annealing, tempering, normalizing and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening.

Module VI (8 hours)
Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro- nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titanium alloys

Suggested Readings
1. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India.
2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
3. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999.
4. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.
5. NPTEL LINK: https://nptel.ac.in/courses/113/106/113106032/
6. NPTEL LINK: https://nptel.ac.in/courses/113/107/113107078/
7. NPTEL LINK: https://nptel.ac.in/courses/112/108/112108150/

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO1	H	M	L			
CO2	M	H				
CO3			H			
CO4				H	H	
CO5					M	H

MNIC0040: INSTRUMENTATION AND CONTROL
(3 Credits-45 hours)(L-T-P: 3-0-0)

Objectives
This course aims provide a basic knowledge about measurement systems and their components. The course would also help students to learn about various sensors used for measurement of mechanical quantities, system stability and control. Integration of the measurement systems with the process for process monitoring and control is also introduced in this course.

Module I (10 hours)

Measurement systems and performance – accuracy, range, resolution, error sources; Instrumentation system elements – sensors for common engineering measurements. Mechanical and Electromechanical sensor: Resistive (potentiometric type), Strain gauge, Inductive sensor, LVDT, Proximity sensor, Capacitive sensors, Stretched diaphragm type, Piezoelectric, Thermal sensors: Material expansion type: solid, liquid, gas and vapor, Resistance change type: RTD materials, tip sensitive and stem sensitive type, Thermister material, shape, ranges and accuracy specification. Thermoemf sensor: types, thermoelectric power, general consideration, Junction semiconductor type IC and PTAT type. Radiation sensors: types, characteristics and comparison. Pyroelectric type, Magnetic sensors, Introduction to smart sensors.

Module II (12 hours)

Signal Processing and conditioning: Processing of the analogue measurement signals- Signal conditioning, filtering, amplification. Digital processing of the measurement signals-A/D and D/A conversion, DFT and FFT, Digital filters. Final control elements: Actuators-Solenoid, motors as actuators, spring and diaphragm actuator, direct action pneumatic actuator and hydraulic actuators. Control system basic elements: Basic block diagram of a control system. Conversion of an electrical circuit into a block diagram. Types of control systems: Automatic process control, Batch and Continuous process, Self regulation, Servo and Regulator operation. Examples of feedback control systems: OpAmp with positive and negative feedbacks.

Module III (8 hours)

Control method – Performance criteria-ISE, IAE, ITAE, selection of controllers-P, PI, PID. Mathematical models-Transfer Function. Time-domain response- step response of 1st and 2nd order systems. Frequency response- Nyquist diagrams gain and phase margins.

Module IV (6 hours)

Any one implementation of the following in groups:
Temperature control using ON/OFF controller using Arduino.
Analogue signal conditioning using simple filter circuits such as RC high/low pass filters.
Analogue signal conditioning using active filters.
Implementation of OpAmp based PI controller.

Course Outcomes

At the end of the course, students will be able to:

1. Understand the measurement of various quantities using instruments, their accuracy and range, and the techniques for controlling devices automatically. (Understanding)
2. Understand and analyze Instrumentation systems and their applications to various industries. (Understanding)
3. Model and analyze transducers. (Applying)
4. Select proper control scheme for a given condition (Applying)

Suggested Readings

1. Instrumentation and control systems by W. Bolton, 2nd edition, Newnes, 2009.
2. Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard V, Mechanical Measurements (6th Edition) 6th Edition, Pearson Education India, 2007
3. Gregory K. McMillan, Process/Industrial Instruments and Controls Handbook, Fifth Edition, McGraw- Hill: New York, 1999.
4. S. Tumanski, Principles of Electrical Measurement (Series in Sensors), First edition, CRC press,, 2006.
5. K. Krishnaswamy, Process Control, Second edition, New Age International, 2011.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	H		H
CO 2	L	H		M
CO 3				H
CO 4			H	H

MNME0041: ELEMENTS OF MECHANICAL ENGINEERING

(3 Credits-40 hours)(L-T-P: 2-1-0)

Objectives:

- To learn about the 1st and 2nd law of thermodynamics.

- To understand the working of petrol and diesel engines.
- To interpret the different types of manufacturing processes and their applicability.
- To familiarize with the belt drive and gear drive.

Course/ Learning Outcomes

After the completion of the course the students will be able to:

1. CO1: Define basic terminologies of 1^{st} and 2^{nd} law of thermodynamics, IC engine, Boilers, types mechanical materials, casting, welding, metal forming processes, types of link, types of Belts and Gears(Remembering)
2. CO2: Explain Zeroth, 1st, and 2^{nd} law of thermodynamics, S.F.E.E, temperature and pressure measuring instruments, Otto cycle and diesel cycle, two stroke and four stroke engines, petrol and diesel engine, boilers- mounting and accessories. (Understanding)
3. CO3: Describe various types of mechanical materials, sand casting, types of patterns, casting defects, Arc welding, gas welding, various metal forming techniques, types of kinematic link, transmission of Power by Belts and Gear Trains.(Understanding)
4. CO4: Solve problems on Zeroth, 1^{st} and 2^{nd} law of thermodynamic, Otto and diesel cycle, performance of IC engine, simple problems on rolling, belt and gear drive.(Applying)

Module I (10 Hours)

Thermodynamics system, surrounding and boundary, thermodynamic properties, path,processes and cycle, Macroscopic and Microscopic approach, Thermodynamic equilibrium, Pressure and Temperature, Zeroth Law of Thermodynamic. Displacement work, path function, point function, Work done for constant volume, constant pressure, isothermal, adiabatic and polytropic processes, Internal energy, enthalpy specific heat at constant pressure and volume. First Law of Thermodynamic and its application to non-steady flow systems, Steady flow energy equation, Limitation of First Law of Thermodynamic, Second Law of Thermodynamic, Clausius and Kelvin Planck Statements, concept of Entropy.

Module II (10 Hours)

Engine, Classification, Definition of Brake power, indicated power, friction power, BTE, ITE,calorific value of fuel, Stoichiometric air-fuel ratio, Engine Terminology- bore, compression ratio, swept volume, clearance volume etc. Difference between 4-stroke and 2-stroke engine, comparison of petrol and diesel engine, simple problems related to performance parameters of IC engine, Classification of boilers, Fire Tube boiler- Cochran and Lancashire boiler, Watertube boiler- Babcock wilcox boiler, Advantages and disadvantages of firetube and water tube boilers.

Module III (10 hours)

Types of materials: Ferrous metals, Non-Ferrous Metals, Alloys and Composites, Casting- Sand casting, Types of Pattern, Pattern Materials, Solidification time, Casting Defects. Metal Forming Techniques- Rolling, Forging, Extrusion, Deep Drawing. Simple Problems on Rolling, Welding- Classification, Arc Welding, Problems related to Open Circuit Voltage-Short Circuit Current characteristics, Welding speed, Gas Welding, Types of Flame, Flux, Slag, working of oxy-acetylene welding.

Module IV (10 Hours)

Resistant Body, Link, Difference between machine and structure, types of link, Kinematic pair, constrained motions, kinematic chain, mechanism, degree of freedom, types of joints, simple problems.Types of Belts and Gears, Transmission of Power by Belts and Gear Trains, Simple Belt Drive and Simple Gear Drive, Velocity Ratio, simple problems.

Suggested Readings

1. Nag P. K., “Engineering Thermodynamics”, 4th Edition, Tata McGraw Hill.
2. Chattopadhyay, P., “Engineering Thermodynamics”, 2nd Edition, Oxford.
3. Domkundwar S., Kothandaraman C.P., “A Course in Thermal Engineering”, 6th Edition, Dhanpat Rai & Co (p) Ltd.
4. Sharma P.C. “Production Technology” S. Chand.
5. Singh V.P. “Theory of Machines” Dhanpat Rai & Co.

Mapping of COs to Syllabus

Course Outcomes	Module1	Module2	Module3	Module4
CO1	H	H		H
CO2	M	H		M
CO3	L		H	L
CO4	L		H	M

MNEE0042: ENGINEERING MECHANICS FOR ELECTRONICS AND ELECTRICAL

(4 credits-60 hours)(L-T-P: 3-1-0)

Objective

At the end of this course, students will demonstrate the ability to

- Understand the concepts of co-ordinate systems.
- Analyse the three-dimensional motion.
- Understand the concepts of rigid bodies.
- Analyse the free-body diagrams of different arrangements.
- Analyse torsional motion and bending moment.

Course/Learning Outcomes

After completing the course successfully the students will be able to-

1. Define the various principles, definitions, theorems related to mechanics, relate the different coordinate systems and their transformations. (Remembering)
2. Illustrate the various types of motions and their effects on a body. (Understanding)
3. Construct free body diagrams for various situations. (Applying)
4. Analyze the concept of virtual work for relevant problem solving. (Analyzing)
5. Assess various simple day to day life problems within the applicable constraints and communicate the solution effectively. (Evaluating)

Module I (9 hours)

a. Introduction to vectors and tensors and coordinate systems; Vector and tensor algebra; Indicial notation; Symmetric and anti-symmetric tensors; Eigenvalues and Principal axes.
b. Three-dimensional rotation: Euler's theorem, Axis-angle formulation and Euler angles; Coordinate transformation of vectors and tensors.

Module II (11 hours)

a. Kinematics of rigid bodies: Dentition and motion of a rigid body; Rigid bodies as coordinate systems; Angular velocity of a rigid body, and its rate of change; Distinction between two and three-dimensional rotational motion; Integration of angular velocity to find orientation; Motion relative to a rotating rigid body: Five term acceleration formula.
b. Kinetics of rigid bodies: Angular momentum about a point; Inertia tensor: Dentition and computation, Principal moments and axes of inertia, Parallel and perpendicular axes theorems; Mass moment of inertia of symmetrical bodies, cylinder, sphere, cone etc., Area moment of inertia and Polar moment of inertia, Forces and moments; Newton-Euler's laws of rigid body motion.

Module III (6 hour)

a. Free body diagrams; Examples on modelling of typical supports and joints and discussion on the kinematic and kinetic constraints that they impose.
b. Transverse loading on beams, shear force and bending moment in beams, analysis of cantilevers, simply supported beams and overhanging beams, relationships between loading, shear force and bending moment, shear force and bending moment diagrams.

Module IV (11 hours)

a. Examples and problems. General planar motions. General 3-D motions. Free precession, Gyroscopes, Rolling coin.
b. Torsion of circular shafts, derivation of torsion equation, stress and deformation in circular and hollow shafts.

Module V (3 hours)

Concept of Friction; Laws of Coulomb friction; Angle of Repose; Coefficient of friction.

Suggested Readings

1. J. L. Meriam and L. G. Kraige, "Engineering Mechanics: Dynamics", Wiley, 2011.
2. M. F. Beatty, "Principles of Engineering Mechanics", Springer Science & Business Media, 1986.
3. NPTEL LINK: https://nptel.ac.in/courses/112/105/112105164/

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
1	H	M	L		

2	M	H	L		
3	M	L	H		
4	M	L	L	H	
5	M	L			H

MNHT0041: HEAT TRANSFER

(4 credits-60 hours) (L-T-P: 3-1-0)

Objectives:

- To build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.
- Rigorous treatment of governing equations and solution procedures for the three modes will be provided, along with solutions of practical problems using empirical correlations.
- The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.

Course/Learning Outcomes

After completing the course successfully the students will be able to-

1. define heat conduction equation for different coordinate systems.
2. apply various empirical correlations of forced convection and free convection under different boundary conditions.
3. evaluate the parameters to design heat exchangers by using LMTD method and NTU method.
4. estimate the radiative heat transfer rate and the shape factors for different geometries.

Module I: Conduction (15 hours)

Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, Fins, Mathematical Equation of a Rectangular Fin of Uniform Cross section, Temperature and Heat Transfer Calculation of Fin with different boundary Conditions, Fin Efficiency and Fin Effectiveness.

Module II: Convection (15 hours)

a. Heat convection, Mechanism of Convection, Concept of Velocity Boundary Layer, Thermal Boundary Layer, Laminar and Turbulent Flow, Forced and Free Convection, Conservation of Mass Equation for the Boundary Layer, Conservation of Continuity Equation for the Boundary Layer, Conservation of Energy Equation for the Boundary Layer.
b. Forced Convection: Flat Plate in Parallel Flow, Exact Solution of Laminar Boundary Layer Over a Flat Plate, Integral Method: Laminar Forced Convection on a Flat Plate, Turbulent Boundary Layer Condition for Flow over an Isothermal Flat Plate, Methodology for Calculation of Convection Coefficient, Analogy Between Heat and Momentum Transfer. Internal Flow: Hydrodynamic Considerations, Thermal Considerations, Laminar Flow Heat Transfer in a Circular Pipe: Fully Developed Flow, Turbulent Flow Convection in Pipes: Empirical Correlations, Heat Transfer Considerations: Constant Wall Temperature and Constant Heat Flux.
c. Natural Convection: Analytical Solution of Laminar Free Convection over a Vertical Flat Plate, Integral Method for Natural Convection Heat Transfer on a Vertical Flat Plate, Correlation from Experimental Results.

Module III: Radiation (10 hours)

Prevost's theory, Absorptivity, Reflectivity and Transmissivity, Black Body, Emissive Power, Emissivity, Kirchhoff's Law, Spectral Energy Distribution of a Black Body, Radiation from Real Surfaces, Intensity of Radiation, Radiant Heat Exchange between Two Black Bodies Separated by a Non Absorbing Medium, Shape Factor, Electrical Analogy, Evaluation of Shape Factor, Radiation Heat Transfer Between Gray Bodies, Radiosity and Irradiation, Radiation Shields.

Module IV: Heat Exchanger, Phase Change and Mass Transfer (10 hours)

Types of heat exchangers, Compact, Shell and Tube and Plate Heat Exchangers, Overall Heat Transfer Coefficient, Fouling Factor, Use of LMTD, Cross Flow Heat Exchanger, Effectiveness-NTU Method, Heat Exchange Design Considerations. Condensation Heat Transfer, Dropwise Condensation, Laminar Film Condensation on a Vertical Plate, Boiling Heat Transfer, Regimes of Boiling, Nucleate Boiling, Correlations of Boiling Heat Transfer Data. Introduction to mass transfer, Diffusion Mass Transfer, Fick's law of Diffusion, Analogy between Momentum, Heat and Mass Transfer.

Suggested Readings

1. A. Bejan, Heat Transfer John Wiley, 1993.

2. J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, Sixth Edition, 2007.
4. Yunus A Cengel, Heat Transfer : A Practical Approach, McGraw Hill, 2002.
5. https://nptel.ac.in/courses/112/105/112105271/
6. https://nptel.ac.in/courses/112/105/112105271/
7. https://nptel.ac.in/courses/112/103/112103276/

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H		L	M
CO 2	L	H		M
CO 3	L	L		H
CO 4			H	L

MNDM0042: DESIGN OF MACHINE ELEMENTS

(4 credits-60 hours)(L-T-P: 3-1-0)

Objectives

To make students learn about various aspects of mechanical component design and understand the origin, nature and applicability of empirical design principles, based on safety considerations. Afterwards, students will have proper conceptualization of available design data and will be able to determine safe dimensions for machine elements under various loading conditions.

Course/Learning Outcomes

After completing the course successfully the students will be able to-

1. Define basic design concepts and procedures.
2. Apply the theories of failure in designing mechanical components.
3. Compute safety parameters by making use of design data hand book.
4. Classify different springs, shafts, bearings and gears and analyze their required design standards to withstand failure.

Module I: Design against Static Load (15 hours)

Overview and need of design, Design procedures, Limits, Fits and Tolerances, BIS standards. Design against Static Loading: Modes of failure, Factor of safety, Stress-strain, Design of cotter and knuckle joints, Theories of failure: Maximum normal-stress theory, Maximum shear-stress theory and Distortion-energy theory.

Module II: Design against Dynamic Load (15 hours)

Stress concentration, Modes of failure, Fluctuating stresses, Fatigue failure and S-N diagram, Notch sensitivity, Soderberg, Goodman and Gerber diagrams, modified Goodman diagrams, Fatigue design under combined stresses.

Module III: Design of shafts and springs (10 hours)

a. Shafts: Design of shaft subjected static and dynamic loading against failure due to bending, torsion and combined bending and torsion.
b. Springs: Design of helical tension and compression springs, leaf springs and helical torsion springs, surge in spring

Module IV: Design of bearings and gears (20 hours)

a. Bearings: Design of rolling contact bearings, Static and dynamic load carrying capacity, Load life relationship, Analysis and design of sliding contact bearings, Reynold's equation.
b. Gears: Design of spur gears, force analysis, beam strength and wear strength of spur gear tooth, design of helical gears, virtual teeth and tooth proportions, force analysis and effective load, design of bevel gears, design of worm gears, strength and wear rating of worm gears.

Suggested Readings

1. J.E. Shigley et al., Mechanical Engineering Design, Tata McGraw-Hill Publications
2. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan.
3. V. B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publications.
4. U. C. Jindal, Machine Design, Pearson Education.
5. K Mahadevan et. al., Design Data Handbook, CBS Publishers and Distributors Pvt. Ltd.
6. V. B. Bhandari, Machine Design: Data book, Tata McGraw Hill Publications.

7. https://nptel.ac.in/courses/112/105/112105124/

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H	H	M	M
CO2	H	H	M	M
CO3	L	M	M	M
CO4			H	H

MNMP0043: MANUFACTURING PROCESSES

(4 credits-60 hours)(L-T-P:3-1-0)

Objectives:

To motivate and challenge students to understand and develop an appreciation of the processes in correlation with material properties which change the shape, size and form of the raw materials into the desirable product by conventional or unconventional manufacturing methods.

COURSE/LEARNING OUTCOMES

After completing the course successfully the students will be able to-

1. Define various conventional and unconventional manufacturing methods.
2. Classify various manufacturing methods for its applications in industries.
3. Analyze the various causes of tool wear and examine the various ways of preventing it.
4. Select the appropriate manufacturing process to manufacture any components.

Module I (9 hours)

Casting and moulding: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses, Introduction to bulk and sheet metal forming, plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk forming (forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending) principles of powder metallurgy.

Module II (8 hours)

Metal cutting: Single and multi-point cutting; Orthogonal cutting, various force components:

Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, Cutting tool materials, Cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNC machining.

Module III (7 hours)

Additive manufacturing: Rapid prototyping and rapid tooling, Joining/fastening processes: Physics of welding, brazing and soldering; design considerations in welding, Solid and liquid state joining processes; Adhesive bonding.

Module IV (16 hours)

Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, principles and process parameters, Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, dielectric, power and control circuits, wire EDM; Electro-chemical machining (ECM), process parameters, MRR and surface finish, Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining

Suggested Readings

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Ed.),Pearson India, 2014
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems
3. Degarmo, Black and Kohser, Materials and Processes in Manufacturing
4. OP Khanna, Foundry technology, Dhanpat Rai
5. Manufacturing Processes by B.H. Amsteal, Philip F. Ostwald and Myron L. Begeman, John Wiley & Sons.
6. P.K. Mishra, Non-Conventional Machining, Narosa Publishing House.
7. A.B.Chattopadhyay, Machining and Machine Tools, Wiley India Pvt Ltd
8. https://nptel.ac.in/courses/112/107/112107258/
9. https://nptel.ac.in/courses/112/103/112103248/
10. https://nptel.ac.in/courses/112/105/112105233/

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M	M	H
CO 2	M	H	H	H
CO 3		H		
CO 4	H	M	M	H

MNKT0044: KINEMATICS & THEORY OF MACHINE

(4 credits-60 hours)(L-T-P:3-1-0)

Objectives:

- To deepen understanding of kinematic analysis as an essential element of the design and synthesize process of different mechanisms.
- To develop skills in analytical, graphical methods for understanding the kinematics and dynamics of different mechanisms.

Course/Learning Outcomes

After completing the course successfully the students will be able to-

1. Define various basic terms related to machine and mechanisms; examine the degree of freedom of a given mechanism; state law of gearing, law of belting; list different types of cam & follower classify various types of gears and gear trains; state the working of bearing, friction clutches and brakes.
2. Construct velocity and/or acceleration analysis diagrams of simple mechanisms.
3. Design suitable cam profile with roller/knife-edge/flat faced follower for simple applications.
4. Solve problems related to gear/gear train; and belting.

Module I (12 hours)

Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain and slider crank chains, Limit positions- Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms.

Module II (14 hours)

Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamics- Coincident points- Coriolis component of acceleration- introduction to linkage synthesis, three position graphical synthesis for motion and path generation.

Module III (14 hours)

Classification of cams and followers- Terminology and definitions- Displacement diagrams: Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, disc cam profile synthesis for roller and flat face followers.

Module IV (10 hours)

Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack and pinion gears, epicyclic and regular gear train kinematics.

Module V (10 hours)

Surface contacts- sliding and rolling friction- friction drives- bearings and lubrication, friction clutches- belt and rope drives- friction in brakes.

Suggested Readings

1. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers and Distributors, 2005.
2. CleghornW. L., Mechanisms of Machines, Oxford University Press, 2005.
3. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGrawHill, 2009.
4. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated EastWest Pvt. Ltd.
5. S. S. Rattan, Theory of Machines, McGrawHill.
6. V. P. Singh, Theory of Machines, Dhanpat Rai and Co.
7. https://nptel.ac.in/courses/112/105/112105268/
8. https://nptel.ac.in/courses/112/104/112104121/

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H		L	L	M
CO 2	L	H			
CO 3			H		
CO 4				H	H

MNMT0045: MANUFACTURING TECHNOLOGY

(4 credits-60 hours)(L-T-P: 4-0-0)

Objectives:

- To provide knowledge on machines and related tools for manufacturing various components
- To understand the relationship between process and system in the manufacturing domain.
- To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.

Course/Learning Outcomes

After completing the course successfully the students will be able to-

1. Illustrate various tool holding mechanisms, die design and press work operations.
2. Examine dimensional accuracy and tolerances of products to design solutions and to design system components
3. Illustrate various assembly practices.
4. Evaluate optimization methods in manufacturing

Module I (12 hours)

Tooling for conventional and non-conventional machining processes: Mould and die design, Press tools, Cutting tools; Holding tools: Jigs and fixtures, principles, applications and design; press tools – configuration, design of die and punch; principles of forging die design.

Module II (16 hours)

Metrology: Dimensions, forms and surface measurements, Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; Metrology in tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as micro-scale machining, inspection and workpiece quality

Module III (6 hours)

Assembly practices: Manufacturing and assembly, process planning, selective assembly, Material handling and devices.

Module IV (16 hours)

Linear programming, objective function and constraints, graphical method, Simplex and duplex algorithms, transportation assignment, Traveling Salesman problem; Network models: shortest route, minimal spanning tree, maximum flow model-Project networks: CPM and PERT, critical path scheduling; Production planning and control: Forecasting models, aggregate production planning, materials requirement planning. Inventory Models: Economic Order Quantity, quantity discount models, stochastic inventory models, practical inventory control models, JIT, Simple queuing theory models.

Suggested Readings

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)-Pearson India, 2014.
2. P.H. Joshi, Jigs and Fixtures, Tata McGraw Hill.
3. Taha H. A., Operations Research, 6th Edition, Prentice Hall of India, 2003.
4. Shenoy G.V. and Shrivastava U.K., Operations Research for Management, Wiley Eastern, 1994.
5. P. C. Sarma, A Textbook of Production Engineering, S Chand.
6. https://nptel.ac.in/courses/112/103/112103263/
7. https://nptel.ac.in/courses/112/104/112104250/

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H	M	L	
CO2	M	H	M	

CO3			H	
CO4				H

MNDD0046: MACHINE DESIGN AND DYNAMICS
(4 credits-60 hours)(L-T-P:3-1-0)

Objectives
This course seeks to provide an introduction to the design of machine elements and introduction to dynamics of machinery, students will learn various design aspects of components like screws, couplings, belt, chain, flywheel etc. and the applicability of available design data during designing. The course involves introduction to gyroscope and governor and aims at developing skills to understand the dynamics of the mechanisms.

COURSE/LEARNING OUTCOMES
After completing the course successfully the students will be able to-
1. Define the basic concepts related to design process.
2. Illustrate the idea of working and design of different types of brakes and clutches based on established theories.
3. Evaluate suitable dimensions for belt drive, chain drive and flywheel based on failure criterion.
4. Compute required balancing weight in machines in static and dynamic balancing cases.
5. Illustrate the use and working principles of governors and gyroscopes.

Module I (20 hours)
a. Power Screw: Analysis and applications of power screws, forms of threads, self-locking, efficiency of screw.
b. Threaded fasteners: ISO Metric screw threads, bolted joint analysis under eccentric load, torque required for bolt tightening.
c. Permanent Joints: Design of Riveted and welded joints and their strength.
d. Keys: Introduction to different types of keys, Force analysis.
e. Couplings: Analysis and design of rigid flange couplings.

Module II (10 hours)
a. Brakes: Analysis of Block, band and disc brakes.
b. Clutches: Classification, Analysis of friction clutches

Module III (15 hours)
a. Design of belt drive: geometrical relationships, analysis, condition for maximum power, V belts.
b. Design of chain drive: geometrical relationships, sprocket wheels, design of chain drive.
c. Design of Flywheels: Introduction, Turning moment diagram, solid disk flywheel, rimmed flywheel.

Module IV (8 hours)
a. Balancing of rotational mass: Static and dynamic balancing.
b. Balancing of reciprocating mass: Partial balancing, Different balancing approaches.

Module V (7 hours)
a. Governor: Introduction, types, principle, working and need.
b. Gyroscope: Introduction, principle and application.

Suggested Readings
1. J.E. Shigley et al., Mechanical Engineering Design, Tata McGraw-Hill Publications.
2. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan.
3. V. B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publications.
4. U. C. Jindal, Machine Design, Pearson Education.
5. K Mahadevan et. al., Design Data Handbook, CBS Publishers and Distributors Pvt. Ltd.
6. V. B. Bhandari, Machine Design: Data book, Tata McGraw Hill Publications

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO1	H	L	H		
CO2	M	H			
CO3			H		

CO4				H	
CO5					H

MNHM0047: HYDRAULICS MACHINES

(3 credits-45 hours) (L-T-P: 3-0-0)

Objective

The course familiarizes students with basic facts relating to working principles of hydraulic machines and equipment used in all industrial fields. It deals with pumps, hydraulic turbines and fluid mechanisms such as hydraulic elements, hydraulic transmissions and couplings.

Course/Learning Outcomes

At the end of the course students will be able to:

1. CO1: Define governing principle of impulse momentum, various hydraulic turbines and pumps. (Remembering)
2. CO2: Classify and identify the various types of pumps and turbines, their performance characteristics, blade triangles and various efficiency studies. (Understanding)
3. CO3: Solve various numerical problems based on the application of impulse momentum theory in impact of jet problems and performance characteristics of turbines and pumps based on velocity triangle approach. (Applying)
4. CO4: Analyze various results to estimate the performance of turbines and pumps. (Analyzing)

Module I (8 hours)

Force exerted on stationary flat plate held normal to jet and inclined to jet, force exerted on curved plate, force exerted on moving flat plate normal to jet and moving inclined to the direction of the jet, jet propulsion of jet.

Module II (12 hours)

Definition of fluid machine and energy transfer machines, Review of classification of hydraulic turbines, Impulse and reaction turbines, work done and efficiency of Pelton wheel, Francis turbine, propeller turbine and Kaplan turbine, theory of draft tube , Concept of specific speed, unit quantities of hydraulics turbine, performance characteristics of hydraulic turbines, cavitation in the turbine, governing of turbines.

Module III (10 hours)

Introduction to Rotodynamic pump, Review of classification of centrifugal pumps, working principles and head of centrifugal pumps, losses and efficiencies of centrifugal pumps, effect of variation of discharge on efficiency, multi stage centrifugal pumps, Concept of specific speed, characteristics performance of centrifugal pumps, Net Positive Suction Head, cavitation and priming of centrifugal pumps.

Module IV (10 hours)

Introduction to positive displacement pump, Review of classification of reciprocating pumps, working principles of reciprocating pumps, discharge, work done, power for reciprocating pumps, single acting and double acting reciprocating pumps, slip of reciprocating pump, effect of acceleration of piston on velocity and pressure in the suction and delivery pipes, indicator diagram and their effect on acceleration and friction of suction and delivery pipes , air vessels and its effect on work done for reciprocating pump

Module V (5 hours)

Working principle of hydraulic accumulator, hydraulic intensifier, hydraulic press, hydraulic crane, hydraulic lift, hydraulic ram, hydraulic coupling, hydraulic torque converter, jet pump, submergible pump, gear pump.

Suggested Readings

1. R.K. Rajput, Text book on hydraulic machines, S. Chand.
2. Dr.R.K. Bansal, Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi publication.
3. P.N Modi and S.M Seth, Hydraulics and Fluid Mechanics, Standard Book House.
4. Jagadish Lal, Fluid machines Including Fluid mechanics, Metropolitan Book Co.
5. Sadhu Singh, Fluid Machinery, Khanna Publishing House, Delhi
6. NPTEL course: Fluid Machine By Prof. S.K. Som, https://nptel.ac.in/courses/112/105/112105206/
7. NPTEL course: Principle of Hydraulics Machine and System Design By Prof. Pranab K. Mondal, https://nptel.ac.in/courses/112/103/112103249/

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO1	M	H	H	H	L
CO2		H	H	H	L
CO3	L	M	H	M	M
CO4		H	M	M	

MNMP0048: ADVANCED MANUFACTURING PROCESSES

(3 credits-45 hours)(L-T-P:3-0-0)

Objective:

- To make the learner familiar with various advanced manufacturing processes; their need and capabilities.
- To make them aware about the modern trends in the field of manufacturing.

Module I (3 hours)

Introduction to Modern Manufacturing Methods, their needs in today's manufacturing scenario, identification and characteristics of these processes, conventional versus modern manufacturing methods.

Module II (8 hours)

Abrasive jet machining, Water jet machining, Abrasive water jet machining, Abrasive flow machining, Ultrasonic machining, Ultrasonic welding, their working principles, equipments, process capabilities, applications, advantages and limitations.

Module III (8 hours)

Chemical machining, Photo chemical machining, Electrochemical machining, drilling, grinding, deburring, their working principles, equipments, process capabilities, applications, advantages and limitations.

Module IV (8 hours)

Electrodischarge machining (EDM), Electrodischarge wire cutting or wire EDM, Electrodischarge grinding, Electrochemical discharge grinding, their working principles, equipment, process capabilities, applications, advantages and limitations. Electron Beam Machining, Electron Beam welding, Plasma arc cutting, Ion beam machining.

Module V (8 hours)

Process principle, type of laser, equipment, and laser processes: drilling, cutting, machining, welding, heat treating, cladding; applications, advantages and limitations.

Module VI (5 hours)

Micromanufacturing, manufacturing processes lead towards micro-manufacturing, micro electro mechanical systems (MEMS), LIGA, Rapid prototyping, 3D printing, concept of nanotechnology and nano-processing techniques.

Course/Learning Outcomes

After completing the course successfully the students will be able to-

1. Define and characterise advanced manufacturing and machining processes, their evolution and usefulness of them & compare with conventional manufacturing. Acquire fundamental knowledge about some emerging trends like rapid prototyping, 3D printing, micro-manufacturing etc.
2. Know the working and process capabilities of Mechanical processes like Abrasive jet machining, Water jet machining, Abrasive water jet machining, Abrasive flow machining, Ultrasonic machining etc.
3. Know the working and process capabilities of Chemical and Electrochemical Processes like chemical machining, Photo chemical machining, Electro-chemical machining etc.
4. Know the working and process capabilities of Electro-thermal Processes like

Suggested Readings

1. V.K. Jain, Advanced Machining processes, Allied publishing pvt. Ltd.
2. G. F. Benedict, Nontraditional manufacturing processes, Marcel Dekker Inc.
3. J.A McGeogh, Advanced Methods of Machining, Chapman and Hall.
4. PK. Mishra, Nonconventional Machining, Narosa Publishing House.
5. G.Boothroyd and W.A. Knight, Fundamentals of Machining and Machine Tools, CRC Press T&F Group.
6. NPTEL LINK: https://nptel.ac.in/courses/112/103/112103202/
7. NPTEL LINK: https://nptel.ac.in/courses/112/104/112104028/

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				H
CO 2		H			
CO 3			H		
CO 4				H	M

MNCM0049: COMPOSITE MATERIALS

(3 credits-45 hours) (L-T-P:3-0-0)

Objectives:

- To understand the mechanical behavior of composite materials.
- To get an overview of the methods of manufacturing composite materials

Course/Learning Outcomes

After completing the course successfully the students will be able to-

1. CO1: Define composite materials and their properties.
2. CO2: Classify various types of composite materials based on various attributes.
3. CO3: have a pure contrast of the mechanical behaviour and application of composite materials.
4. CO4: Interpret the failure behavior in different composites

Module1 (12 hours)

Definition and applications of composite materials, Fibers- glass, carbon, ceramic and aramid fibers; Matrices- polymer, graphite, ceramic and metal matrices; characteristics of fibers and matrices. Lamina- assumptions, macroscopic viewpoint, generalized Hooke;s law, reduction of homogeneous orthotropic lamina, isotropic limit case, orthotropic stiffness matrix, commercial material properties, rule of mixtures, transformation matrix, transformed stiffness.

Module II (16 hours)

Manufacturing of composite materials, bag moulding, compression moulding, pultrusion, filament welding, other manufacturing processes. Basic assumptions of laminated anisotropic plates, symmetric laminates, angle ply laminates, cross ply laminates, laminate structural moduli, evaluation of lamina properties, determination of lamina stresses, maximum stress and strain criteria, von Mises Yield criterion for isotropic materials, generalized Hill's criterion for anisotropic materials, Tsai-Hill's criterion for composites, prediction of laminate failure, thermal analysis of composite laminates.

Module III (12 hours)

Analysis of laminated plates- equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies.

Suggested Readings

1. Gibson R.F. Principles of Composite Material Mechanics, second edition, McGraw Hill, 1994.
2. Hyer M.W., Stress Analysis of Fiber- Reinforced Composite Materials, McGraw Hill, 1998.
3. https://nptel.ac.in/courses/112/104/112104229/
4. https://nptel.ac.in/courses/112/104/112104168/

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H	M	
CO 2	M	H	
CO 3		H	M
CO 4			H

MNIC0050: INTERNAL COMBUSTION ENGINES

(3 credits-45 hours) (L-T-P:3-0-0)

Objectives:

- To familiarize with the terminology associated with IC engines.
- To understand the basics of IC engines.

- To understand combustion, and various parameters and variables affecting it in various types of IC engines.
- To learn about various systems used in IC engines and the type of IC engine required for various applications.

Course/Learning Outcomes

After completing the course the students will be able to

1. C01: define the relevant performance parameters of an engine.
2. C02: compare the difference between combustion in SI and CI engines.
3. CO3: illustrate the effect of exhaust emissions on the environment.
4. CO4: elaborate the working of the lubrication system of the IC engine.

Module I (10 hours)

Review of Petrol and Diesel engines, Revision of Air standard cycle-assumptions, Otto cycle, Diesel cycle and dual cycle. Fuel-air cycle, effect of variation of specific heats, fuel-air ratio, compression ratio and dissociation, actual cycle, losses in actual cycle.

Module II (10 hours)

a. Elementary carburetor, complete carburetor, air fuel ratio, stoichiometric ratio, Spark plug,Magneto and battery ignition system, fuel pump, drawbacks of carburettor and introduction of multipoint fuel injection.
b. Diesel injection system, fuel pump, injectors and nozzles.
c. Firing order, Ignition timing, and valve timing diagram.

Module III (10 hours)

a. Combustion in S.I and C.I engines, Parameters influencing combustion, Detonation and knocking in S.I. and C.I. engines and their prevention, Combustion chamber types, Basic principles of combustion chamber in I.C.engines,
b. Supercharging, Thermodynamic cycle with supercharging, Supercharging power, Supercharging of I.C. engines, Effect of supercharging on performance of the engine, Turbocharging.

Module IV (10 hours)

a. Lubrication of I.C. engines, properties of lubricating oils, lubricating systems,
b. Cooling of I.C engines, air and water cooling systems.
c. Classification and desirable characteristics of I.C. engine fuels, Rating of S.I. and C.I. engine fuels: Octane number (RON and MON), Cetane number, CFR engine, Alternative fuels (liquid, gaseous etc).
d. Greenhouse Gases and Exhaust emissions from I.C. engines (Pollutants: CO, HC, NO_X and PM)
e. Environmental effects of I.C. Engine exhaust pollutants, Introduction to Catalytic converters and other technological changes in IC engines for control.

Suggested Readings

1. Heywood J. B, “Internal Combustion Engine Fundamentals”, McGraw Hill Book Co. NY, 1989.
2. Mathur M.L., “Internal Combustion Engine”, Dhanpat Rai Company Ltd.
3. Ganesan V., “Internal Combustion Engine”, Tata McGraw Hill.
4. https://nptel.ac.in/courses/112/104/112104033/ Engine combustion
5. https://nptel.ac.in/courses/101/104/101104070/ Fundamentals of Combustion (Part1) https://nptel.ac.in/courses/101/104/101104072/ Fundamentals of Combustion (Part2) https://nptel.ac.in/courses/103/105/103105110/ (Fuels & Combustion Technology) [PDF Notes]

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M	M	M
CO 2		L	H	M
CO 3			M	H
CO 4				H

MNAM0051: AUTOMATION IN MANUFACTURING

(L-T-P: 3-0-0)

Objectives:

- To understand the importance of automation in the field of machine tool based manufacturing.

- To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC.
- To understand the basics of product design and the role of manufacturing automation.

Course Outcomes:
After completing the course successfully, the students will be able to-
1. Define and recall automation in manufacturing, modeling and product design.
2. Classify different automation assisting technological aids in different manufacturing processes.
3. Apply the knowledge of computer based automation of manufacturing operations.

Module I
Introduction: Why automation, Current trends, CAD, CAM, CIM; Rigid automation: Part handling, Machine tools. Flexible automation: Computer control of Machine Tools and Machining Centers, NC and NC part programming, CNC-Adaptive Control, Automated Material handling. Assembly, Flexible fixturing.

Module II
Computer Aided Design: Fundamentals of CAD - Hardware in CAD-Computer Graphics Software and Data Base, Geometric modeling for downstream applications and analysis methods; Computer Aided Manufacturing: CNC technology, PLC, Micro-controllers, CNC Adaptive Control

Module III
Low cost automation: Mechanical and Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies

Module IV
Introduction to Modeling and Simulation: Product design, process route modeling, Optimization techniques, Case studies and industrial applications.

Suggested Readings

1. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall.
2. Serope Kalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7^{th} edition, Pearson.
3. YoramKoren, Computer control of manufacturing system, 1st edition
4. Ibrahim Zeid , CAD/CAM : Theory and Practice, 2nd edition.
5. https://nptel.ac.in/courses/112/103/112103174/ Mechatronics And Manufacturing Automation

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	M	M	L	M
CO2	L	H	M	L
CO3	M	M	L	H

MNRC0052: REFRIGERATION AND AIR-CONDITIONING
(L-T-P: 3-0-0)

Objectives
- To familiarize with the terminology associated with refrigeration systems and air conditioning.
- To understand basic refrigeration processes.
- To understand the basics of psychrometry and practice of applied psychrometrics.
- To acquire the skills required to model, analyse and design different refrigeration as well as air conditioning processes and components.

Course Outcomes:
After completing the course successfully the students will be able to-
1. define the different types of aircraft refrigeration systems.
2. explain the working principle of vapour compression and vapour absorption systems.
3. examine the effect of operating parameters on the performance of a vapour compression system.
4. estimate cooling load, sensible heat and latent heat in air conditioning systems.

Module I (10 hours)
Concept of throttling, Joule-thomson effect, Concepts of Refrigeration and Air-conditioning. Difference between engine, refrigerator and heat pump. COP, power consumption of a refrigerating machine, Heat pump v/s electric resistance heater.

Module II (12 hours)
a. Simple cycles – Carnot and Bell-Coleman; Air-craft refrigerating system – simple, boot-strap, regeneration, reduced ambient; Actual cycles, DART.
b. Analysis of simple cycles, representation of T-s, p-h charts; methods of improving COP;
c. Deviations of actual cycles from theoretical cycles. Compound compression with liquid flash cooler, flash inter-cooler multiple systems – COP, power required.

Module III (8 hours)
a. Vapour Absorption Refrigeration System (VARS): Advantages of VARS over VCRS. Working principle of simple VARS, practical VARS. Limitations of VARS, maximum COP of a VARS, Lithium bromide-water System; Aqua-ammonia systems.
b. Nomenclature, classification, desirable properties. Important refrigerants and their comparisons, selection of refrigerants.

Module IV (10 hours)
Basic definitions and principles related to Psychometric; Psychometric Charts and Their Uses; adiabatic saturation and enthalpy deviation. Adiabatic mixing of air stream. Constant sensible heat and latent heat processes, Total heat process, sensible heat factors, grand sensible heat ratio lines, apparatus dew points, Bypass factors, Air washer-humidifying efficiency, Summer Air-conditioning, Winter Air-conditioning.

Suggested Readings

1. Stoecker, W.F. and Jones, J.W., Refrigeration and Air conditioning, Tata McGraw Hill, 1986.
2. Arora, C.P., Refrigeration and Air conditioning, Tata McGraw Hill, 2nd Edition, 2000.
3. Prasad, M, "Refrigeration and Air Conditioning", New Age International Publishers.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	L	H		
CO2	L	H	H	M
CO3		H	L	
CO4			L	H

MNSE0053: NON-CONVENTIONAL ENERGY SYSTEMS
(L-T-P: 3-0-0)

Objective
To convey the knowledge of basics of different non-conventional energy systems in detail so that it helps them in understanding the need and role of Non-Conventional Energy sources particularly when the conventional sources are meager in nature.

Course outcomes: After completing the course successfully the students will be able to-
- Compare the various fossil fuel sources with respect to their impact on the environment.
- Analyze harnessing of solar energy.
- Analyze harnessing of microhydel and wind energy
- Analyze harnessing of Biomass and wave energy
- To study and compare energy storage systems.

Module I (5 hours)
a. Fossil fuel based systems: Impact of fossil fuel based systems. Non-conventional energy – Seasonal variations and availability. Renewable energy – sources and features. Hybrid energy systems Distributed energy systems and dispersed generation (DG)
b. Traditional Energy Systems: Sources. Features and characteristics. Applications: Transport – bullock cart, horse carriage, camels; Agriculture – ox plough, water lifting devices; Human power – bicycle, cycle rickshaw etc.; House hold – cooking (bio mass), lighting etc.

Module II (11 hours)

a. Solar Thermal Systems: Solar radiation spectrum. Radiation measurement. Technologies. Applications: Heating, Cooling, Drying, Distillation, Power generation
b. Solar Photovoltaic System: Operating principles. Photovoltaic cell concepts. Cell, module, array. Series and parallel connections. Maximum power point tracking. Applications: Battery charging, Pumping, Lighting, and Peltier cooling.

Module III (7 hours)
a. Microhydel: Operating principles. Components of a microhydel power plant. Types and characteristics of turbines. Selection and modification. Load balancing.
b. Wind: Wind patterns and wind data. Site selection. Types of windmills. Characteristics of wind generators. Load matching.

Module IV (6 hours)
a. Biomass: Operating principles. Combustion and fermentation. Anaerobic digester. Wood gassifier. Pyrolysis. Applications: Biogas, Wood stoves, Bio diesel, Combustion engine.
b. Wave Energy Systems: Shoreline systems. Near shore systems. Off shore systems.

Module V (7 hours)
a. Costing: Life cycle costing (LCC). Solar thermal system LCC. Solar PV system LCC. Microhydel LCC. Wind system LCC. Biomass system LCC
b. Hybrid Systems: Need for Hybrid Systems. Range and type of Hybrid systems. Case studies of Diesel-PV, Wind-PV, Microhydel-PV, Biomass-Diesel systems, electric and hybrid electric vehicles

Suggested Readings:
1. Rai.G.D, “Non-Conventional Energy Sources”, Khanna Publishers, 4th edition, New Delhi, 2009.
2. Roland Wengenmayr, Thomas Buhrke,” Renewable energy: Sustainable energy concepts for the future”, Wiley-VCH, 1st edition, 2008.
3. B H Khan, “Non-Conventional Energy Resources”, 2nd Edition, Tata Mc Graw Hill Education Pvt Ltd, 2011
4. S. Hasan Saeed and D. K. Sharma, “Non-Conventional Energy Resources”, 3rd Edition, S. K. Kataria and Sons, 2012
5. G.N. Tiwari and M.K.Ghosal, “Renewable Energy Resource: Basic Principles And Applications”, Narosa Publishing House, 2004 Godfrey Boyle, “Renewable energy”, Oxford University Press, 2nd edition, 2010
6. Hans-Josef Fell, “Global cooling strategies for climate protection”, CRC Press, 2012.
7. Ottmar Edenhofen, “Renewable energy sources and climate change mitigation”, Cambridge University Press, 2011.
8. B.K. Hodge, “Alternative energy systems and applications”, John Wiley and Sons, 2009.
9. Mark Diesendorf, “Greenhouse solutions with sustainable energy”, University of New South Wales Press, 2007.
10. https://nptel.ac.in/courses/108/108/108108078/
11. https://nptel.ac.in/courses/121/106/121106014/

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H			
CO 3			H		
CO 4				H	
CO 5	L	L	M	M	H

MNSN0054: SOLID MECHANICS
(L-T-P: 3:0:0)

Objective
The objective is to present the mathematical and physical principles in understanding the linear continuum behavior of solids.

Module I (10 hours)
Introduction to Cartesian tensors, Strains: Concept of strain, derivation of small strain tensor and compatibility, Stress: Derivation of Cauchy relations and equilibrium and symmetry equations, principal stresses and directions.

Module II (11 hours)
Constitutive equations: Generalized Hooke’s law, Linear elasticity, Material symmetry; Boundary Value Problems: concepts of uniqueness and superposition.

Module III (15 hours)
Plane stress and plane strain problems, introduction to governing equations in cylindrical and spherical coordinates, axisymmetric problems. Application to thick cylinders, rotating discs, torsion of non-circular cross-sections, stress concentration problems, thermo-elasticity, 2-d contact problems. Solutions using potentials, Energy methods. Introduction to plasticity.

Suggested Readings:

1. G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, Third Edition, CRC Press, 2004.
2. Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International, 1965.
3. Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hall international, 1969.
4. S.M.A. Kazimi, Solid mechanics, MGH
5. https://nptel.ac.in/courses/112/102/112102284/

Course Outcomes:
After completing the course successfully the students will be able to-
1. Know the basics including various laws related to solid mechanics and concept of stress and strain
2. Demonstrate the deformation behaviour of solids under different types of loading, use of Hooke's law and solve boundary value problems
3. Solve and obtain mathematical solutions for simple geometries under loading, plane stress & strain problems and use of potential & energy methods

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H	M	
CO 2		H	
CO 3			H

MNER0055: ENERGY CONSERVATION AND WASTE HEAT RECOVERY
(L-T-P: 3-0-0)

Objectives
To provide the understanding on basic principles and available technologies for energy conservation as well as waste heat recovery. To provide a comprehensive understanding on industrial waste heat recovery systems and how to use those waste heat for batter engineering purpose.

Module I (10 hours)
Introduction to energy conservation and Importance of Waste Heat Recovery, Review of Thermodynamics, Introduction to First and Second Laws Entropy Generation, Rankine Cycle, modification of Rankine cycle, Lenior cycle, Atkinson cycle, Brayton cycle, Gas Turbine Cycle, Combined Cycle, Combined Gas Turbine-Steam Turbine Power Plant, Thermodynamic cycles for low temperature application. Heat Recovery Steam Generators**.**

Module II (8 hours)
Configuration and thermodynamic performance – steam turbine cogeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – combined cycle cogeneration system.

Module III (10 hours)
Utilization of industrial waste heat; Properties of exhaust gas; Gas-to- gas, gas-to-liquid heat recovery systems, Recuperators and regenerators , Shell and tube heat exchangers, Spiral tube and plate heat exchangers. Special Heat Exchangers for Waste Heat Recovery.

Module IV (10 hours)
Waste heat boilers: various types and design aspects. Heat pipes: theory and applications in waste heat recovery. Prime movers: sources and uses of waste heat; Fluidized bed heat recovery systems; Utilization of waste heat in refrigeration, heating, ventilation and air conditioning systems; Thermoelectric system to recover waste heat; Heat pump for energy recovery; Heat recovery from incineration plants.

Module V (7 hours)
Energy storage technique: Thermal, electrical, magnetic and chemical storage systems. Investment cost – economic concepts – measures of economic performance – procedure for economic analysis.

Course Outcomes:

At the end of the course students will be able to:

1. Define energy conservation and waste heat recovery system. (Remembering)
2. Compare the performance of various waste recovery systems. (Understanding)
3. Categorize various waste recovery systems and sources. (Applying)

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO1	H	M	M	L	L
CO2	L	H	L	L	H
CO3	L	M	H	H	L

MNAE0056: AUTOMOBILE ENGINEERING

(L-T-P: 3-0-0)

Objective

This course is an introduction to the description and working of various mechanical parts of an automotive vehicle. After learning the course students will be able to understand the usage of mechanical components and their assembly. As there is a growing demand for design and development of modern environment friendly vehicles, this course serves as an introduction to enable students to develop better technologies.

Course Outcome:

1. Relate different aspects of mechanical design to automobile engineering. (Remembering)
2. Classify various assemblies of an automobile. (Understanding)
3. Apply the knowledge of cooling, lubrication system, exhaust system and emission control system in automobiles. (Applying)
4. Examine the performance of transmission, suspension, steering and braking systems. (Analysing)

Module I (9 hours)

a. History and development of Automobiles, classification, layout of various components in an automobile, design considerations and materials.
b. Various parts: chassis, frame and body, aerodynamic considerations,
c. Various types of engines: Identification of petrol, diesel, gas and hybrid engines, Inline, Radial and V engines, Overhead Camshaft (OHC) engine, CRDI engine, Introduction to Single point injection or Throttle Body injection (TBI) engine and Multi point Injection (MPI) engine.
d. Tyres (with tube and tubeless, radial) and spark plugs (heat range, hot and cold).

Module II (9 hours)

a. Clutch: types and working.
b. Gearbox: classification, sliding mesh, constant mesh and synchro-mesh gear boxes, Gear shifting mechanism.
c. Manual transmission, Automatic transmission: torque converters, epicyclic gear train, freewheeling mechanism, propeller shaft and universal joint. Final drive: rear axle, mounting methods, differential mechanism.

Module III (9 hours)

a. History, functions and requirements, elements of a suspension system, loads and characteristics.
b. Springs: leaf, coil and torsion bar, air springs.
c. Shock absorbers: dampers. Different types of suspension systems. Wheels and tyres.

Module IV (14 hours)

a. Steering mechanism: function and requirements, layout of steering system, front axle and stub axles, steering linkages, cornering force and self righting torque, power steering.
b. Braking mechanism: function and requirements, classification, mechanical and hydraulic brakes, air brake, brake efficiency. Antilock braking systems (ABS).
c. Four wheel drive mechanism, variable valve timing (VVT) technology,
d. Cooling and Lubrication systems, SAE grades for lubricant oils used.
e. Exhaust system and Emission control system.
f. Vehicle safety systems.

Module V

a. Electric and hybrid vehicles
b. Fuel cell operated vehicles

Suggested Readings

1. P. S. Gill, Automobile Engineering I and II, S. K. Kataria and sons.
2. D. S. Kumar, Automobile Engineering, S. K. Kataria and sons.
3. K. K. Jain, R. B. Asthana, Automobile Engineering, Tata McGraw Hill publishing co. Ltd.
4. R K. Rajput, A Textbook of Automobile Engineering, Laxmi Publications (P) Ltd.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO1		M	M	M	
CO2	H				L
CO3				H	
CO4		H	H	H	L

MNPE0057: POWER PLANT ENGINEERING

(L-T-P: 3-0-0)

Objective

This course will enable students to study the preliminary design of the major systems of conventional fossil-fuel steam-cycle, nuclear, gas turbine, combined cycle, hydro, wind, geothermal, solar, and alternate power plants. It will also make the students aware regarding the economic, environmental, and regulatory issues related to power generation.

Module I (5 hours)

Introduction to different power plants, Load duration curves, Location of power Plants, Power plant economics and Indian energy scenario.

Module II (15 hours)

Introduction to Rankine cycle, Typical layout of steam power plant, Efficiencies in steam power plant, Cogeneration of power and process heat, Combined cycle power generation, Different types of fuel and their properties, coal handling, ash handling of steam generation, Draught system, Natural Draught, Mechanical Draught. Pollution control technologies for coal.

Module III (10 hours)

a. Introduction, Classification of different gas turbine power plants, Analysis of closed cycle and open cycle constant pressure gas turbine plant, Reheat, Intercooling and regeneration cycle, components of gas turbine plants, combined cycle power plants, gas turbine fuels and gas turbine materials.
b. Introduction, Application of diesel engines in power field, Advantages and disadvantages of diesel engine power plant, General layout, Performance characteristics, Supercharging.

Module IV (10 hours)

a. Introduction, Classification of hydro-electric power plant, Site selection, Elements of hydro-electric power plant, Advantages of hydro-electric power plant, Classification of hydraulic turbines and its selection, Hydrographs, Flow duration curves.
b. Introduction to nuclear engineering, Types of nuclear reactors, Pressurized water reactor, Boiling water reactor, CANDU reactor, Gas-cooled reactor, Liquid metal fast breeder reactor, India's nuclear power programme. Waste disposal for nuclear materials.

Module V (5 hours)

Prospect of renewable energy source, Types of non-conventional power plants, solar plants, Wind power plants, Bio-mass plants, Geo-thermal power plant, Tidal power plant.

Course Outcomes

At the end of the course students will be able to:

a. CO1: Recall the basic of power plant engineering terminologies and economics of power plant.. (Remembering)
b. CO2: Classify conventional and Non-conventional power plants along with various equipment of power plant engineering. (Understanding)

c. CO3: Explain the design parameters of conventional and non-conventional power plant. (Understanding)
d. CO4: Identify and solve power plant engineering problems. (Applying)

Suggested Readings

1. P. K. Nag, Power Plant Engineering, Tata McGraw-Hill.
2. S.C. Arora and S. Domkundwar, A course in Power Plant Engineering, Dhanpat Rai and Co.
3. R.K.Rajput, Power Plant Engineering, Laxmi Publishers.
4. Black and Veatch, Power plant Engineering, McGraw-Hill.
5. S. Domkundwar, Solar energy and Non –conventional energy.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO1	H	M	M	M	H
CO2		H	H	H	M
CO3		M	H	L	
CO4	M	H	L	H	

MNQM0058: TOTAL QUALITY MANAGEMENT

(L-T-P: 3-0-0)

Objectives

This Course is introduced with the objective of analyzing the relevance of total quality management system in the engineering profession in the light of its increased involvement in company practices.

Course Outcomes

At the end of the course students will be able to:

1. Define quality and its various dimensions. (Remembering)
2. Interpret various principles of TQM. (Understanding)
3. Apply the tools of quality control in various engineering application. (Applying)

Module I (8 hours)

Introduction, need for quality, evolution of quality; Definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation and satisfaction, customer complaints, customer retention; costs to quality.

Module II (11 hours)

TQM principles; leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating and selection.

Module III (18 hours)

The seven traditional tools of quality; New management tools; Six sigma- concepts, methodology, applications to manufacturing, service sector including IT, Bench marking process; FMEA- stages, types. TQM tools and techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM-concepts, improvement needs, performance measures.

Module IV (8 hours)

Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation, Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and service sectors.

Suggested Readings

1. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India
2. Besterfield D.H. et al., Total Quality Management, Pearson Education Asia
3. Arora, K.C., Total Quality Management, Kaston Books.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H	M	M	M

CO2		H	M	H
CO3	L	M	H	H

MNCA0059: COMPUTER AIDED DESIGN AND MANUFACTURING

(L-T-P: 3-0-0)

Objective

To provide the learner with involving fundamental concepts and state-of-the-art techniques in the field of CAD/CAM. To equip students, with knowledge and skill to undertakes, design, analysis, evaluation of system, processes and components.

Course Outcomes

After completing the course successfully the students will be able to-

1. Name various hardware, software components and system requirements for implementing CAD/CAM; Illustrate the product design and manufacturing process ; state the different laws governing robotics & understand the use of robotics and automation in different environment; summarize the concepts of group technology, FMS and their applications
2. Solve transformation operation related problems to manipulate an object under consideration as per the need of the design/manufacturing process
3. Understand and compare various types of geometric modelling techniques, know different geometric primitives, curves, surfaces, product data exchange in CAD
4. Synthesize a CNC manual or computer assisted part program to use it for machining of different parts by various manufacturing operations.

Module I (7 hours)

Introduction to CAD/CAM, need, advantages, Fundamentals of design process, stages in design process and product development cycle, Computers in design applications, role of computers in industrial manufacturing, components of CAD/CAM/CAE systems, system software and application software, CAD database and structure, coordinate systems in CAD, Typical Product Life Cycle

Module II (10 hours)

Intro to Rigid body transformation, affine transformation and general transformations; Basic transformations: Translation, Rotation, Scaling, Reflection and Shear; Introduction to Homogeneous coordinate representation: 2D and 3D; Concatenated transformation.

Module III (10 hours)

a. 3D wire frame modeling, wire frame entities- definitions interpolation and approximation curves, concept of parametric and nonparametric representation of curves, curve fitting techniques, definitions of cubic spline and Bezier, B-spline.
b. Surface modeling: Algebraic and geometric form, parametric space of surface, blending functions, Reparametrization of a surface patch, subdividing, cylindrical surface, ruled surface, surface of revolution, spherical surface, Composite surface, Bezier surface, B-spline surface.
c. Solid modeling: Definition of cell composition and spatial occupancy enumeration, sweep representation, constructive solid geometry, boundary representations.
d. Product data exchange: Need, advantage, IGES, STEP

Module IV: NC Part Programming and Robotics (9 hours)

a. Introduction to NC, CNC, DNC; NC coordinate system; Introduction to NC part programming: manual part programming, computer assisted part programming (APT language), advantages and limitations of programming methods.
b. Introduction to Robotics: Robot definition, origin and characteristics; History of robotics; Asimov's laws of robotics, types of robots, specifications and applications, advantages and limitations, Introduction to robot anatomy.

Module V: Group Technology and Flexible Manufacturing System (4 hours)

Group technology and flexible manufacturing system: Part families, parts classification and coding, production flow analysis, machine cell design, FMS workstations, Material handling and storage system, Application of Group technology and FMS.

Suggested Readings

1. MickelP.Groover, "Automation, production systems and computer Integrated manufacturing", 3rd edition, PHI, 2009.
2. Ibrahim Zeid., "CAD/CAM Theory and practice" Tata Mcgraw Hill education private limited, 2009
3. David D Bedworth, "Computer Integrated design and Manufacturing," McGraw Hill International 1991
4. P. N. Rao, "CAD/CAM Principles and Applications," 3rd edition, Tata McGraw Hill, 2010

5. Dr. K. C.Jain, Sanjay Jain, "Principles of Automation and Advanced Manufacturing Systems," 1 st Edition, Khanna Publishers.
6. K. Lalit Narayan, K. Mallikajurna Rao, M.M.Sarcar "Computer aided design and manufacturing." PHI.
7. https://nptel.ac.in/courses/112/102/112102102/
8. https://nptel.ac.in/courses/112/102/112102103/

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H			M	H
CO 2		H			
CO 3			H		
CO 4				H	

MNSG0060: SURFACE ENGINEERING

(L-T-P: 3-0-0)

Objective

The course is designed to have systematic and comprehensive understanding on various aspects related with surface engineering of metallic components for enhanced tribological life.

Course outcomes:

After completing the course successfully the students will be able to-

1. Define and the different types of surface engineering, and wear mechanism. .
2. Classify and compare the surface engineering methodologies.
3. Analyze the processes for controlling wear.
4. Identify the suitable surface engineering technique as per the requirement.
5. Find methods to improve the surface characteristics.

Module I (9 hours)

Purpose and need of surface engineering, Surface sub-surface regions, Classification of surface modification techniques, Scope of surface engineering, Role of surface properties on friction and wear

Module II (10 hours)

a. Advantages and limitations of surface engineering, Materials properties and its effect on performance of components, Fundamentals of wear mechanism: Adhesive wear, Fundamentals of wear mechanism: Abrasive wear, Fundamentals of wear mechanism: Surface fatigue wear.
b. Fundamentals of wear mechanism: Corrosion wear, Fundamentals of wear mechanism: Cavitation wear, Fundamentals of wear mechanism: Erosion wear and Fretting wear, Fundamentals of wear mechanism: Diffusive wear and Seizure, Evaluation of damage on wear surfaces

Module III (9 hours)

Material properties for controlling wear: Material properties for specific type of wear, Structure and wear relationship for materials of commercial importance, New coating system: Functionally Graded Thermal Barrier Coatings (FGM), Thermal Barrier Coatings (TBCs), Guidelines for selection of materials for engineering the surface.

Module IV (11 hours)

b. Fundamental approaches of structural modification, Candidate materials for structural modification, Processes: Localised plastic deformation Processes: Localised plastic deformation, Shot peening, Burnishing
c. Transformation hardening, Laser Hardening Processes, Induction hardening. Advantages, limitations and application, Fundamental approach of changing chemical composition, Candidate material for controlling wear.
d. Carburizing and plasma carburizing, Carbo-nitriding and Cyaniding, Nitriding and plasma nitriding, Chromizing and Aluminizing V. Boronizing
e. Laser Plasma TIG alloying, Vapor deposition and Ion implantation, Chemical vapour deposition (CVD) and Ion bean assisted CVD, Physical vapour deposition, Advantages, limitations and application

Module V: Processes for Controlling Wear (8 hours)

a. Coatings and Overlays: Fundamentals of approach, Heat input, and dilution, Welding based methods, Laser cladding Thermal spray based methods.

b. Coatings and Characterization: Electrolysis based methods, Advantages, limitations and application Purpose, Characterization of soundness, Thickness measurement, Surface roughness measurement
c. Characterization of Engineered Surfaces: Mechanical properties, Chemical properties, Metallurgical properties, Wear properties.

Suggested Readings

1. ASM Handbook, Surface Engineering, ASM, (1995) Ohio.
2. D K Dwivedi, Surface Engineering: Enhancing life of tribological component, Springer (2017) New Delhi.
3. Materials and Surface Engineering in Tribology, Willey (2007).
4. Materials Degradation and its control by surface engineering, Imperial College Press, (2006),
5. Surface engineering in metals, CRC Press (1999) London.
6. https://nptel.ac.in/courses/112/107/112107248/

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M			
CO 2	L	H	M	L	
CO 3			L	M	H
CO 4			M	H	L
CO 5			L	M	H

MNWT0061: WELDING TECHNOLOGY

(L-T-P: 3-0-0)

Objectives

- To familiarize the students with the fundamentals of arc welding processes, weld joint design, metallurgical aspects in welding of steel, and assessing the quality and suitability of weld joints.
- To equip the students technological input for handling the problems in welding of selected metals and alloys.

Course Outcomes:

After completing the course the student will be able

1. CO1: To define the welding process.
2. CO2: To classify the different types of welding.
3. CO3: To identify suitable processes for producing quality weldments based on materials and applications.
4. CO4: To inspect the quality of weldments and suggest methods of producing quality joints.
5. CO5: To compare the selection and design of appropriate consumables for welding involving different types of materials.
6. CO6: To an environment for developing and adopting in energy saving and eco-friendly techniques in welding industries.

Module I (6 Hours)

a. Introduction:
Evolution of welding; classification of welding processes; heat sources and shielding methods.
b. Physics of Welding Arc
Welding arc; voltage distribution along the arc; thermionic and non-thermionic cathodes; theories of cathode and anode mechanism; arc characteristics and its relationship with power source; arc efficiency; heat generation; effect of type of shielding gas on arc; isotherms of arcs.
c. Welding Power Sources
Conventional welding power sources; constructional features; static and dynamic characteristics; duty cycle; influence of inductance on arc and power source characteristics; internal and external regulation; specific power source requirements; special welding power sources.

Module II (6 Hours)

Consumable electrode welding processes. Manual metal arc (MMA) welding; Gas metal arc welding; pulsed MIG welding; Submerged arc welding, Significance of flux-metal combination; Electroslag welding: heat generation; principle; Gas tungsten arc welding; selection of polarity, Plasma arc welding; transferred and nontransferred plasma arc welding; selection of gases; welding parameters; keyhole technique.

Module III (8 Hours)
Effect of welding parameter on heat distribution; calculation of peak temperatures; thermal cycles; cooling rate and solidification; Residual stresses and their distribution in welds; influence of residual stresses in static and dynamic loading, distortion.

Module IV (8 Hours)
Introduction to design; engineering properties of steels; Type of welds and weld joints; description of welds: terminology, definitions and weld symbols; edge preparation; sizing of welds in structure; Design for Static loading, Weld Calculations in lap, butt and fillet welds; design for fatigue loading, Introduction to Fatigue; nature of the fatigue process; fatigue strength; factors affecting fatigue life; improvement methods for fatigue strength; reliability analysis and safety factors applied to fatigue design.

Module V (6 Hours)
Chemical tests; Metallographic tests; Hardness tests; Mechanical test for groove and fillet welds-full section, reduced section and all-weld- metal tensile tests, root, face and side bend tests, fillet weld break tests, creep and fatigue testing. Non-Destructive Testing of Weldments; Visual inspection; Dye-penetrant inspection; Magnetic particle inspection; Ultrasonic inspection principle of ultrasonic testing, Radiographic inspection –principle of radiography, X-ray tubes, gamma-ray sources, defect discernibility; Eddy current inspection; Leak tests: N.D.T. Standard procedure for specification and qualification of welding procedure.

Module VI (8 Hours)
Solidification of weld metal; heat affected zone (HAZ), factors affecting properties of HAZ; gas-metal, slag-metal and solid state reactions in welding and their influence on soundness of weld joint; lamellar tearing and hydrogen damage; weldability; definition, factor affecting the weldability of steel Carbon equivalent. weldablity of steel, cast iron and aluminium alloys of commercial importance, failure analysis of welded joints.

Suggested Readings
1. The Metallurgy of Welding, 6th Edition, Lancaster, William Andrew Publishing, NY.
2. Principles of Welding (Processes, Physics, Chemistry and Metallurgy), Robert and Messler, Wiley Interscience Publishers.
3. Welding Hand Book Vol. 5; 7th edition, AWS, 1984.
4. Welding METALLURGY, S Kou, John Wiley, USA, 2003.
5. NPTEL LINK: https://nptel.ac.in/courses/112/107/112107090/
6. NPTEL LINK: https://nptel.ac.in/courses/112/103/112103263/
7. NPTEL LINK: https://nptel.ac.in/courses/112/107/112107090/

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H	M				
CO 2		H				
CO 3		M	H	H		
CO 4				M	H	
CO 5			M	H		
CO 6					M	H

MNGT0062: GAS TURBINES AND JET PROPULSION
(L-T-P: 3-0-0)

Objectives:
- To understand the major components and the working principle of a gas turbine power plant.
- To acquire the skills required to determine the performance of a combined cycle power plant.
- To learn about the various design of a combustion chamber and their modifications.
- To familiarize the classification of jet propulsion cycles and their working principles.

Module I (10 hours)
Open cycle Arrangements, Closed cycle, Basic requirements of the Working Medium, Applications, Comparison of Gas Turbines with Reciprocating Engines, Assumptions in Ideal Cycle Analysis, Simple Gas Turbine Cycle, Reheat Cycle, Intercooled Cycle, Regeneration Cycle, Comparison of various cycles, Combined Steam-Gas Turbine Plant, Blade Materials, Manufacturing Techniques, Blade Fixing.

Module II (10 hours)

Centrifugal Compressors: Essential Parts, Principle of Operation, Ideal Energy Transfer, Blade Shapes and Velocity Triangles, Analysis of Flow through the Compressor, Diffuser, Volute Casing, Performance Parameter, Losses in Centrifugal Compressor, Compressor Characteristics, Surging and Choking.

Axial Compressors: Geometry and Working Principle, Stage Velocity Triangles, Work Done Factor, Enthalpy-Entropy Diagram, Compressor Stage Efficiency, Performance Coefficients, Degree of Reaction, Flow through Blade Rows, Flow Losses, Stage Losses, Performance Characteristics, Comparison of Axial and Centrifugal Compressor.

Module III (8 hours)

Combustion Theory Applied to Gas Turbine Combustor, Factors affecting Combustion Chamber Design, Factors affecting Combustion Chamber Performance, Form of Combustion System, Requirements of the Combustion Chamber, Process of Combustion in a Gas Turbine, Combustion Chamber Geometry. Ignition and Pollution.

Module IV (12 hours)

Reciprocating or Propeller Engines, Gas Turbine Engines, Ramjet engine, Pulse Jet engine, Turbo prop engine, Turbo jet engine, Thrust and Thrust equation, Specific thrust of the Turbojet engine, Efficiencies, Parameters affecting Flight Performance, Thrust Augmentation.

Classification of Rockets, Principle of Rocket Propulsion, Analysis of an Ideal Chemical Rocket, Classification of Chemical Rocket-Solid Propellant, Liquid Propellant and Free radial rockets.

Course Outcomes

After completing the course the student will be able to

1. define the open cycle gas turbine plants with modifications.
2. analyze the performance of open cycle gas turbines with modifications.
3. compare the difference between the working of centrifugal and axial flow compressors.
4. formulate the different types of combustion chamber design and modifications.

Suggested Readings

1. Ganesan, V. “Gas Turbines”, Mc Graw Hills.
2. Kharuja and Dubey, “Gas Turbines and Propulsive Systems''. Dhanpat Rai Publications.
3. Mattingly, J. “Element Gas Turbine Propulsion”, Mc Graw Hill Education.
4. Cohen and Rogers, “Gas Turbine Theory”, Pearson Education.

Mapping of COs to Syllabus

Course Outcomes	Module1	Module2	Module3	Module4
CO1	H		L	M
CO2	H			L
CO3	L	H		M
CO4	L		H	M

MNRA0064: ROBOTICS AND AUTOMATION

(L-T-P: 3-0-0)

Objectives

- To develop the student’s knowledge in various robot structures and their workspace
- To develop student’s skills in perform kinematics analysis of robot systems
- To provide the student with some knowledge and skills associated with robot control

Course Outcomes:

After completing the course successfully the students will be

CO 1: describe various types of robots, robotic sensors and their manipulators used in industries

CO 2: explain the mechanical structure of robot, motion of rigid bodies, kinematics of mechanisms and dynamics of robotics

CO 3: discuss various uses of industrial robots

CO 4: solve forward kinematics, inverse kinematics of simple robot manipulators

Module I: (8 hours)
Evolution of Robots and Robotics, Laws of Robotics, What is and what is not a Robot, Progressive Advancement in Robots. Robot Anatomy, Human Arm Characteristics, Design and Control Issues, Manipulation and Control, Sensors and Vision, Programming Robots

Module II: (8 hours)
a. Robot End Effectors: Classification of end effectors, drive system for grippers, Mechanical, Magnetic, Vacuum, Adhesive grippers, Hooks Scoops, Miscellaneous devices, Gripper force analysis and Design, Active and Passive Grippers
b. Coordinate Frames, Mapping and Transforms: Coordinate Frames, Description of Objects in Space, Transformation of Vectors, Inverting a Homogeneous Transform, Fundamental Rotation Matrices.

Module III: (8 hours)
Symbolic Modelling of Robots: Direct Kinematic Model, Mechanical Structure and Notations, Description of Links and Joints, Kinematic Modelling of the Manipulator, Denavit –Hartenberg Notation, Kinematic Relationship between Adjacent Links, Manipulator Transformation Matrix. Introduction to Inverse Kinematic model

Module IV: (8 hours)
a. Robotic Sensors: The Meaning of Sensing, Sensors in Robotics, Kinds of Sensors used in Robotics, Choosing the right sensors
b. Robotic vision: Introduction to Robotic Vision, Industrial Applications of Vision-Controlled Robotic Systems, Process of Imaging, Architecture of Robotic Vision Systems

Module V: (8 hours)
a. Robot Applications: Industrial Applications, Material Handling, Processing Applications, Assembly Applications, Inspection Application, Principles for Robot Application and Application Planning, Justification of Robots, Robot Safety, Non-industrial Applications.
b. Robot Programming: Robot languages, Classification of Robot language, Computer control and robot software

Suggested Readings
1. Saeed B. Niku, Introduction to Robotics, Wiley.
2. Mittal R.K., Nagarath, I.K., Robotics and Control, Tata Mc Graw Hill.
3. Deb S.R., Robotics Technology and Flexible Automation, Tata McGraw Hill.
4. Groover, M. P., Wiess, M., Nagel, R. N. and Odery, N. G. Industrial Robotics- Technology, Programming and Applications, McGraw Hill Inc. Singapore
5. Ghoshal, A., Robotics Fundamental Concepts and Analysis, Oxford University Press.
6. Craig JJ, Introduction to Robotics, Mechanics and Control, Addison-Wesley, 2nd Ed.
7. Fu, K.S., Gonzales, R.C. and Lee, C.S.G., Robotics: Control, Sensing, Vision and Intelligence, McGraw Hill.
8. https://nptel.ac.in/courses/112/101/112101098/

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H			H	
CO 2		H	M		
CO 3				M	H
CO 4		L	H		

MNRA0064: ROBOTICS AND AUTOMATION
(L-3: T-0: P-0)

Objectives:
- 1. To develop the student’s knowledge in various robot structures and their workspace
- 2. To develop student’s skills in perform kinematics analysis of robot systems
- 3. To provide the student with some knowledge and skills associated with robot control

Course Outcomes:
After completing the course successfully the students will be
CO 1: describe various types of robots, robotic sensors and their manipulators used in industries
CO 2: explain the mechanical structure of robot, motion of rigid bodies, kinematics of mechanisms and dynamics of robotics

CO 3: discuss various uses of industrial robots
CO 4: solve forward kinematics, inverse kinematics of simple robot manipulators

Module I: (12 hours)

a. Introduction: Evolution of Robots and Robotics, Laws of Robotics, what is and what is not a Robot, Progressive Advancement in Robots. Robot Anatomy, Human Arm Characteristics, Design and Control Issues, Manipulation and Control, Sensors and Vision, Programming Robots
b. Robot End Effectors: Classification of end effectors, drive system for grippers, Mechanical, Magnetic, Vacuum, Adhesive grippers, Hooks Scoops, Miscellaneous devices, Gripper force analysis and Design, Active and Passive Grippers

Module II: (16 hours)

a. Coordinate Frames, Mapping and Transforms: Coordinate Frames, Description of Objects in Space, Transformation of Vectors, Inverting a Homogeneous Transform, Fundamental Rotation Matrices.
b. Symbolic Modelling of Robots: Direct Kinematic Model, Mechanical Structure and Notations, Description of Links and Joints, Kinematic Modelling of the Manipulator, Denavit –Hartenberg Notation, Kinematic Relationship between Adjacent Links, Manipulator Transformation Matrix. Introduction to Inverse Kinematic model

Module III: (12 hours)

a. Robotic Sensors: The Meaning of Sensing, Sensors in Robotics, Kinds of Sensors used in Robotics, Choosing the right sensors
b. Robotic vision: Introduction to Robotic Vision, Industrial Applications of Vision-Controlled Robotic Systems, Process of Imaging, Architecture of Robotic Vision Systems
c. Robot Applications: Industrial Applications, Material Handling, Processing Applications, Assembly Applications, Inspection Application, Principles for Robot Application and Application Planning, Justification of Robots, Robot Safety, Non-industrial Applications.
d. Robot Programming: Robot languages, Classification of Robot language, Computer control and robot software

Suggested Readings

1. Saeed B. Niku, Introduction to Robotics, Wiley.
2. Mittal R.K., Nagarath, I.K., Robotics and Control, Tata Mc Graw Hill.
3. Deb S.R., Robotics Technology and Flexible Automation, Tata McGraw Hill.
4. Groover, M. P., Wiess, M., Nagel, R. N. and Odery, N. G. Industrial Robotics- Technology, Programming and Applications, McGraw Hill Inc. Singapore
5. Ghoshal, A., Robotics Fundamental Concepts and Analysis, Oxford University Press.
6. Craig JJ, Introduction to Robotics, Mechanics and Control, Addison-Wesley, 2nd Ed.
7. Fu, K.S., Gonzales, R.C. and Lee, C.S.G., Robotics: Control, Sensing, Vision and Intelligence, McGraw Hill.
8. https://nptel.ac.in/courses/112/101/112101098/

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H		M
CO 2	M	H	
CO 3	L		H
CO 4		H	

MNOR0065: OPERATIONS RESEARCH (Open Elective for all branches)

(L-3;T-0;P-0) **(3 credits - 45 hours)**

Objective: Operations Research can be described as a scientific approach to the solution of problems in the management of complex systems. In a rapidly changing environment an understanding is sought which will facilitate the choice and the implementation of more effective solutions which, typically, may involve complex interactions among people, materials and money.

Course Outcomes

At the end of the course students will be able to:
CO1: Recall the basic of operation research and classification of optimization techniques. (Remembering)

CO2: Express the characteristics of different types of decision-making environments and the appropriate decision making approaches. (Understanding)
CO3: Build and solve linear programming, graphical method, simplex method transportation model, assignment model, sequencing model, Bracketing method, Region elimination method and Gradient based method, . (Applying)

Module I: Introduction to Linear Programming (12 hours)
Introduction to operation research, advantages and disadvantages of operation research along with applications Introduction to linear programming - formulation, graphical method, Simplex method and its applications, initial basic feasible solution, optimality test, Big M method

Module II: Special topics in Linear Programming (8 hours)

Duality in linear programming, the dual simplex method.

Module III: The Transportation Model and The Assignment Model (8 hours)
a. Formulation and solution of Transportation Model, North-west Corner method, Vogel's approximation method, modified distribution method, degeneracy in Transportation problem,
b. Mathematical representation and solution of assignment model, Hungarian method.

Module IV: Sequencing Model (6 hours)
Assumptions in sequencing problem, processing of n jobs through: one machine, two machines and three machines, processing of two jobs through m machines.

Module V: Nonlinear programming: single variable optimization algorithms (11 hours)
Introduction to nonlinear programming, Local and global optimum, Concave and convex function, Bracketing method: Exhaustive search method, Bounding phase method, Region elimination method: Fibonacci search method, Golden section search method, Gradient based method: Newton Raphson method, Secant method.

Suggested Readings
1. D. S. Hira and P.K. Gupta, "Operations Research"S. Chand
2. J.K. Sarma"Operations Research "Macmillan
3. Taha " Operation Research an introduction"Pearson
4. Kalyanmoy Deb "Optimization for Engineering design Algorithms and examples " PHI

Mapping of COs to Syllabus

COs	Module1	Module2	Module3	Module4	Module5
CO1	M				H
CO2	M	L	L	L	M
CO3	H	H	H	H	H

MNOR0065: NUMERICAL METHODS IN MECHANICAL ENGINEERING

(L-3;T-0;P-0) (3 Credits- 45 Hours)
Objective: To learn and understand the various numerical approximation methods used to solve different types of equations, which are used to model mechanical engineering phenomena. The subject gives an insight into how real life problems in the field of mechanical engineering are solved.
Module I (15 Hours)
Taylor Series; Roots of equations: The Bisection Method, The False Position Method, Simple Fixed Point Iteration, Newton Raphson method, Secant method. Roots of polynomials: Muller's and Bairstow's Method. Sets of Linear algebraic equations: Gauss Elimination method, Gauss Jordan elimination method, LU Decomposition method, Matrix Inversion method, Gauss Siedel iteration method. Numerical Integration: Trapezoidal rule, Simpson's 1/3rd rule, Simpson's 3/8th rule, Ordinary Differential Equations: Euler's method, RungeKutta Methods.

Module II (15 Hours)
Numerical solutions to Partial Differential Equations using Finite Difference Method (FDM): Elliptic Equations, Parabolic equations. Curve Fitting: Least Squares Regression, Interpolation.

Module III (15 Hours)
Basic finite element concepts-Basic ideas in a finite element solution, General finite element solution procedure, Application of Finite element concepts to 1D and 2D problems. Finite volume method:Conceptual Basics and Illustrations through 1-D Steady State Problems.

Course Outcomes:
After completing the course successfully, the students will be able to-
CO1: Classify the different approaches used to solve partial differential equation numerically.
CO2: Apply the numerical method which can optimize the solution for specific problems in terms of computation effort and accuracy.
CO3: Analyse data sets through applications of curve fitting methods.
CO4: Develop Finite Element, Finite Difference and Finite Volume formulations of mechanical engineering problems.

Suggested Readings
1. Steven C. Chapra et al., "Numerical Methods for Engineers", Tata McGraw Hills Publication.
2. Dr. B. S. Grewal, "Numerical Methods in Engineering and Science with Programs in C and C++", Khanna Publications.
3. Bhatti, M.A., "Fundamental Finite Element Analysis and Applications: with Mathematical and MATLAB Computations", Wiley, 2005.
4. https://nptel.ac.in/courses/127/106/127106019/ (IIT Madras)
5. https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ge20/ (IIT Madras)
6. https://nptel.ac.in/courses/122/102/122102009/ (IIT Delhi)
7. https://nptel.ac.in/courses/111/106/111106101/ (IIT Madras)
8. https://onlinecourses.nptel.ac.in/noc19_ge30/preview (Swayam Portal)

Mapping of COs to syllabus

COs	Module1	Module2	Module3
CO1	L	H	M
CO2	H	M	M
CO3		H	L
CO4			H

LAB COURSES

MNWM6023: WORKSHOP/MANUFACTURING PRACTICES

(3 Credits) (L-T-P: 1-0-4)

Objective

Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

Course/Learning Outcomes

At the end of the experiments students will be able to

1. Recognize different fabrication techniques. (Remembering)
2. Identify the tools and machinery involved in the various experiments related to material processing. (Understanding)
3. Demonstrate some of the advanced and latest manufacturing techniques being employed in the industry. (Applying)
4. Recognize the different manufacturing processes which are commonly employed in the industry. (Understanding)
5. Fabricate simple components using different materials and fabrication techniques. (Applying)

Manufacturing Practice

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods (3 hours)
2. CNC machining, Additive manufacturing (1 hour)
3. Fitting operations and power tools (1 hour)
4. Electrical and Electronics (1 hour)
5. Carpentry (1 hour)
6. Plastic moulding, glass cutting (1 hour)
7. Metal casting (1 hour)
8. Welding (arc welding and gas welding), brazing (1 hour)

Workshop Practice

1. Machine shop (10 hours)
2. Fitting shop (8 hours)
3. Carpentry (6 hours)
4. Electrical and Electronics (8 hours)
5. Welding shop (8 hours (Arc welding 4 hrs + gas welding 4 hrs)
6. Casting (8 hours)
7. Smithy (6 hours)
8. Plastic moulding and Glass Cutting (6 hours)

Suggested Readings

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., “Elements of Workshop Technology”, Vol I and Vol II, Media promoters and publishers private limited, Mumbai, 2010.
2. Kalpakjian S. And Steven S. Schmid, “Manufacturing Engineering and Technology”, 4th edition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu, “Manufacturing Technology – I” , Pearson Education, 2008.
4. Roy A. Lindberg, “Processes and Materials of Manufacture”, 4th edition, Prentice Hall India, 1998.
5. Rao P.N., “Manufacturing Technology”, Vol. I and Vol. II, Tata McGraw Hill House, 2017.

MNMD6024: MACHINE DRAWING LAB

(0 credits) (L-T-P: 0-0-2)

Objectives:

- To develop basic understanding of projections and sectional views of various mechanical parts.
- To get an idea about the assembly drawing of machines.

Course Outcomes

At the end of the course students will be able to:

1. Explain the concepts of different types of projections. (Explaining)
2. Identify the full and half sectional views of machine parts based on requirements. (Applying)

3. Construct different types of assembly drawings of machine units based on their uses. (Creating)

Orthographic projections and Perspective projections
1. Principle of projections.
2. First and third angle projections.
3. Orthographic projections in first and third angle.
4. Perspective projections.

Sectional views
1. Introduction and types of sectional views
2. Full section
3. Half section
4. Full and half sectional views of different machine parts.

Assembly drawings
1. Procedure and types of assembly drawings.
2. Assembly drawings of machine units like stuffing box, connecting rod, foot step bearing, tool-post, flanged coupling etc.

Text Books/ References:
1. N. D. Bhatt, V. M. Panchal, Machine Drawing, Charotar Publishing House.

MNMF6025: MECHANICAL ENGINEERING LAB 1: MATERIALS AND MANUFACTURING LAB
(2 Credits) (L-T-P: 0-0-4)

Objectives:
- To provide an understanding of various manufacturing processes.
- To get an idea of the dimensional and form accuracy of products.

A:
1. Facing, Turning: Step turning, taper turning.
2. Thread Cutting- Internal and external thread cutting using a single point cutting tool.
3. Contour milling using a vertical milling machine.
4. Spur gear cutting in milling machine.
5. Study of CNC part programming.
6. Use of CNC machine tools: Lathe (2 Axis)
7. Use of CNC machine tools: Milling (3 Axis)
8. Use of CNC machine tools: Milling (4 Axis)
9. Study and use of Universal Robot Arm.

B:
1. Use of slip gauges and sine bar.
2. To study the Brinell hardness testing machine and perform the Brinell hardness test.
3. To study the Rockwell hardness testing machine and perform the Rockwell hardness test.
4. To study the Vickers hardness testing machine and perform the Vicker hardness test.
5. Comparative study of microstructures of different given specimens (mild steel, gray C.I., brass, copper etc.)
6. To study the Impact testing machine and perform the Izod Impact tests.
7. To study the Impact testing machine and perform the Charpy Impact tests.
8. To study the Universal testing machine and perform the tensile test.
9. Use of Vernier caliper and height gauge.
10. Use of micrometer, depth gauge.

Course/Learning Outcomes
After completion of this course, students will be able to
1. Label various engineering measurement devices with its characteristics and to perform some advanced manufacturing operations. (Remembering)
2. Relate the theoretical learning into applications with various engineering measurement devices and tools. (Understanding)

3. Make use of various measuring devices for taking different measurements and to evaluate the accuracy and tolerance of components produced. (Applying)
4. Distinguish the implementations and critical use of various devices for precise measurement. (Analysing)
5. Justify theoretical and practical knowledge into the actual working environment for various measurements. (Evaluating)
6. Elaborate the processes related to measurement in engineering and determine the use of various tools. (Creating)

MNFT6026: Mechanical Engineering Lab2: Fluid and Thermal
(2 Credits) (L-T-P: 0-0-4)

Objective
Introduce the student the fundamental theories and laws along with the industrial applications of thermodynamics, heat transfer, fluid mechanics and hydraulic machines

A. Thermal Engineering
1. Determination of dryness fraction of combined separating and throttling calorimeter.
2. Determination of Coefficient of Performance of Vapour Compression Refrigeration System.
3. Study and Performance test of Single Acting Reciprocating Air Compressor.
4. Determination of Thermal Conductivity of Metal Rod and Composite Wall
5. Determination of Heat Transfer Coefficient in Natural Convection and Forced Convection.
6. Determination of Temperature Distribution and Fin Efficiency in both Natural and Forced Convection.
7. Determination of Stefan Boltzmann Constant.
8. Determination of LMTD of both parallel flow and counter flow heat exchanger.
9. Study and Performance test on a Petrol Engine.
10. Study and Performance test on a Diesel Engine.

B. Fluid and Hydraulics Machines.
1. Determination of metacentric height.
2. Study of fluid pressure distribution on immersed bodies.
3. Experimental verification of Bernoulli’s theorem.
4. Study of discharge through orifice meter and venturimeter.
5. Study of discharge through Triangular and Rectangular notches.
6. Study of different types of pipe flow.
7. Determination of vorticity of free and forced vortex.
8. Determination of velocity through Pitot tube.
9. Determination of performance of Pelton Wheel & Francis turbine.
10. Determination of performance of Reciprocating pump, Centrifugal pump and Submersible pump.

Course/Learning Outcomes
After completing the course successfully the students will be able to-
1. Define various studies for understanding the practical concepts of laws of fluid mechanics, hydraulic machine and thermal engineering system. (Remembering)
2. Explain various basic concepts used for performing experiments in I.C engine, Refrigeration system, Air conditioning system, Hydraulics machines and equipment. (Explaining)
3. Apply basic formulae of heat transfer to perform experiment in conduction, convection and radiation and study of discharge over notches, orifice, hydrostatic force, experimental verification on Bernoulli theorem, laminar flow apparatus, hydraulics turbine and hydraulic pumps (Applying)
4. Analyse the characteristics parameter of various heat transfer equipment, I. C engine, Refrigeration system, Air conditioning system, Hydraulics machines. (Analysing)
5. Evaluate the characteristics parameter of various heat transfer equipment, I. C engine, Refrigeration system, Air conditioning system, Hydraulics machines. (Evaluating)
6. Elaborate the characteristics parameter of various heat transfer equipment, I. C engine, Refrigeration system, Air conditioning system, Hydraulics machines and equipment. (Creating)

MNMI6027: MINI PROJECT (30 HOURS)

Objectives:

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

MNDS6028: Mechanical Engineering Lab3: Design

(2 Credits) (L-T-P: 0-0-4)

Objectives:

- To understand the measurement of mechanical properties of materials
- To understand the deformation behaviour of materials
- To understand the kinematic and dynamic characteristics of mechanical devices Contents

Course/Learning Outcomes

After completing the course successfully the students will be able to-

1. Define laws of Engineering mechanics, Theory of machine and vibration of mechanical system. (Remembering)
2. Explain various basic concepts for performing experiments in Governors, cam follower, gyroscope, brakes and dynamometers and equipment. (Explaining)
3. Identify the study of frequency of undamped single and two degree freedom systems. (Applying)
4. Distinguish the implementations and critical use of various devices for precise measurement.
5. Analyse numerical solutions to vibration problems by simple algorithms, and display the findings in graphical form. (Analysing)
6. To evaluate the motion and the natural frequency for forced vibration of a single degree of freedom damped or undamped system. (Evaluating)
7. Construct a cam profile for a particular application. (Creating)

A.

1. Determination of Coefficient of Friction between two given surfaces.
2. Determination of Moment of Inertia of the Fly Wheel.
3. Verification of Triangle Law and Polygon Law of Forces.
4. Determination of efficiency of Screw Jack.
5. Worm and Worm wheel experiment
6. To verify the law of moment of force and to determine the Bending Moment for a simply supported beam.
7. Study of gyroscope and gyroscopic effect/couple.
8. Study of different types of brakes and dynamometers.

B.

1. Determination of the sleeve lift for various speeds of a Hartnell governor.
2. To plot follower displacement vs Cam rotation for various cam follower systems.
3. Velocity ratios of simple, compound, epicyclic and differential gear trains.
4. Study of four bar mechanism, slider crank mechanism and their inversions.
5. Cam and follower and motion studies.
6. Determination of natural frequency of an undamped single and two degree freedom system.
7. Single degree of freedom Spring-mass-damper system, determination of natural frequency and damping coefficient.
8. To study the free vibration and to determine the natural frequency of vibration of the Two-Rotor system.
9. To study the torsional vibration and to determine the natural frequency vibration of a single rotor system.

MNMP6029: MAJOR PROJECT (PHASE I)

(2 credits)

The major project phase I requires an understanding of core concepts including mechanics, kinematics, thermodynamics, materials science, etc. students will learn to use these core principles along with tools like computer-aided design, ABAQUS, ANSYS to design and Analyse manufacturing plants, industrial equipment and machinery, refrigeration and air conditioning systems, transport systems, aircraft, watercraft, robotics, medical devices, and others under the guidance of faculty members.

Course/Learning Outcomes

At the end of Project Phase I students will be able to

1. Find potential gaps and needs related to mechanical engineering through study of existing literature. (Remembering)
2. Interpret the potential gaps in mechanical engineering through literature review. (Understanding)
3. Develop a feasibility study on the proposed topic. (Applying)
4. Discover the problem statement. (Analysing)
5. Assess the proposed topic by application of basic principles of mechanical engineering. (Evaluating)
6. Evaluate and validate their respective results and propose further scope for advancement in that particular domain. (Evaluating)
7. Compile their results using various engineering application tools. (Creating)
8. Construct the mechanical engineering component using resources available. (Wherever applicable). (Creating)
9. Build reports of the work. (Creating)

MNMP6031: MAJOR PROJECT (PHASE II) AND VIVA VOCE

(4 credits)

The major project phase II involves the students in realising their goal towards fulfilling the identified problem from the first phase of the major project. Accordingly students will design/ fabricate/analyse whichever is/are needed. The complete report of the work in proper format is prepared and finally the work is evaluated. The modality and components of the internal assessment and their weightages shall be notified at the beginning of each semester.

Course/Learning Outcomes

At the end of Project Phase II students will be able to

1. Find potential gaps and needs related to mechanical engineering through study of existing literature. (Remembering)
2. Interpret the potential gaps in mechanical engineering through literature review. (Understanding)
3. Develop a feasibility study on the proposed topic. (Applying)
4. Discover the problem statement. (Analysing)
5. Assess the proposed topic by application of basic principles of mechanical engineering. (Evaluating)
6. Evaluate and validate their respective results and propose further scope for advancement in that particular domain. (Evaluating)
7. Compile their results using various engineering application tools. (Creating)
8. Construct the mechanical engineering component using resources available. (Wherever applicable). (Creating)
9. Build reports of the work. (Creating).

MNSL0200: SERVICE-LEARNING

(2 Credits)

Module I: Theory (15 hours)

a. Understanding Service Learning – Its philosophy, historical background, purpose, value & theoretical framework; Locating Service-Learning within the University context
b. Principles of Service Learning; Classification of Service-Learning Models; Experiential Learning; Reflective Learning; Journaling; Service-Learning Pedagogy; Difference between Service Learning and other community experiences;
c. The historical context of University-Community Partnership; Understanding Community & Community Partnership; Ethical understanding of partnership;
d. Understanding the agency of the Community – as co-educators; Community barriers; Understanding of society & social issues; Effective communication skills
e. Culture and Power Dynamics; Power & Privilege; Social Justice; Human Solidarity & Diversity; Need & Asset based assessment. Theory of efficient team building & execution of the task in a team.

Understanding of Professional and Ethical Responsibility

a. The context in which service-learning projects are situated provides a natural opportunity for students to examine the professional and ethical responsibilities of their profession. The multidimensional reflection and analysis embedded in the service-learning process ensure that students will explore these issues in a guided manner to deepen their overall understanding of their roles as engineering professionals.
b. Design thinking in context to Service Learning
c. Social Activity value addition and procedure to identify the technological gaps & finding out solutions to rectify the same

d. Understanding Community-Based Participatory Research (CBPR) and Basic knowledge on preparation of detailed project reports related to social development projects
e. Technological intervention towards traditional activities in the society, for example, effective project monitoring, health monitoring system
f. Internal Assessment -1: Report writing of fieldwork
g. Internal Assessment -2: Report writing of fieldwork

Module II: Practical (15 Hours)

a. Hands-on training in Design Thinking
b. Field Visit and communication skill development
c. Field Visit and identification of the scope of technological intervention in various social areas
d. Data Collection techniques and interpretation of collected data
e. Workshop on effective report writing
f. Training on Grant writing
g. Training on IPR

VALUE ADDED COURSE

MNRF6032: ROYAL ENFIELD FRESHERS COURSE

Objective
To make the learners familiar with the state of the art of Royal Enfield two wheelers' working, troubleshooting and servicing and technical knowhow of different parts.

Course/Learning Outcomes
After completing the course successfully, the students will be able to-

1. Identify and locate different parts of Royal Enfield two wheelers, understand their working & troubleshooting and perform basic maintenance work.

Pre-requisite
Basic knowledge of IC engines, Kinematics & Theory of Machines

Module I: Technical theory Sessions (6 hrs)
History, 4 stroke/2 stroke engines and their working, bore, stroke, cubic capacity, technical specifications of engine & components, valve overlapping, Electrical Connections, parts locations, different sensors- their working & troubleshooting, clutch, brake, chain, suspension, steering, BS IV and BS VI

Module II: Practical Sessions (24 hrs)
Hands on training Practical on **UCE, Himalayan, 650, meteor.** Dos and Don'ts at training center, engine dismantling, engine & gearbox assembly, wheel removal, refit, freeplay, clutch, suspension, steering, brake, air filter, use of multimeter & special tools, Electrical systems: inspection of components and troubleshooting.

Suggested Readings

a) Engineering Fundamentals of the Internal Combustion Engine – Willard W. Pulkrabek
b) Clutch and Brakes: Design and Selection – William C. Orthwein
c) Internal Combustion Engines- V. Ganesan
d) Theory Of Machine And Mechanisms– Gordon R. Pennock & Joseph E. Shigley John J. Uicker

MNQC6033: QUANTITATIVE APTITUDE FOR COMPETITIVE EXAMINATION

Objective: This course is aimed to provide the learners a platform to have an insight about the various quantitative aptitude problems

Pre-requisite: Fundamental of mathematics
Module I: Simplification, HCF and LCM, Ratio and Proportion, Percentage, Partnership, Average, Profit and Losses, Areas and Volumes, Simple Interest and Compound Interest.
Module II: Time and work, Time and distance, Problems on ages, Pipes and cisterns, Boats and streams, Visualization of space, Probability.

COURSE/LEARNING OUTCOMES
After completing the course successfully, the students will be able to-
CO1: Solve different numerical problem related to quantitative aptitude.

Suggested Readings

1. Dr. R.S. Aggarwal , Quantitative Aptitude for Competitive Examinations

MNIA6034: INTRODUCTION TO AUTOCAD

Objectives: To learn the basics of technical drawing thoroughly by using AUTOCAD software.

Course outcomes

1. Demonstrate basic concepts of the AutoCAD software.
2. Apply basic concepts to develop Geometric construction (drawing) techniques.
3. Analyze technical drawings using CAD.

Module 1 (8 hours)

Interface of AutoCAD, Cartesian coordinate system: absolute coordinate system, relative coordinate system, AutoCAD basics: Function keys, Draw Commands, Modify commands, Annotate dimension style manager, Single line text, Multiline text, Layer properties, Insert blocks, Parametric, Isometric views

Module 2 (8 hours)

Isometric and Perspective projections, Isometric diagram's exercise, 2D Fundamentals in Auto CAD, Drawing units. Interactive Input method: grid snap mode, introduction to 3d interface of Auto CAD.

Module 3 (8 hours)

a) Mechanical diagrams: nut and bolt, rivets, types of threads, keys, knuckle joint, Idler plate, Hook Joint, mechanical tools etc.
b) Civil engineering drawing: Brief history of building drawing Introduction to building drawing, simple building drawing plan.
c) Electrical and Electronic drawings: Circuit, transistor symbols, electrical plans etc.

Group Assignment/ Activity (6 hours)

SCHOOL OF TECHNOLOGY

DEPARTMENT OF BASIC SCIENCES

BOBI0001: BIOLOGY (2-1-0)

Course Outcomes
1. Recall the biological observations of 18th Century that lead to major discoveries? (Remembering)
2. Compare the two, three, four and five kingdom classifications. Highlight the criteria for classification (Understanding)
3. Apply thermodynamic principles to biological systems. (Applying)
4. Analyze biological processes at the reductionist level. (Analyzing)
5. Examine DNA as a genetic material in the molecular basis of information transfer (Evaluating)

Module 1: Introduction (4 lectures)
Importance of Biology: Fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft; Aspect of biology as an independent scientific discipline. History of Biology: Biological observations of the 18th Century; Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor.

Module 2: Classification (5 lectures)
Classification and its criteria: Morphological, Biochemical and Ecological; Hierarchy of Classifications, based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eukaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e)Habitata- acquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life; Organism from different based on classification for the study :1. E.coli, 2. S.cerevisiae, 3. D. Melanogaster, 4.C. elegance, 5. A. Thaliana, 6. M. Musculus

Module 3: Genetics and Information Transfer (13 lectures)
a) Mendel's laws: Law of segregation and Law of independent assortment, Dominance, Recessiveness; Allele, Gene mapping, Gene interaction, Epistasis; Meiosis and Mitosis in heredity; Gene – mapping; Genetic disorders in humans; complementation in human genetics.
b) DNA as a genetic material; Structure of DNA- single stranded, double stranded and nucleosomes; Genetic code- Salient features; Gene - complementation and recombination.

Module 4: Biomolecules and Enzymes (14 lectures)
a) Biomolecules of life: Micromolecules and Macromolecules- sugars, starch and cellulose; Amino acids and proteins; Nucleotides and DNA/RNA; Two carbon units and lipids. Structure of proteins: Primary, Secondary, tertiary and Quaternary; Proteins as enzymes, transporters, receptors and structural elements.
b) Enzyme classification. Mechanism of enzyme action of any two enzyme. Enzyme kinetics and kinetic parameters; RNA catalysis.

Module 5: Metabolism (5 lectures)
Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergonic reactions. Key and its relation to standard free energy.
Spontaneity. ATP as an energy currency; Glycolysis and Krebs cycle; Photosynthesis; Energy yielding and energy consuming reactions. Energy charge

Module 6: Microbiology (4 lectures)
Unicellular organisms; Species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of unicellular organisms. Sterilization and media compositions. Growth kinetics.

Suggested Readings
1. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd
2. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons
3. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company
4. Molecular Genetics (Second edition), Stent, G. S.; and Calendar, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher
5. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M	M			
CO 2	H	H	M		H	
CO 3					M	
CO 4		M		M	H	H
CO 5		M	H	H		

BOBE0002: BIOLOGY FOR ENGINEERING (3-0-0)

Course Outcomes

1. Recall the biological observations of 18th Century that lead to major discoveries? (Remembering)
2. Compare the two, three, four and five kingdom classifications Highlight the criteria for classification (Understanding)
3. Apply thermodynamic principles to biological systems. (Applying)
4. Analyse biological processes at the reductionist level. (Analysing)
5. Examine DNA as a genetic material in the molecular basis of information transfer (Evaluating)

Module 1: Introduction (4 lectures)

Importance of Biology: Fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft; Aspect of biology as an independent scientific discipline. History of Biology: Biological observations of the 18th Century; Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor.

Module 2: Classification (5 lectures)

Classification and its criteria: Morphological, Biochemical and Ecological; Hierarchy of Classifications, based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e)Habitata- acquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life; Organism from different based on classification for the study :1. E.coli, 2. S.cerevisiae, 3. D. Melanogaster, 4.C. elegance, 5. A. Thaliana, 6. M. musculus

Module 3: Genetics and Information Transfer (13 lectures

a) Mendel's laws: Law of segregation and Law of independent assortment, Dominance, Recessiveness; Allele, Gene mapping, Gene interaction, Epistasis ; Meiosis and Mitosis in heredity; Gene – mapping; Genetic disorders in humans; complementation in human genetics.

b) DNA as a genetic material; Structure of DNA- single stranded, double stranded and nucleosomes; Genetic code- Salient features; Gene - complementation and recombination.

Module 4: Biomolecules and Enzymes (14 lectures)

a) Biomolecules of life: Micromolecules and Macromolecules- sugars, starch and cellulose; Amino acids and proteins; Nucleotides and DNA/RNA; Two carbon units and lipids. Structure of proteins: Primary, Secondary, tertiary and Quaternary;Proteins as enzymes, transporters, receptors and structural elements.

b) Enzyme classification. Mechanism of enzyme action of any two enzyme. Enzyme kinetics and kinetic parameters; RNA catalysis.

Module 5: Metabolism (5 lectures)

Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergonic reactions. Key and its relation to standard free energy. Spontaneity. ATP as an energy currency; Glycolysis and Krebs cycle; Photosynthesis; Energy yielding and energy consuming reactions. Energy charge

Module 6: Microbiology (4 lectures)

Unicellular organisms; Species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of unicellular organisms. Sterilization and media compositions. Growth kinetics.

Suggested Readings

1. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd
2. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons
3. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company
4. Molecular Genetics (Second edition), Stent, G. S.; and Calendar, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher
5. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	H	M	L	L	L	L
CO 2	H	H	L	L	H	L
CO 3	L	L	L	M	H	L
CO 4	L	M	L	L	H	H
CO 5	L	L	H	H	L	L

MBLS0001: LIFE SCIENCE (2-0-0) (2 Credit-30 lectures)

Course Outcome:

1. Recall various structures of biomolecules and statistical tools. (Remembering)
2. Describe about the environment. (Understanding)
3. Apply statistical tools in life sciences. (Applying)
4. Analyze biological processes at the reductionist level. (Analyzing)
5. Prove the problems of Biostatistics. (Evaluating)
6. Create environmental awareness among people. (Creating)

Module 1: (4 Lectures)

a. Plant Physiology covering, Transpiration; Mineral nutrition (3 Lectures)

b. Ecology covering, Ecosystems- Components, types, flow of matter and energy in an ecosystem; Community ecology- Characteristics, frequency, life forms, and biological spectrum; Ecosystem structure- Biotic and Abiotic factors, food chain, food web, ecological
pyramids

Module 2: (4 Lectures)

a. Population Dynamics covering, Population ecology- Population characteristics, ecotypes; Population genetics- Concept of gene pool and genetic diversity in populations, polymorphism and heterogeneity;

b. Environmental Management covering, Principles: Perspectives, concerns and management strategies; Policies and legal aspects- Environment Protection Acts and modification, International Treaties; Environmental Impact Assessment- Case studies (International Airport, thermal power plant)

Module 3: (4 Lectures)

a. Molecular Genetics covering, Structures of DNA and RNA; Concept of Gene, Gene regulation, e.g., Operon concept;

b. Biotechnology covering, Basic concepts: Totipotency and Cell manipulation; Plant & Animal tissue culture- Methods and uses in agriculture, medicine and health; Recombinant DNA Technology- Techniques and applications

Module 4 (3 Lectures)

Biostatistics covering, Introduction to Biostatistics: -Terms used, types of data; Measures of Central Tendencies- Mean, Median, Mode, Normal and Skewed distributions; Analysis of Data- Hypothesis testing and ANNOVA (single factor)

Module 5: **(15 Lectures)-**

Laboratory & Fieldwork Sessions covering, Comparison of stomatal index in different plants; Study of mineral crystals in plants; Determination of diversity indices in plant communities; To construct ecological pyramids of population sizes in an ecosystem; Determination of ImportanceValue Index of a species in a plant community; Seminar (with PPTs) on EIA of a Mega- Project (e.g.,Airport, Thermal/Nuclear Power Plant/ Oil spill scenario); Preparation and extraction of genomic
DNA and determination of yield by UV absorbance; Isolation of Plasmid DNA and its separation byGel Electrophoresis; Data analysis using Bio-statistical tools;

Suggested Readings:

1. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.;
2. Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd
3. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H. John Wiley
4. and Sons
5. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H.
6. Freeman and Company
7. Molecular Genetics (Second edition), Stent, G. S.; and Calender, R. W.H. Freeman and

8. company, Distributed by Satish Kumar Jain for CBS Publisher
9. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C.
10. Brown Publishers

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1			H		
CO 2	H	H			
CO 3		M		H	
CO 4	H	M			
CO 5				H	M
CO 6	H	H			M

CHES0002: ENVIRONMENTAL STUDIES
CHES0029: ENVIRONMENTAL SCIENCE (2-0-0)

Course Outcomes:

1. Name different types of natural resources; state the concept of an ecosystem, recall the types of biodiversity and ways of conserving biodiversity, causes, effects and control measures of pollution, social issues and its effect on the environment. (Remembering)
2. Explain what they understand by an ecosystem, biodiversity, explain how environmental pollution occurs and steps that can be taken to control pollution. (Understanding)
3. Value the overall benefit to the environment of preserving natural resources, preserving ecosystems and conserving biodiversity. Learn about sustainable development to protect the environment and promote human health. (Evaluating)
4. Develop ideas of how to preserve the environment by connecting the ideas of minimizing pollution, regulating human population growth, conserving biodiversity by preserving ecosystems and judicious use of natural resources. (Creating)

Module 1: The Multidisciplinary Nature of Environmental Studies (3 lectures)
Definition, scope and importance, need for public awareness.

Module 2: Natural Resources (3 lectures)
a) Different types of natural resources and associated problems - forest resources, water resources, mineral resources, food resources, energy resources, land resources.
b) Conservation of natural resources.

Module 3: Ecosystems (4 lectures)
a) Concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in the ecosystem, food chains, food webs.
b) Structure of following ecosystems - forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystems.

Module 4: Biodiversity and Its Conservation (4 lectures)
Types of biodiversity – genetic, species and ecosystem, value of biodiversity, global biodiversity, India as a mega-diversity nation, threats to biodiversity, conservation of biodiversity - in-situ and ex-situ conservation.

Module 5: Environmental Pollution (6 lectures)
a) Definition, causes, effects and control measures of - air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards and e- pollution.
b) Solid waste management
c) Disaster management

Module 6: Social Issues and the Environment (6 lectures)
a) From unsustainable to sustainable development, urban problems related to energy, water conservation, rain water harvesting, climate change, global warming, acid rain, ozone layer depletion.
b) Environment protection act.
c) Introduction to environmental impact assessment.

Module 7: Human Population and the Environment (4 lectures)
Population growth and sex ratio; Population explosion - family welfare programme; Environment and human health; HIV/AIDS; Role of information technology in environment and human health.

Suggested Readings

1. Textbook of Environmental Studies, Erach Bharucha; UGC, New Delhi
2. Environmental Studies, University , J.P. Sharma; Science Press
3. Real World Cases in Green Chemistry, Cann, M.C. & Connelly, M.E., ACS, 2000
4. Understanding our Environment: An Introduction to Environmental Chemistry and Pollution, Roy, M. Harrison; R.S.C.

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6	Module 7
CO 1		H			M		H
CO 2	M			H		H	
CO 3		M					M
CO 4			M		H		

CHCE0027: ENGINEERING CHEMISTRY (3-1-0)

Course Outcomes:

1. Recall fundamental concepts of 10+2 level of physical, organic and inorganic chemistry. (Remembering).
2. An ability to gain knowledge on molecular structure and spectroscopy, intermolecular forces and periodic properties (Understanding).
3. Analyse the structures of atoms and molecules using spectroscopic techniques. (Analysis)
4. Apply the knowledge of spectroscopy for determining molecular geometries, interpret the thermodynamics of system and structure of organic compounds and their reaction paths/mechanism. (Applying)
5. Assess the knowledge of atomic and molecular structure to evaluate the energy level diagram in the atomic and molecular level (Evaluating)

Module 1: Atomic and molecular structure (12 lectures)
Schrodinger equation, Particle in a box solutions, Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations, Equations for atomic and molecular orbitals, Energy level diagrams of diatomic, Pi-molecular orbitals of butadiene and benzene and aromaticity, Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties, Structure of Solids, Band structure of solids and the role of doping on band structures.

Module 2: Spectroscopic techniques and applications (12 lectures)
Principles of spectroscopy and selection rules, electronic spectroscopy, Fluorescence and its applications in medicine, Vibrational and rotational spectroscopy of diatomic molecules, Nuclear magnetic resonance and magnetic resonance imaging, surface characterisation techniques, Diffraction and scattering.

Module 3: Use of free energy in chemical equilibria (8 lectures)
Thermodynamic functions: energy, entropy and free energy, Free energy and emf, Cell potentials, the Nernst equation and applications., Acid base, oxidation reduction and solubility equilibria, Corrosion, Use of free energy considerations in metallurgy through Ellingham diagrams.

Module 4: Intermolecular forces and Periodic properties (12 lectures)
a) Ionic, dipolar and van Der Waals interactions.
b) Effective nuclear charge, penetration of orbitals, variations of s, p, d orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases.

Module 5: Stereochemistry (10 lectures)
Representations of three-dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis, Isomerism in transition metal compounds.

Module 6: Organic reactions and synthesis of a drug molecule (6 lectures)
Introduction to reactions involving substitution, addition, elimination, oxidation and reduction, Synthesis of a commonly used drug molecule – Aspirin and Paracetamol.

Suggested Readings

1. University chemistry, by B. H. Mahan
2. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
3. Fundamentals of Molecular Spectroscopy, by C. N. Banwell
4. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan

5. Physical Chemistry, by P. W. Atkins
6. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
CO 1	L		H	H		
CO 2	H	H		H	H	H
CO 3			M	L	H	
CO 4	M	H	M			H
CO 5	M	H			M	M

CHCE6006: ENGINEERING CHEMISTRY I LAB (1 Credit) (L:0, T:0, P:2)

Course Outcomes:

1. Explain the principles of the experiments learned about in class, illustrating the principles of chemistry relevant to the study of science and engineering (Understanding)
2. Estimate molecular/system properties such as surface tension, viscosity, conductance of solution, water hardness, etc. (Applying)
3. Assess the limitations and advantages of the procedures they use in the laboratory for the various estimations and analysis. (Evaluating)

List of experiments:

1. Determination of Water Hardness with EDTA.
2. Estimation of Calcium in Limestone.
3. Determination of dissolved Oxygen in a given Water Sample by Winkler's Method.
4. Determination of Surface Tension of a given Liquid by Stalagmometer.
5. To determine the co-efficient of Viscosity of a given liquid or solution with the help of Ostwald's Viscometer.
6. Adsorption of Acetic Acid by Charcoal.
7. Determination of Chloride Content of Water.
8. To determine the Strength of Magnesium Ions in Magnesium Sulphate solution by Complexometric Method.
9. Determination of Partition Coefficient of a substance between two immiscible liquids.
10. Determination of Free Carbon Dioxide in a given Water sample.
11. To determine the Alkalinity of a given water Sample.
12. Determination of Ferrous Ion in Mohr's Salt by $KMnO_4$.
13. To determine the Acidity of the given water sample.
14. Determination of the Cell Constant and Conductance of solution.
15. Determination of Sodium Hydroxide and Sodium Carbonate in mixture.

Suggested Readings

1. Engineering Chemistry, Shashi Chawla, Dhanpat Rai and Co, Education and technical publishers
2. Vogel's Practical Chemistry.

CHCE6007: ENGINEERING CHEMISTRY II LAB (2 Credits) (L:0, T:0, P:4)

***Objective**: This course consists of experiments illustrating the principles of chemistry relevant to the study of science and engineering.*

Course Outcomes:

1. Explain the principles of the experiments learned about in class, illustrating the principles of chemistry relevant to the study of science and engineering (Understanding)
2. Estimate molecular/system properties such as surface tension, viscosity, conductance of solution, water hardness, etc. (Applying)
3. Assess the limitations and advantages of the procedures they use in the laboratory for the various estimations and analysis. (Evaluating)

List of experiments:

1. Determination of Water Hardness with EDTA.
2. Estimation of Calcium in Limestone.
3. Determination of dissolved Oxygen in a given Water Sample by Winkler's Method.
4. Determination of Surface Tension of a given Liquid by Stalagmometer.
5. To determine the co-efficient of Viscosity of a given liquid or solution with the help of Ostwald's Viscometer.
6. Adsorption of Acetic Acid by Charcoal.
7. Determination of Chloride Content of Water.
8. To determine the Strength of Magnesium Ions in Magnesium Sulphate solution by Complexometric Method.
9. Determination of Partition Coefficient of a substance between two immiscible liquids.
10. Determination of Free Carbon Dioxide in a given Water sample.
11. To determine the Alkalinity of a given water Sample.
12. Determination of Ferrous Ion in Mohr's Salt by $KMnO_4$.
13. To determine the Acidity of the given water sample.
14. Determination of the Cell Constant and Conductance of solution.
15. Determination of Sodium Hydroxide and Sodium Carbonate in mixture.

Suggested Readings

1. S. Rattan Experiments in Applied Chemistry, Katson Books
2. S. Giri, D. N. Bajpai, O. P. Pandey Practical Chemistry, S. Chand And Co.

MACL0012: MATHEMATICS I - CALCULUS AND LINEAR ALGEBRA (3-1-0)

Course Outcomes:

1. Classify various types of mean value theorems, and their properties, (understanding)
2. Develop different methods to definite integrals to determine surface areas and volumes of revolutions. (Applying)
3. Find the concepts of convergence of sequence and series of real numbers. (Remembering)
4. Determine vector spaces, linear transformations and their properties (Evaluating)
5. Examine and recognize the use of eigen values and eigen vectors of matrices applicable to various complex engineering problems. (Analysing)

Module 1: Differential and Integral Calculus (23 lectures)

(a) Rolle's theorem, mean value theorems, Taylor's and Maclaurin's theorems with remainders; indeterminate forms and L'Hospital's rule; maxima and minima.

(b) Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; maxima, minima and saddle points; method of Lagrange multipliers.

(c) Evolutes and involutes; evaluation of definite and improper integrals; beta and gamma functions and their properties; applications of definite integrals to evaluate surface areas and volumes of revolutions.

Module 2: Sequence and Series (11 lectures)

Convergence of sequence and series, tests for convergence, power series, Taylor's series. Series for exponential, trigonometric and logarithmic functions; Fourier series: half range sine and cosine series, Parseval's theorem.

Module 3: Linear Algebra (11 lectures)

Vector space, linear dependence of vectors, basis, dimension; Linear transformations (maps), range and kernel of a linear map, rank and nullity, inverse of a linear transformation, rank nullity theorem, composition of linear maps, matrix associated with a linear map.

Module 4: Matrices (15 lectures)

Matrices, linear systems of equations, linear independence, rank of a matrix, determinants, Cramer's rule, inverse of a matrix, Gauss elimination and Gauss-Jordan elimination. eigenvalues, eigenvectors, symmetric, skew-symmetric, and orthogonal Matrices, eigenbasis, diagonalization; Inner product spaces, Gram-Schmidt orthogonalization.

Suggested Readings:

1. Calculus and Analytic geometry, 9th Edition, G.B. Thomas and R.L. Finney, Pearson, Reprint,2002.
2. Advanced Engineering Mathematics, 9th Edition, Erwin Kreyszig , John Wiley & Sons, 2006.
3. Engineering Mathematics for first year, Veerarajan T., Tata McGraw-Hill, New Delhi, 2008.
4. Higher Engineering Mathematics, 11th Reprint, Ramana B.V.Tata McGraw Hill New Delhi 2010.
5. Linear Algebra: A Modern Introduction, 2nd Edition, D. Poole, Brooks/Cole, 2005.
6. 6.A textbook of Engineering Mathematics, N.P. Bali and Manish Goyal, Laxmi Publications, Reprint, 2008.
7. Higher Engineering Mathematics, 36th Edition, B.S. Grewal, Khanna Publishers, 2010.

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2	H			
CO 3		H		
CO 4			H	
CO 5			M	H

MAIN0013: MATHEMATICS II - MULTIPLE INTEGRALS, NUMERICAL METHODS AND DIFFERENTIAL EQUATIONS (3-1-0)

Course Outcomes:

1. Classify gradient, curl and divergence and evaluate multiple integrals in various co-ordinates systems. (Understanding)
2. Appraise numerical solutions of algebraic and transcendental equations with error analysis, (Evaluating)
3. Solve initial and boundary value problems in differential equations using numerical methods. (Creating)
4. Categorize the techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order. (Analysing)
5. Determine the solution of partial differential equations by adopting various methods, (Evaluating)

Module 1: Multiple Integrals (12 lectures)
Gradient, curl and divergence, multiple integration: Double and triple integrals (cartesian and polar), change of order of integration in double integrals, change of variables (cartesian to polar), applications: areas and volumes by (double integration) Center of mass and gravity (constant and variable densities). Theorems of Green, Gauss and Stokes, orthogonal curvilinear coordinates, simple applications involving cubes, sphere and rectangular parallelepipeds.

Module 2: Numerical Methods (23 lectures)
a) Solution of polynomial and transcendental equations – bisection method, Newton-Raphson method and Regula-Falsi method. finite differences, relation between operators, interpolation using Newton's forward and backward difference formulae. interpolation with unequal intervals: Newton's divided difference and Lagrange's formulae. numerical differentiation
b) Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules. Ordinary differential equations: Taylor's series, Euler and modified Euler's methods. Runge- Kutta method of fourth order for solving first and second order equations. Milne's and Adam's predicator-corrector methods. partial differential equations: finite difference solution two dimensional Laplace equation and Poission equation, implicit and explicit methods for one dimensional heat equation

Module 3: Ordinary Differential Calculus (15 lectures
Exact, linear and Bernoulli's equations, Euler's equations, equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type .second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy- Euler equation; power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

Module 4: Introduction to Partial Differential Equations (10 lectures)
First order partial differential equations, solutions of first order linear and non-linear PDEs. solution to homogeneous and non-homogenous linear partial differential equations second and higher order by complementary function and particular integral methods.

Suggested Readings

1. Calculus and Analytic geometry, 9th Edition, G.B. Thomas and R.L. Finney, Pearson,Reprint, 2002.
2. 2Advanced Engineering Mathematics, 9th Edition, . Erwin Kreyszig, John Wiley & Sons, 2006.
3. Elementary Differential Equations and Boundary Value Problems, 9th Ed., W. E. Boyce and R. C. DiPrima, Wiley India, 2009.
4. Differential Equations, 3rd Ed., S. L. Ross, Wiley India, 1984.
5. An Introduction to Ordinary Differential Equations, E. A. Coddington, Prentice Hall India, 1995.
6. Tata McGraw Hill, B.V.Ramana, Higher Engineering Mathematics, New Delhi, 11th Reprint, 2010
7. Ordinary Differential Equations, E. L. Ince, Dover Publications, 1958
8. A textbook of Engineering Mathematics, N.P. Bali and Manish Goyal, Laxmi Publications, Reprint, 2008.
9. Higher Engineering Mathematics, 36th Edition, B.S. Grewal, Khanna Publishers, 2010.

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4

CO 1	H			
CO 2		H		
CO 3		H		
CO 4			H	
CO 5				H

MAPS0024: MATHEMATICS III -PROBABILITY AND STATISTICS (2-0-0)

Course Outcomes:

1. Explain the ideas of probability and random variables and various discrete and probability distributions and their properties. (Understanding)
2. Determine probabilities and derive the marginal and conditional distribution of bivariate random variables. (Evaluating)
3. Apply the basic ideas of the measures of central tendency, correlation and regression to solve social and scientific related problems. (Applying)
4. Use appropriate statistical methods to summarize and analyse data using testing of hypothesis. (Analysing)

Module 1: Basic Probability and Continuous Probability Distributions: (12 lectures)

a) Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality.

b) Continuous random variables and their properties, distribution function and densities, normal, exponential and gamma densities.

Module 2: Bivariate Distribution (5 lectures)

Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.

Module 3 Applied Statistics (13 lectures)

Measure of Central tendency: Moments, skewness and Kurtosis-Probability distribution: Binomial, Poisson and Normal-evaluation of statistical parameters for these three distributions, Correlation and regression-Rank correlation. Curve fitting by the method of least squares-fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations. Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.

Suggested Readings

1. Advanced Engineering Mathematics, 9th Edition, Erwin Kreyszig, John Wiley & Sons, 2006
2. Introduction to Probability Theory, P.G.Hoel, S.C.Port and C.J.Stone , Universal Book Stall,
3. 2003(Reprint)
4. 3 A first course in Probability, 6th Ed.. S.Ross, Pearson Education India, 2002
5. An Introduction to Probability Theory and its Applications, Vol.1. 3rd Ed. W. Feller, Wiley, 1968
6. A textbook of Engineering Mathematics, N.P.Bali and Manish Goyal, Laxmi Publications, Reprint, 2010
7. Higher Engineering Mathematics , 35th Edition,,B.S.Grewal, Khanna publishers, 2000
8. Engineering Mathematics, Veeranjan T., Tata McGraw-Hill, New Delhi, 2010

Mapping COs to the syllabus

COs	Module 1	Module 2	Module 3
CO1	H		
CO2		H	
CO3		M	H
Co4			H

MADM0025: DISCRETE MATHEMATICS WITH APPLICATIONS (3-1-0)

COURSE OUTCOMES

1. Show a given logic sentence express it in terms of predicates, quantifiers, and logical connectives. (Understanding)
2. Derive the solution using deductive logic and prove the solution based on logical inference. (Evaluating)
3. For a given a mathematical problem, classify its algebraic structure. (Understanding)

4. Evaluate Boolean functions and simplify expressions using the properties of Boolean algebra (Evaluating)
5. Develop the given problem as graph networks and solve with techniques of graph theory. (Understanding)

Module 1: Sets, Relation and Function (14 lectures)
Operations and Laws of Sets, Cartesian Products, Binary Relation, Partial Ordering Relation, Equivalence Relation, Image of a Set, Sum and Product of Functions, Bijective functions, Inverse and Composite Function, Size of a Set, Finite and infinite Sets, Countable and uncountable Sets, Cantor's diagonal argument and The Power Set theorem, Schroeder-Bernstein theorem. Principles of Mathematical Induction: The Well-Ordering Principle, Recursive definition, The Division algorithm: Prime Numbers, The Greatest Common Divisor: Euclidean Algorithm, The Fundamental Theorem of Arithmetic.

Module 2: Introduction to Counting (8 lectures)
Basic counting techniques-inclusion and exclusion, pigeon-hole principle, permutation and combination.

Module 3: Propositional Logic: (12 lectures)
Syntax, Semantics, Validity and Satisfiability, Basic Connectives and Truth Tables, Logical Equivalence: The Laws of Logic, Logical Implication, Rules of Inference, The use of Quantifiers. Proof Techniques: Some Terminology, Proof Methods and Strategies, Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof of Necessity and Sufficiency.

Module 4: Algebraic Structures and Morphism (14 lectures)
Algebraic Structures with one Binary Operation, Semi Groups, Monoids, Groups, Congruence Relation and Quotient Structures, Free and Cyclic Monoids and Groups, Permutation Groups, Substructures, Normal Subgroups, Algebraic Structures with two Binary Operation, Rings, Integral Domain and Fields. Boolean Algebra and Boolean Ring, Identities of Boolean Algebra, Duality, Representation of Boolean Function, Disjunctive and Conjunctive Normal Form

Module 5: Graphs and Trees (12 lectures)
Graphs and their properties, Degree, Connectivity, Path, Cycle,Sub Graph, Isomorphism, Eulerian and Hamiltonian Walks, Graph Colouring, Colouring maps and Planar Graphs, Colouring Vertices, Colouring Edges, List Colouring, Perfect Graph, definition properties and Example, rooted trees, trees and sorting, weighted trees and prefix codes, Bi-connected component and Articulation Points, Shortest distances.

Suggested Readings
1. Discrete Mathematics and its Applications, Kenneth H. Rosen, Tata McGraw – Hill
2. Discrete Mathematics with Applications,4th edition, Susanna S. Epp, Wadsworth Publishing Co.Inc.
3. Elements of Discrete Mathematics A Computer Oriented Approach, 3rdEdition, C L Liu and D P Mohapatra, Tata McGraw – Hill.
4. Discrete Mathematical Structure and Its Application to Computer Science", TMG Edition, J.P. Tremblay and R. Manohar Tata McGraw-Hill
5. Norman L. Biggs, Discrete Mathematics, 2nd Edition, Oxford University Press.
6. Discrete Mathematics, Schum's Outlines Series, Seymour Lipschitz, Marc Lipson, Tata McGraw- Hill

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H			M	
CO 2	M	H			
CO 3			H		
CO 4	M			H	
CO 5					H

MATC0026: MATHEMATICS III- (TRANSFORM CALCULUS, COMPLEX VARIABLE AND PROBABILITY AND STATISTICS) (2-1-0)

(3-credit-45 hours) (L-T-P:2-1-0)

Course Outcomes
1. Apply Laplace transform for evaluation of integrals and solving ODEs and PDEs. (Applying)
2. Illustrate the significance of differentiability and analyticity of complex functions leading to the Cauchy–Riemann equations. (Understanding)
3. Learn Taylor and Laurent series expansions of analytic functions, classify the nature of singularity, poles and residues and application of Cauchy Residue theorem. (Analysing)
4. Illustrate the concepts of random variables and various probability distributions and their properties. (Understanding)

Module 1: Transform Calculus (14 lectures)
a) Polynomials-Orthogonal Polynomial-Lagrange's, Chebyshev polynomials; Trigonometric polynomials; Laplace

transform, Properties of Laplace transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs and PDEs by Laplace transform method.

b) Fourier series: convergence and sum of Fourier series, even and off functions, cosine and sine Fourier series; Fourier Integrals: Fourier cosine and sine integrals; Fourier transforms, Z-transform and wavelet transform: properties, methods, inverses and their applications

Module 2: Complex variable (15 lectures)

a) Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties.

b) Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy integral formula (without proof), Liouville's theorem and Maximum-modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine.

Module 3: Basic Probability (8 lectures)

Probability spaces, conditional probability, independence; Discrete random variables, the multinomial distribution, Poisson approximation to the binomial distribution, Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality. Continuous random variables and their properties, distribution function and densities, normal, exponential and gamma densities. Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.

Module 4: Applied Statistics (8 lectures

Measures of Central tendency: Moments, skewness and Kurtosis -Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation. Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves.

Suggested Readings

1. Advanced Engineering Mathematics, 9th Edition, Erwin Kreyszig, John Wiley & Sons, 2006
2. Introduction to Probability Theory, P.G.Hoel, S.C.Port and C.J.Stone , Universal Book Stall,
3. 2003(Reprint)
4. 3 A first course in Probability, 6th Ed.. S.Ross, Pearson Education India, 2002
5. An Introduction to Probability Theory and its Applications, Vol.1. 3rd Ed. W. Feller, Wiley, 1968
6. A textbook of Engineering Mathematics, N.P.Bali and Manish Goyal, Laxmi Publications, Reprint, 2010
7. Higher Engineering Mathematics , 35th Edition,,B.S.Grewal, Khanna publishers, 2000
8. Engineering Mathematics, Veeranjan T., Tata McGraw-Hill, New Delhi, 2010

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2		H		
CO 3			H	M
CO 4			M	H

MACS0027: MATHEMATICS III-(COMPLEX VARIABLE, TRANSFORM CALCULUS, PROBABILITY AND STATISTICS) (3-1-0)

Course Outcomes:

1. Use the tools of differentiation and integration of functions of complex variable that are used in various techniques dealing engineering problems. (Applying)
2. Develop the tool of Laplace transform and Fourier series for learning advanced Engineering Mathematics. (Understanding)
3. Apply the basic ideas of the measures of central tendency, correlation and regression to solve social and scientific related problems. (Applying)
4. Define the basic principles of probability theory and the concept of random variables. (Remembering)

Module 1: Complex variable (18 lectures)

a) Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties.

b) Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy integral formula (without proof), Liouville's theorem and Maximum-modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, evaluation of certain improper integrals using the Bromwich contour.

Module 2: Transform Calculus (10 lectures)
Laplace transform, properties of Laplace of transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs and PDEs by Laplace transform method. Fourier Series and Fourier transform.

Module 3: Basic probability (10 lectures)
Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality. Continuous random variables and their properties, distribution function and densities, normal, exponential and gamma densities. Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.

Module 4: Applied Statistics (12 lecture)
Measure of Central tendency: Moments, skewness and Kurtosis-Probability distribution: Binomial, Poisson and Normal-evaluation of statistical parameters for these three distributions, Correlation and regression-Rank correlation. Curve fitting by the method of least squares-fitting of straight lines, second degree parabolas and more general curves. Test of significance : Large sample test for single proportion, difference of proportions, test for single mean, difference of means and standard deviations. Test for ratio of variance-Chi-square test for goodness of fit and independence of attributes.

Suggested Readings:
1. Advanced Engineering Mathematics, 9th Edition, Erwin Kreyszig, John Wiley & Sons, 2006
2. Introduction to Probability Theory, P.G.Hoel, S.C.Port and C.J.Stone , Universal Book Stall,
3. 2003(Reprint)
4. 3 A first course in Probability, 6th Ed.. S.Ross, Pearson Education India, 2002
5. An Introduction to Probability Theory and its Applications, Vol.1. 3rd Ed. W. Feller, Wiley, 1968
6. A textbook of Engineering Mathematics, N.P.Bali and Manish Goyal, Laxmi Publications, Reprint, 2010
7. Higher Engineering Mathematics , 35th Edition,,B.S.Grewal, Khanna publishers, 2000
8. Engineering Mathematics, Veeranjan T., Tata McGraw-Hill, New Delhi, 2010

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2		H		
CO 3			H	
CO 4			M	H

MATD0028: MATHEMATICS III- TRANSFORM CALCULUS AND DISCRETE MATHEMATICS (2-0-0)

COURSE OUTCOMES:
1. Develop the tool of Laplace transform and Fourier series for learning advanced Engineering Mathematics. (Understanding)
2. Solve problems using counting techniques and combinatorics. (Applying)
3. Explain the ideas of probability and random variables and various discrete and probability distributions and their properties. (Understanding)

Module 1: Transform Calculus (9 lectures)
a) Polynomials-Orthogonal Polynomial-Lagrange's, Chebyshev polynomials; Trigonometric polynomials; Laplace transform, Properties of Laplace transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs and PDEs by Laplace transform method.
b) Fourier transforms, Z-transform and wavelet transform: properties, methods, inverses and their applications.

Module 2: Discrete Mathematics: Sets, relations and functions: (10 lectures)
a) Basic operations on sets, Cartesian products, disjoint union (sum), and power sets. Different types of relations, their compositions and inverses. Different types of functions, their compositions and inverses. Complete partial ordering.
b) Basic counting techniques – inclusion and exclusion, pigeon-hole principle, permutation, combination, summations. Introduction to recurrence relation and generating functions. Graphs and their basic properties – degree, path, cycle, subgraph, isomorphism, Eulerian and Hamiltonian walk, trees.

Module 3: Basic Probability and Distributions: (11 lectures)
Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities.

Suggested Readings

1. Advanced Engineering Mathematics, 9th Edition, Erwin Kreyszig, John Wiley & Sons, 2006
2. Introduction to Probability Theory, P.G.Hoel, S.C.Port and C.J.Stone , Universal Book Stall, 2003(Reprint)
3. A first course in Probability, 6th Ed., S.Ross, Pearson Education India, 2002
4. An Introduction to Probability Theory and its Applications, Vol.1. 3rd Ed., W. Feller, Wiley, 1968
5. Fourier Analysis with Application to Boundary Value Problems, M.R.spiegel, Tata McGraw Hill Publishing Company Ltd., New Delhi 2005
6. 6 A textbook of Engineering Mathematics, . N.P.Bali and Manish Goyal, Laxmi Publications, Reprint, 2010
7. Higher Engineering Mathematics, 35th Edition, B.S.Grewal, Khanna publishers, 2000
8. Engineering Mathematics, Veeranjan T., Tata McGraw-Hill, New Delhi, 2008

Mapping of COs to Syllabus

COs	Module 1	Module 2	Module 3
CO1	H		
CO2		H	
CO3			H

MACP0029: MATHEMATICS III - COMPLEX VARIABLES, PDE AND PROBABILITY AND STATISTICS (3-1-0)

Course Outcomes:

1. Use the tools of differentiation and integration of functions of complex variable that are used in various techniques dealing engineering problems. (Applying)
2. Solve partial differential equations by range of techniques and to predict the behaviour of certain model physical phenomena. (Applying)
3. Define the basic principles of probability theory and the concept of random variables. (Remembering)
4. Apply the basic ideas of the measures of central tendency, correlation and regression to solve social and scientific related problems. (Applying)

Module 1: Complex Variables (19 lectures)

a) Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties.

b) Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy integral formula (without proof), Liouville's theorem and Maximum-modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, evaluation of certain improper integrals using the Bromwich contour.

Module 2: Partial differential equations (17 lectures)
Second order linear equations and their classification, initial and boundary conditions, D'Alemberts solution of the wave equation; Duhamel's principle for one dimensional wave equation. Finite vibrating string problem and Fourier series. Heat diffusion and vibration problems, separation of variables method to simple problems in Cartesian coordinates. The Laplacian in plane, cylindrical and spherical polar coordinates, solution with Bessel functions and Legendre function. One dimensional diffusion equation and its solution by separation of variables.

Module 3: Basic probability (12 lectures)
Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's
Inequality. Continuous random variables and their properties, distribution function and densities, normal, exponential and gamma densities. Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Beyes' rule.

Module 4: Applied Statistics (12 lectures
Measure of Central tendency: Moments, skewness and Kurtosis-Probability distribution: Binomial, Poisson and Normal-evaluation of statistical parameters for these three distributions, Correlation and regression-Rank correlation. Curve fitting by the method of least squares-fitting of straight lines, second degree parabolas and more general curves. Test of significance : Large sample test for single proportion, difference of proportions, test for single mean, difference of means and standard deviations. Test for ratio of variance-Chi-square test for goodness of fit and independence of attributes.

Suggested Readings
1. Advanced Engineering Mathematics, 9th Edition, Erwin Kreyszig, John Wiley & Sons, 2006
2. Introduction to Probability Theory, P.G.Hoel, S.C.Port and C.J.Stone , Universal Book Stall, 2003(Reprint)
3. A first course in Probability, 6th Ed., S.Ross, Pearson Education India, 2002
4. An Introduction to Probability Theory and its Applications, Vol.1. 3rd Ed., W. Feller, Wiley, 1968
5. Fourier Analysis with Application to Boundary Value Problems, M.R.spiegel, Tata McGraw Hill Publishing Company Ltd., New Delhi 2005
6. 6 A textbook of Engineering Mathematics, . N.P.Bali and Manish Goyal, Laxmi Publications, Reprint, 2010
7. Higher Engineering Mathematics, 35th Edition, B.S.Grewal, Khanna publishers, 2000
8. Engineering Mathematics, Veeranjan T., Tata McGraw-Hill, New Delhi, 2008

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2		H		
CO 3			H	
CO4			M	H

CAMF0043: MATHEMATICAL FOUNDATION OF COMPUTER SCIENCE (4-0-0) (4 Credits-60 lectures)

COURSE OUTCOMES
1. Discuss application of mathematical logic to solve problems (Remembering, Understanding)
2. Describe basic concept of set theory, graph theory and Group theory. (Understanding)
3. 3.Derive the solution of a problem using deductive logic and prove the solution based on logical inference (Applying)
4. 4.Evaluate Boolean functions and simplify expressions using the properties of Boolean algebra (Evaluating)
5. Develop the given problem as graph networks and solve with techniques of graph theory. (Applying)

Module 1(13 lectures)
Mathematical Logic: Statements and notations, Connectives, Well-formed formulas, Truth Tables, tautology, Logical equivalence: The Laws of logic, Logical Implication, Normal forms, Quantifiers, universal quantifiers. Predicates: Predicate logic, Free & Bound variables, Rules of inference, Consistency, proof of contradiction.

Module 2(20 lectures)
Set theory: Introduction, Basic Concepts of Set Theory, Representation of Discrete Structures, Relations and Ordering, Matrix representation of relations and partial ordered sets, representation of relations by Graphs; Lattices as Partially Ordered Sets, Boolean algebra; Functions. Algebraic Structures: Introduction, Algebraic Systems, Semi groups and Monoids; Groups, Congruence Relation and Quotient Structures, permutation groups, Lagrange's Theorem; Normal subgroups. Algebraic Structures with two Binary Operation, Rings, Integral Domain and Fields. (Definition, basic properties and examples)

Module 3 (12 lectures)
Elementary Combinatorics: Basics of counting, Combinations & Permutations with repetitions, Constrained repetitions, Binomial Coefficients, Binomial and Multinomial theorem, Pigeonhole Principle, principles of Inclusion – Exclusion.

Module 4 (15 lectures)
Graph Theory: Basic Concepts, Sub graphs, Multi graphs Representation of Graphs, Isomorphism, Paths and Circuits, Traversing a Graph, DFS, BFS, Eulerian and Hamiltonian graphs, shortest path algorithms, Planar Graphs, Chromatic Numbers. Tree and Spanning Trees. Applications of Graph Theory.

Suggested Readings
1. Discrete Mathematical Structures with Applications to Computer Science by J. P. Tremblay and R Manohar, Tata McGraw-Hill Publications, 1997.
2. Graph Theory by Narsingh Deo, Prentice-Hall of India publications, 2004.
3. Discrete Mathematical Structures, Theory and Applications. D.S. Malik, Thomson Learning, I Edn
4. Discrete Mathematics for Computer Science, Haggard, Thomson Learning, I Edn

5. Discrete Mathematics and Its Applications by Kenneth H Rosen. Tata McGraw-Hill Publications
6. Mathematical foundation of Computer Science by Y. N Sings. New Age international Publishers
7. Bernard Kolman, Robert. C.Busby & Sharon Ross, "Discrete Mathematical structures" Prentice Hall of India,2001.

Mapping of COs to Syllabus

	Module I	Module II	Module III	ModuleIV
CO 1	H	M		
CO 2	H	H		H
CO 3	H		H	
CO 4		M	H	
CO5				H

PSPT0038: PHYSICS FOR TECHNOLOGISTS (3-1-0)

Course Outcomes

1. Recall the principles of wave optics (Remembering)
2. Explain the electromagnetic theory and electromagnetic waves (Understanding)
3. Interpret the concepts and principles in quantum mechanics (Understanding)
4. Analyse the physics of semiconductors and their applications (Analysing)

Module 1: Wave Optics (10 lectures)

a) Interference and diffraction: Huygen's principle, superposition of two waves, coherent sources, Young's double slit experiment, intensity distribution; Newton's rings and applications. Fresnel and Fraunhofer diffraction, Fraunhofer diffraction due to a single slit, plane transmission grating; zone plates. Polarization of transverse waves, plane, circular, and elliptically polarized light; polarization by reflection, refraction and scattering.

b) Photonics: spontaneous and stimulated emission, fundamentals of laser action, ruby Laser, He-Ne laser, applications of lasers. Elements of fibre optics, types of optical fibres, numerical aperture. Principles of holography.

Module 2: Electromagnetic Theory (18 lectures

a) Electromagnetism: basic idea of divergence and stokes theorems, Gauss's law and its applications, electrostatic potential, Poisson's and Laplace's equation, work and energy, dielectric polarization bound charges, electric displacement (D); magnetic induction (B), magnetic intensity (H), Biot-Savart's Law, Ampere's circuital law; magnetic susceptibility and ferromagnetic, paramagnetic and diamagnetic materials; Faraday's law of electromagnetic induction, displacement current, Maxwell's equations in differential and integral forms.

b) Electromagnetic waves: Electromagnetic energy densities, Electromagnetic wave equations for E and B, transverse nature and speed of electromagnetic waves, Poynting vector, Poynting theorem.

Module 3: Quantum Physics and Applications (14 lectures)

a) Quantum physics: historical overview; particle aspect of radiation – blackbody radiation, photoelectric effect, Compton scattering; wave aspect of particles – de Broglie's hypothesis, matter waves; Heisenberg's uncertainty principle; transition from deterministic to probabilistic states of a system – wave functions, probability density, superposition principle; observables and operators, expectation values. Schrodinger wave equation.

b) Application of quantum mechanics: solutions of one-dimensional problem, infinite deep potential well – energy eigenvalues, eigenfunctions, potential barrier – tunneling.

Module 4: Semiconductor Physics (18 lectures)

a) Free electron theory, density of states and energy band diagrams, Kronig-Penny model (to introduce origin of band gap), energy bands in solids, E-k diagram, direct and indirect bandgaps, types of electronic materials: metals, semiconductors, and insulators, density of states, occupation probability, Fermi level, effective mass, phonons.

b) Intrinsic and extrinsic semiconductors, dependence of Fermi level on carrier- concentration and temperature (equilibrium carrier statistics), carrier generation and recombination, carrier transport: diffusion and drift, p-n junction, metal-semiconductor junction.

c) Optical transitions in bulk semiconductors: absorption, spontaneous emission, and stimulated emission; joint density of states, density of states for photons, transition rates (Fermi's golden rule), optical loss and gain; photovoltaic effect, exciton, drude model.

Suggested Readings

1. S. Dey, Physics for Engineers and Technologists, Eastern Book House.
2. Halliday, Resnick and Walker, Fundamentals of Physics (Extended), Wiley.
3. H. D. Young and R. A. Freedman, Sears and Zemansky's University Physics, Pearson Education.
4. A. Ghatak, Optics, Tata Mcgraw Hill.

5. D. J. Griffiths, Introduction to Electrodynamics, Pearson, Prentice Hall.
6. A. Beiser, Concepts of Modern Physics, McGraw Hill.
7. L. I. Shiff, Quantum Mechanics, McGraw Hills.
8. E. Merzbacher, Quantum Mechanics, Wiley.
9. G. Aruldas, Quantum Mechanics, PHI Learning.
10. H. Goldstein, Classical Mechanics, Addison-Wesley.
11. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw Hill.
12. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley.
13. P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India.

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4
CO 1	H	L		
CO 2		H		
CO 3		L	H	
CO 4			L	H

PSEP0039: ENGINEERING PHYSICS: MECHANICS (3-1-0)

Course Outcomes:
1. Recall vector algebra and its application (Remembering)
2. Explain motion under constraints and friction (Understanding)
3. Analyse rotating and translating motion of a rigid body (Analysing)
4. Explain the concept elasticity, stress and strain at a point (Evaluating)

Module 1: Vector Mechanics of Particles (20 lectures)
Transformation of scalars and vectors under Rotation transformation; Forces in Nature; Newton's laws and its completeness in describing particle motion; Form invariance of Newton's Second Law; Solving Newton's equations of motion in polar coordinates; Problems including constraints and friction; Extension to cylindrical and spherical coordinates; Potential energy function; F = - Grad V; Conservative and non-conservative forces; Central forces; Conservation of Angular Momentum; Energy equation and energy diagrams; Elliptical, parabolic and hyperbolic orbits; Application: Satellite manoeuvres; Non-inertial frames of reference; Rotating coordinate system: Five-term acceleration formula — Centripetal and Coriolis accelerations; Applications: Weather systems, Foucault pendulum; Harmonic oscillator; Damped harmonic motion; Forced oscillations and resonance.

Module 2: Planar Rigid Body Mechanics (10 lectures)
Definition and motion of a rigid body in the plane; Rotation in the plane; Kinematics in a coordinate system rotating and translating in the plane; Angular momentum about a point of a rigid body in planar motion; Euler's laws of motion, their independence from Newton's laws, and their necessity in describing rigid body motion; Examples; Introduction to three-dimensional rigid body motion — only need to highlight the distinction from two- dimensional motion in terms of (a) Angular velocity vector, and its rate of change and (b) Moment of inertia tensor; Three-dimensional motion of a rigid body wherein all points move in a coplanar manner: e.g. Rod executing conical motion with center of mass fixed — only need to show that this motion looks two-dimensional but is three-dimensional, and two-dimensional formulation fails.

Module 3: Statics (10 lectures)
Free body diagrams with examples on modelling of typical supports and joints; Condition for equilibrium in three- and two-dimensions; Friction: limiting and non- limiting cases; Force- displacement relationship; Geometric compatibility for small deformations; Illustrations through simple problems on axially loaded members like trusses.

Module 4: Mechanics of solids (20 lectures)
Concept of stress at a point; Planet stress: transformation of stresses at a point, principal stresses and Mohr's circle; Displacement field; Concept of strain at a point; Plane strain: transformation of strain at a point, principal strains and Mohr's circle; Strain RoseOe; Discussion of experimental results on one- dimensional material behaviour; Concepts of elasticity, plasticity, strain hardening, failure (fracture / yielding); Idealization of one- dimensional stress-strain curve; Generalized Hooke's law with and without thermal strains for isotropic materials; Complete equations of elasticity; Force analysis — axial force, shear force, bending moment and twisting moment diagrams of slender members (without using singularity functions); Torsion of circular shafts and thin-walled tubes (plastic analysis and rectangular shafts not to be discussed)

Suggested Readings
1. Engineering Mechanics, M. K. Harbola,

2. Introduction to Mechanics., M. K. Verma,
3. An Introduction to Mechanics. D. Kleppner and R. Kolenkow,
4. A. Griths, Principles of Mechanics. J. L. Synge and B. Mechanics. J. P. Den Hartog
5. Engineering Mechanics – Dynamics. J. L. Meriam,
2. Mechanical Vibrations. J. P. Den Hartog,
3. Theory of Vibrations with Applications. W. T. Thomson
4. An Introduction to the Mechanics of Solids. S. H. Crandall, N. C. Dahl & T. J. Lardner,
5. , Engineering Mechanics: Statics. J. L. Meriam
6. , Engineering Mechanics of Solids. E. P. Popov

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4
CO 1	H	L		
CO 2	M	H		
CO 3		M	H	
CO 4			L	H

PSET0040: ENGINEERING PHYSICS: ELECTROMAGNETIC THEORY (3-1-0)

Course Outcomes:

1. Recall the concepts of vector algebra and its application (Remembering)
2. Explain the basic laws of electrostatics and magnetostatics (Understanding)
3. Analyse Faraday's law in terms of EMF produced by changing magnetic flux (Analysing)
4. Explain Maxwell's equations and Electromagnetic waves (Evaluating)

Module 1: Electrostatics in Vacuum (10 lectures)
Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential and uniqueness of their solution and connection with steady state diffusion and thermal conduction; Practical examples like Farady's cage and coffee-ring effect; Boundary conditions of electric field and electrostatic potential; method of images; energy of a charge distribution and its expression in terms of electric field.

Module 2: Electrostatics in a Linear Dielectric Medium (8 lectures)
Electrostatic field and potential of a dipole. Bound charges due to electric polarization; Electric displacement; boundary conditions on displacement; Solving simple electrostatics problems in presence of dielectrics – Point charge at the centre of a dielectric sphere, charge in front of a dielectric slab, dielectric slab and dielectric sphere in uniform electric field.

Module 3: Magnetostatics (9 lectures)
Bio-Savart law, Divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; the equation for the vector potential and its solution for given current densities.

Module 4: Magnetostatics in a Linear Magnetic Medium (7 lectures)
Magnetization and associated bound currents; auxiliary magnetic field ; Boundary conditions on and Solving for magnetic field due to simple magnets like a bar magnet; magnetic susceptibility and ferromagnetic, paramagnetic and diamagnetic materials; Qualitative discussion of magnetic field in presence of magnetic materials.

Module 5: Faraday's law (8 lectures)
Faraday's law in terms of EMF produced by changing magnetic flux; equivalence of Faraday's law and motional EMF; Lenz's law; Electromagnetic braking and its applications; Differential form of Faraday's law expressing curl of electric field in terms of time-derivative of magnetic field and calculating electric field due to changing magnetic fields in quasi-static approximation; energy stored in a magnetic field.

Module 6: Maxwell's equations (9 lectures)
Continuity equation for current densities; Modifying equation for the curl of magnetic field to satisfy continuity equation; displace current and magnetic field arising from time dependent electric field; calculating magnetic field due to changing electric fields in quasistatic approximation. Maxwell's equation in vacuum and non-conducting medium; Energy in an electromagnetic field; Flow of energy and Poynting vector with examples. Qualitative discussion of momentum in electromagnetic fields.

Module 7: Electromagnetic Waves (9 lectures)
The wave equation; Plane electromagnetic waves in vacuum, their transverse nature and polarization; relation between electric and magnetic fields of an electromagnetic wave; energy carried by electromagnetic waves and examples. Momentum

carried by electromagnetic waves and resultant pressure. Reflection and transmission of electromagnetic waves from a nonconducting medium-vacuum interface for normal incidence.

Suggested Readings
1. Introduction to Electrodynamics. David Griffiths,
2. Electricity, Magnetism and Light. , Halliday and Resnick, Physics. W. Saslow,

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6	Module 7
CO 1	H	L					
CO 2		H	H	M			
CO 3					H	M	
CO 4						M	H

PSWO0052: ENGINEERING PHYSICS: WAVES AND OPTICS (3-1-0)

COURSE OUTCOMES
1. Recall the principle of simple harmonic motion (Remembering)
2. Explain the reflection and transmission of waves at a boundary and characteristics of standing waves (Understanding)
3. Analyse the principles of wave optics, interference and diffraction (Analysing)
4. Explain the working principles of optical instruments like interferometers, Newton's rings, etc. and LASER (Evaluating)

Module 1: SHM and Oscillators (11 lectures)
Mechanical and electrical simple harmonic oscillators, complex number notation and phasor representation of simple harmonic motion, damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators, electrical and mechanical impedance, steady state motion of forced damped harmonic oscillator, power absorbed by oscillator.

Module 2: 1D Waves and Dispersion (11 lectures)
Transverse wave on a string, the wave equation on a string, Harmonic waves, reflection and transmission of waves at a boundary, impedance matching, standing waves and their Eigen frequencies, longitudinal waves and the wave equation for them, acoustics waves and speed of sound, standing sound waves. Waves with dispersion, water waves, superposition of waves and Fourier method, wave groups and group velocity.

Module 3: Light propagation and geometrical optics (15 lectures)
Fermat's principle of stationary time and its applications e.g. in explaining mirage effect, laws of reflection and refraction, Light as an electromagnetic wave and Fresnel equations, reflectance and transmittance, Brewster's angle, total internal reflection, and evanescent wave. Mirrors and lenses and optical instruments based on them, transfer formula and the matrix method.

Module 4: Wave Optics (11 lectures)
Huygens' principle, superposition of waves and interference of light by wave front splitting and amplitude splitting; Young's double slit experiment, Newton's rings, Michelson interferometer, Mach-Zehnder interferometer. Farunhofer diffraction from a single slit and a circular aperture, the Rayleigh criterion for limit of resolution and its application to vision; Diffraction gratings and their resolving power

Module 5: Laser Fundamentals (12 lectures)
Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO 2), solid-state lasers(ruby, Neodymium), dye lasers; Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, laser speckles, applications of lasers in science, engineering and medicine.

Suggested Readings
1. Oscillations and waves in physics., Ian G. Main,
2. The physics of vibrations and waves., H. J. Pain,
3. Optics., E. Hecht,
4. Optics. A. Ghatak,
5. Laser Fundamentals, W. T. Silfvast,
6. Principles of Lasers., O. Svelto,

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	L			
CO 2		H			
CO 3			M	H	
CO 4				L	H

PSTC6016: PHYSICS LAB FOR TECHNOLOGISTS (2 credits) (L-T-P:0-0-4)

Course Outcomes:

1. Explain the usage of mechanical and optical systems for various measurements (Understanding)
2. Apply the analytical techniques and graphical analysis to the experimental data (Applying)
3. Evaluate vernier calipers, various rulers, meters, scales and other measuring devices to acquire measurements within the stated precision (Evaluating)

At least 10 experiments to be performed from the following.

1. To determine the frequency of an Electrical maintained tuning fork by Melde's experiments
2. Determination of surface tension by capillary rise method.
3. Determination of wavelength of light by Newton's ring method.
4. Determination of grating element of a diffraction grating.
5. Determination of wavelength of laser source by diffraction grating method.
6. Study of photoemission.
7. Determination of Rigidity modulus by static method.
8. Determination of acceleration due to gravity by Bar pendulum.
9. Determination of thermal conductivity by Lee's method
10. Plotting of characteristic curve of a PN junction diode.
11. Determination of Young's modulus by Searle's method.
12. Study of RC circuit.

PSEG6017: PHYSICS LAB FOR ENGINEERS (1 credit) (L-T-P:0-0-2)

Course Outcomes:

1. Explain the usage of mechanical and optical systems for various measurements (Understanding)
2. Apply the analytical techniques and graphical analysis to the experimental data (Applying)
3. Evaluate vernier calipers, various rulers, meters, scales and other measuring devices to acquire measurements within the stated precision (Evaluating)

At least 10 experiments to be performed from the following.

1. To determine the frequency of an Electrical maintained tuning fork by Melde's experiments
2. Determination of surface tension by capillary rise method.
3. Determination of wavelength of light by Newton's ring method.
4. Determination of grating element of a diffraction grating.
5. Determination of wavelength of laser source by diffraction grating method.
6. Study of photoemission.
7. Determination of Rigidity modulus by static method.
8. Determination of acceleration due to gravity by Bar pendulum.
9. Determination of thermal conductivity by Lee's method
10. Plotting of characteristic curve of a PN junction diode.
11. Determination of Young's modulus by Searle's method.
12. Study of RC circuit.

BOBY0003: BIOLOGY (2-0-0)

Course Outcomes

1. Compare the two, three, four and five kingdom classifications. Highlight the criteria for classification (Understanding)
2. Apply thermodynamic principles to biological systems. (Applying)
3. Analyze biological processes at the reductionist level. (Analyzing)
4. Examine DNA as a genetic material in the molecular basis of information transfer (Evaluating)

Module I: Classification 5 lectures

Classification and its criteria**:** Morphological, Biochemical and Ecological; Hierarchy of
Classifications, based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e)Habitata-acquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life; Organism from different based on classification for the study :1. E.coli, 2. S.cerevisiae, 3. D. Melanogaster, 4.C. elegance, 5. A. Thaliana, 6. M. musculus

Module 2: Genetics and Information Transfer 13 lectures

a. Mendel's laws: Law of segregation and Law of independent assortment, Dominance,Recessiveness; Allele, Gene mapping, Gene interaction, Epistasis ; Meiosis and Mitosis in heredity; Gene – mapping; Genetic disorders in humans; complementation in human genetics.

b. DNA as a genetic material; Structure of DNA- single stranded, double stranded and nucleosomes; Genetic code-Salient features; Gene - complementation and recombination.

Module 3: Biomolecules and Enzymes 14 lectures

a. Biomolecules of life: Micromolecules and Macromolecules- sugars, starch and cellulose; Amino acids and proteins; Nucleotides and DNA/RNA; Two carbon units and lipids. Structure of proteins: Primary, Secondary, tertiary and Quaternary; Proteins as enzymes, transporters, receptors and structural elements.

b. Enzyme classification. Mechanism of enzyme action of any two enzyme. Enzyme kinetics and kinetic parameters; RNA catalysis.

Module 4: Metabolism 5 lectures

Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergoinc reactions. Keq and its relation to standard free energy. Spontaneity. ATP as an energy currency; Glycolysis and Krebs cycle; Photosynthesis; Energy yielding and energy consuming reactions. Energy charge

Module 5: Microbiology 4 lectures

Unicellular organisms; Species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of unicellular organisms. Sterilization and media compositions. Growth kinetics.

Suggested Readings

1. **Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd**
2. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons
3. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company
4. Molecular Genetics (Second edition), Stent, G. S.; and Calender, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher
5. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C.Brown Publishers

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	M		H	
CO 2				M	
CO 3	M		M	H	H
CO 4	M	H	H		

SCHOOL OF TECHNOLOGY

DEPARTMENT OF HUMANITIES

EGRW0015: ENGLISH FOR RESEARCH PAPER WRITING (Audit Course)

***Objectives**: Students will be able to:*

- *Understand that how to improve your writing skills and level of readability*
- *Learn about what to write in each section*
- *Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission.*

Module I (4 hours)
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Module II (4 hours)
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

Module III (4 hours)
Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Module IV (4 hours)
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

Module V (4 hours)
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

Module VI (4 hours)
Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Suggested Readings

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg

EGCS0110: COMMUNICATION SKILLS (Audit Course)

***Objective**: The objective of this audit course is to prepare students to be effective in their career in the corporate world where they will use their professional expertise. This course enables students*

- *To understand the difference between hard skills and soft skills*
- *To learn the importance of communication skills as part of the soft skills,*
- *To be familiar with the various features of effective communication, which includes verbal, non-verbal, written communication and body language.*

COURSE/LEARNING OUTCOMES

At the end of this course students will be able to:

CO 1: *Recognise* the difference between hard and soft skills
CO 2: *Understand* the importance of communication skills
CO 3: *Analyse* features of effective communication
CO 4: *Apply* the soft skills in the corporate world

EGEH0111: ENGLISH (2 Credits- 30 hours) (L-T-P: 2-0-0)

***Objective:** The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.*

Module I: Vocabulary Building (6 hours)

1. The concept of Word Formation

2. Root words from foreign languages and their use in English
3. Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.
4. Synonyms, antonyms, and standard abbreviations.

Module II: Basic Writing Skills (6 hours)

a) Sentence Structures
b) Use of phrases and clauses in sentences
c) Importance of proper punctuation
d) Creating coherence
e) Organizing principles of paragraphs in documents
f) Techniques for writing precisely

Module III: Identifying Common Errors in Writing (5 hours)

Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés

Module IV: Nature and Style of sensible Writing (6 hours)

Describing, Defining, Classifying, providing examples or evidence, Writing introduction and conclusion

Module V: Writing Practices (7 hours)

Comprehension, Précis Writing, Essay Writing

Suggested Readings

1. *Practical English Usage*. Michael Swan. OUP. 1995.
2. *Remedial English Grammar*. F.T. Wood. Macmillan.2007
3. *On Writing Well.* William Zinsser. Harper Resource Book. 2001
4. *Study Writing*. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.

EGOC6005: ORAL COMMUNICATION PRACTICE LAB (1 Credit) (L-T-P:0-0-2)

(This unit involves interactive practice sessions in Language Lab)

1. Listening Comprehension
2. Pronunciation, Intonation, Stress and Rhythm
3. Common Everyday Situations: Conversations and Dialogues
4. Communication at Workplace
5. Interviews
6. Formal Presentations

COURSE /LEARNING OUTCOMES

After the completion of this Lab the students will be able to:

CO 1: *List* out the different vowel sounds and consonant sounds (Remembering)
CO 2: *Illustrate* the stress and intonation patterns in language. (Understanding)
CO 3: *Identify* the erroneous pronunciations. (Applying)
CO 4: *Compare* the pronunciation of similar sounding words. (Analysing)
CO 5: *Discuss* the tips for facing an interview. (Evaluating)
CO 6: *Determine* the common patterns in everyday conversations and dialogues. (Creating)

Suggested Readings

1. Communication Skills. Sanjay Kumar and Pushp Lata. Oxford University Press. 2011.
2. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

MTOB0069: INTRODUCTION TO ORGANISATIONAL BEHAVIOUR (2 credits – 30 hours) (L-T-P:2-0-0)

Objective*: This course is designed to give students the basic knowledge of human behavior needed to provide a more effective organizational environment. The basic elements of the course will be the behavior of individuals in organizations, group behavior in organizations, and how these behaviors affect the overall performance of organizations. Particular emphasis is placed on individual difference, attitude, motivation, job satisfaction, communication, leadership, stress, change, and organizational culture.*

Module I (5 hours)

The Study of Organizational Behaviour (OB): Learning objectives, Definition and Meaning, Why Study OB, Models in OB, New Challenges for OB Manager. Learning – Nature of Learning, How Learning occurs, Learning and OB. Case Analysis

Module II (7 hours)

Foundations of Individual Behaviour: Personality – Meaning and Definition, Determinants of Personality, Personality Traits, Personality and OB. Perception – Meaning and Definition, Perceptual Process, Importance of Perception in OB. Motivation– Nature and Importance, Hertzberg's Two Factor Theory, Maslow's Need Hierarchy Theory, Alderfer's ERG Theory, Evaluations. Case Analysis

Module III (10 hours)

a) Organizational Behaviour Process: Communication – Importance, Types, Gateways and Barriers to Communication, Communication as a tool for improving Interpersonal Effectiveness. Groups in Organizations - Nature, Types, Why do people join groups, Group Cohesiveness and Group Decision making Managerial Implications, Effective Team Building.
b) Leadership – Leadership and Management, Theories of Leadership – Trait theory, Leader Behaviour theory, Contingency Theory, Leadership and Followership, How to be an effective Leader. Conflict – Nature of Conflict and Conflict Resolution. An Introduction to Transactional Analysis (TA). Case Analysis

Module IV (8 hours)

Organization: Organizational Culture – Meaning and Definition, Culture and Organizational Effectiveness. Introduction to Human Resource Management – Selection, Orientation, Training and Development, Performance Appraisal, Incentives; Organizational Change – Importance of Change, Planned Change and OB techniques. International Organizational Behaviour – Trends in International Business, Cultural Differences and Similarities, Individual and Interpersonal Behaviour in Global Perspective. Case Analysis

Suggested Readings

1. VSP Rao, Organizational Behaviour, Excel Books.
2. Stephen P Robbins, Organizational Behaviour, PHI Learning, New Delhi
3. JW Newstorm and K. Davis, Organizational Behaviour: Human Behaviour at Work, MGH, New Delhi
4. K. Aswathappa, Organizational Behaviour, Himalaya Publishing House, New Delhi
5. PN Khandawalla, Organizational Behaviour, McGraw Hill, New Delhi.

COURSE/LEARNING OUTCOMES

At the end of the course students will be able to:

CO1: Define the meaning of organization behavior (Knowledge)
CO2: Explain the models and the theory of learning and the foundations of individual behavior. (Comprehension)
CO3: Establish the relationship between the various theories of motivation and workplace behavior. (Application)
CO4: Differentiate between leadership and management and the different leadership theories. (Analysis)
CO5: Formulate different types of leadership strategies. (Synthesis)
CO6: Evaluate the various human resource management functions. (Evaluation)

MTEC0074: ECONOMICS FOR ENGINEERS (2 credits – 30 hours)(L-T-P:2-0-0)

***Objective**: The objective of this course is to make the students of engineering aware of the basic concepts in Economics, introduce them to the preliminary techniques of quantitative analysis in Economics and finally to certain relevant concepts of the stock market. The purpose of this course is to increase the all round knowledge of the engineer and enhance his/her professional competence in the work field.*

Module I (9 hours)

a) Definition of Economics: Subject matter, scope, principal division of Economics – Microeconomics and Macroeconomics.
b) Theory of Demand: Meaning of Demand and Supply, The law of demand, meaning of utility, marginal utility and total utility, law of diminishing marginal utility, Indifference curve approach, Consumer's Equilibrium, elasticity of demand- determinants, types and measurement, exceptions to the law of demand.
c) Theory of Production: Meaning of Production function, production function with one variable input – Law of Variable Proportions, production function with two variable inputs– Law of Returns to Scale, Cobb-Douglas production function. Economic concept of cost- short-run and long-run.
d) Market Structure: Market Classification- perfect competition, monopoly, monopolistic competition. Concepts of Revenue - Average Revenue, Marginal Revenue and Total Revenue. The firm- objectives and constraints, Equilibrium of the firm- TR-TC approach, MR-MC approach.

Module II (10 hours)

a) Macroeconomic concepts and aggregates: Circular flow of income, National Income- GDP, GNP, Meaning and relation between: consumption, saving, investment. Aggregate demand and aggregate supply - Saving and Investment functions, Multiplier Mechanism
b) Money: Definition of money, functions of money, Money Supply- M1M2M3M4, Inflation- meaning, types, control of inflation- monetary policy, fiscal policy.
c) Banking: Central Banks, Commercial Banks, creation of credit.

d) Trade Cycles: Meaning of Trade Cycle, Various phases of Trade Cycle.
e) International Trade: Balance of Payments, Devaluation, Exchange Rate, Special Drawing Rights (SDR), IMF, WTO, concept of Globalization, Role of MNCs, Regional Economic Integration.

Module III (6 hours)
a) Quantitative Analysis in Economics: Profit Maximization problems, break-even analysis, demand estimation.
b) Introduction to Statistics: Data, diagram, Data Interpretation problems, Measures of Central Tendency, Measures of Dispersion, dispersion, Index numbers.

Module IV (5 hours)
a) Introduction to Stock Market: Stock Markets - Meaning, NSE, BSE, NYSE, Stock Market Indices - SENSEX, NIFTY, DOW. Bull Market and Bear Market, Role of SEBI in stock market, FDIs and FIIs, Role of FIIs in stock market.
b) Basic terms related to stock market: Shares, equity shares, bonus shares, preference shares, buyback shares, splitting of shares, trading - intraday trading, commodity trading, futures, hedging, arbitrage.
c) Mutual Funds: Meaning of Mutual funds, Types of Mutual Fund.

COURSE/LEARNING OUTCOMES
At the end of the course students will be able to:
CO1: Describe the subject matter of Economics. (Comprehension)
CO2: Define and comprehend the meaning of demand and supply. (Knowledge & Comprehension)
CO3: Describe the factors of production (Comprehension)
CO4: Distinguish between different market forms (Knowledge)
CO5: Compute cost, revenue and profit of firms (Comprehension)
CO6: Explain how money is circulated in an economy. (Comprehension)
CO7: Outline the different concepts of national income. (Analysis)
CO8: Describe the banking system of an economy. (Comprehension)
CO9: Apply the statistical concepts to interpret different forms of data. (Application)
CO10: Construct price index. (Synthesis)
CO11: Interpret and evaluate the functioning of the stock market. (Evaluation)

Suggested Readings
1. H.L. Ahuja, Modern Economics, S. Chand & Co. Ltd., New Delhi
2. Dr. K.K Dewett and M.H. Navalur, Modern Economic Theory, S. Chand & Co. Ltd., New Delhi
3. Manab Adhikary, Business Economics, Excel Books.
4. Madhu Vij, International Financial Management, Excel Books.
5. Koutsoyiannis, Modern Microeconomics, Palgrave MacMillan, 2003, 2nd Revised edition
6. Dominik Salvatore, Microeconomic Theory, Schaum's Outline series, TMH.
7. Bradley Schiller, Essentials of Economics, Tata Mcgraw Hill.
8. Atmanand, Managerial Economics, Excel Books.
9. M S Loganathan and B Nandhakumar, Dictionary for Economics, Excel Books.
10. Sheetal Thomas, Dictionary of Finance, Excel Books.

MTOB0086: ORGANISATIONAL BEHAVIOUR (3 credits – 30 hours) (L-T-P:3-0-0)
Objective*: This course is designed to give students the basic knowledge of human behavior needed to provide a more effective organizational environment. The basic elements of the course will be the behavior of individuals in organizations, group behavior in organizations, and how these behaviors affect the overall performance of organizations. Particular emphasis is placed on individual difference, attitude, motivation, job satisfaction, communication, leadership, stress, change, and organizational culture.*

Module I (5 hours)
The Study of Organizational Behaviour (OB): Learning objectives, Definition and Meaning, Why Study OB, Models in OB, New Challenges for OB Manager. Learning – Nature of Learning, How Learning occurs, Learning and OB. Case Analysis

Module II (7 hours)
Foundations of Individual Behaviour: Personality – Meaning and Definition, Determinants of Personality, Personality Traits, Personality and OB. Perception – Meaning and Definition, Perceptual Process, Importance of Perception in OB. Motivation– Nature and Importance, Hertzberg's Two Factor Theory, Maslow's Need Hierarchy Theory, Alderfer's ERG Theory, Evaluations. Case Analysis

Module III (10 hours)
a) Organizational Behaviour Process: Communication – Importance, Types, Gateways and Barriers to Communication,

Communication as a tool for improving Interpersonal Effectiveness. Groups in Organizations - Nature, Types, Why do people join groups, Group Cohesiveness and Group Decision making Managerial Implications, Effective Team Building.

b) Leadership – Leadership and Management, Theories of Leadership – Trait theory, Leader Behaviour theory, Contingency Theory, Leadership and Followership, How to be an effective Leader. Conflict – Nature of Conflict and Conflict Resolution. An Introduction to Transactional Analysis (TA). Case Analysis

Module IV (8 hours)

Organization: Organizational Culture – Meaning and Definition, Culture and Organizational Effectiveness. Introduction to Human Resource Management – Selection, Orientation, Training and Development, Performance Appraisal, Incentives; Organizational Change – Importance of Change, Planned Change and OB techniques. International Organizational Behaviour – Trends in International Business, Cultural Differences and Similarities, Individual and Interpersonal Behaviour in Global Perspective. Case Analysis

COURSE/LEARNING OUTCOMES

At the end of the course students will be able to:

CO1: Define the meaning of organization behavior (Knowledge)
CO2: Explain the models and the theory of learning and the foundations of individual behavior. (Comprehension)
CO3: Establish the relationship between the various theories of motivation and workplace behavior. (Application)
CO4: Differentiate between leadership and management and the different leadership theories. (Analysis)
CO5: Formulate different types of leadership strategies. (Synthesis)
CO6: Evaluate the various human resource management functions. (Evaluation)

Suggested Readings

1. VSP Rao, Organizational Behaviour, Excel Books.
2. Stephen P Robbins, Organizational Behaviour, PHI Learning, New Delhi
3. JW Newstorm and K. Davis, Organizational Behaviour: Human Behaviour at Work, MGH, New Delhi
4. K. Aswathappa, Organizational Behaviour, Himalaya Publishing House, New Delhi
5. PN Khandawalla, Organizational Behaviour, McGraw Hill, New Delhi.

MTEE0104: ECONOMICS FOR ENGINEERS (3 credits – 45 hours) (L-T-P:3-0-0)

***Objective**: The objective of this course is to make the students of engineering aware of the basic concepts in Economics, introduce them to the preliminary techniques of quantitative analysis in Economics and finally to certain relevant concepts of the stock market. The purpose of this course is to increase the all round knowledge of the engineer and enhance his/her professional competence in the work field.*

Module I (15 hours)

a) Definition of Economics: Subject matter, scope, principal division of Economics – Microeconomics and Macroeconomics.
b) Theory of Demand: Meaning of Demand and Supply, The law of demand, meaning of utility, marginal utility and total utility, law of diminishing marginal utility, Indifference curve approach, Consumer's Equilibrium, elasticity of demand- determinants, types and measurement, exceptions to the law of demand.
c) Theory of Production: Meaning of Production function, production function with one variable input – Law of Variable Proportions, production function with two variable inputs – Law of Returns to Scale, Cobb-Douglas production function. Economic concept of cost- short-run and long-run.
d) Market Structure: Market Classification- perfect competition, monopoly, monopolistic competition. Concepts of Revenue - Average Revenue, Marginal Revenue and Total Revenue. The firm- objectives and constraints, Equilibrium of the firm- TR-TC approach, MR-MC approach.

Module II (10 hours)

a) Macroeconomic concepts and aggregates: Circular flow of income, National Income- GDP, GNP, Meaning and relation between: consumption, saving, investment. Aggregate demand and aggregate supply - Saving and Investment functions, Multiplier Mechanism.
b) Money: Definition of money, functions of money, Money Supply- M1M2M3M4, Inflation- meaning, types, control of inflation- monetary policy, fiscal policy.
c) Banking: Central Banks, Commercial Banks, creation of credit.
d) Trade Cycles: Meaning of Trade Cycle, Various phases of Trade Cycle.
e) International Trade: Balance of Payments, Devaluation, Exchange Rate, Special Drawing Rights (SDR), IMF, WTO, concept of Globalization, Role of MNCs, Regional Economic Integration.

Module III (10 hours)

a) Quantitative Analysis in Economics: Profit Maximization problems, break-even analysis, demand estimation.

b) Introduction to Statistics: Data, diagram, Data Interpretation problems, Measures of Central Tendency, Measures of Dispersion, dispersion, Index numbers.

Module IV (10 hours)

a) Introduction to Stock Market: Stock Markets - Meaning, NSE, BSE, NYSE, Stock Market Indices - SENSEX, NIFTY, DOW. Bull Market and Bear Market, Role of SEBI in stock market, FDIs and FIIs, Role of FIIs in stock market.
b) Basic terms related to stock market: Shares, equity shares, bonus shares, preference shares, buyback shares, splitting of shares, trading - intraday trading, commodity trading, futures, hedging, arbitrage.
c) Mutual Funds: Meaning of Mutual funds, Types of Mutual Fund.

COURSE/LEARNING OUTCOMES

At the end of the course students will be able to:

CO1: Describe the subject matter of Economics. (Comprehension)
CO2: Define and comprehend the meaning of demand and supply. (Knowledge & Comprehension)
CO3: Describe the factors of production (Comprehension)
CO4: Distinguish between different market forms (Knowledge)
CO5: Compute cost, revenue and profit of firms (Comprehension)
CO6: Explain how money is circulated in an economy. (Comprehension)
CO7: Outline the different concepts of national income. (Analysis)
CO8: Describe the banking system of an economy. (Comprehension)
CO9: Apply the statistical concepts to interpret different forms of data. (Application)
CO10: Construct price index. (Synthesis)
CO11: Interpret and evaluate the functioning of the stock market. (Evaluation)

Suggested Readings

1. H.L. Ahuja, Modern Economics, S. Chand & Co. Ltd., New Delhi
2. Dr. K.K Dewett and M.H. Navalur, Modern Economic Theory, S. Chand & Co. Ltd., New Delhi
3. Manab Adhikary, Business Economics, Excel Books.
4. Madhu Vij, International Financial Management, Excel Books.
5. Koutsoyiannis, Modern Microeconomics, Palgrave MacMillan, 2003, 2nd Revised edition
6. Dominick Salvatore, Microeconomic Theory, Schaum's Outline series, TMH.
7. Bradley Schiller, Essentials of Economics, Tata Mcgraw Hill.
8. Atmanand, Managerial Economics, Excel Books.
9. M S Loganathan and B Nandhakumar, Dictionary for Economics, Excel Books.
10. Sheetal Thomas, Dictionary of Finance, Excel Books.

MTPP0105: PROFESSIONAL PRACTICE LAW AND ETHICS (2 credits –30 hours) (L-T-P:2-0-0)

Objective*: Basic elements of civil engineering professional practice are introduced in this course. Roles of all participants in the process-owners, developers, designers, consultants, architects, contractors, and suppliers - are described. Basic concepts in professional practice, business management, public policy, leadership, and professional licensure are introduced. The course covers professional relations, civic responsibilities, and ethical obligations for engineering practice. The course will make the students understand contracts management and various legal aspects related to engineering. Further, the course familiarizes students with elementary knowledge of laws that would be of utility in their profession, including several new areas of law such as IPR, ADR. The course is designed to address the following:*

To make the students understand the types of roles they are expected to play in the society as practitioners of the civil engineering profession. To develop some ideas of the legal and practical aspects of their profession.

Module I: Professional Practice (5 Hours)

Respective roles of various stakeholders: Government (constituting regulatory bodies and standardization organizations, prescribing norms to ensure safety of the citizens); Standardization Bodies (ex. BIS, IRC)(formulating standards of practice); professional bodies (ex. Institution of Engineers(India), Indian Roads Congress, IIA/ COA, ECI,
Local Bodies/ Planning Authorities) (certifying professionals and offering platforms for interaction);
Clients/ owners (role governed by contracts); Developers (role governed by regulations such as RERA); Consultants (role governed by bodies such as CEAI); Contractors (role governed by contracts and regulatory Acts and Standards); Manufacturers/ Vendors/ Service agencies (role governed by contracts and regulatory Acts and Standards)

Module II: Professional Ethics (4 Hours)

Definition of Ethics, Professional Ethics, Business Ethics, Corporate Ethics, Engineering Ethics, Personal Ethics; Code of Ethics as defined in the website of Institution of Engineers (India); Profession, Professionalism, Professional Responsibility, Professional Ethics; Conflict of Interest, Gift Vs Bribery, Environmental breaches, Negligence, Deficiencies in state-of-the-art; Vigil Mechanism, Whistleblowing, protected disclosures.

Module III: General Principles of Contracts Management (4 Hours)

Indian Contract Act, 1972 and amendments covering General principles of contracting; Contract Formation & Law; Privacy of contract; Various types of contract and their features; Valid & Voidable Contracts; Prime and subcontracts; Joint Ventures & Consortium; Complex contract terminology; Tenders, Request Proposals, Bids & Proposals; Bid Evaluation; Contract Conditions & Specifications; Critical /"Red Flag" conditions; Contract award & Notice To Proceed; Variations & Changes in Contracts; Differing site conditions; Cost escalation; Delays, Suspensions & Terminations; Time extensions & Force Majeure; Delay Analysis; Liquidated damages & Penalties; Insurance & Taxation; Performance and Excusable Non-performance; Contract documentation; Contract Notices; Wrong practices in contracting (Bid shopping, Bid fixing, Cartels); Reverse auction; Case Studies; Build- Own-Operate & variations; Public- Private Partnerships; International Commercial Terms.

Module IV: Arbitration, Conciliation and ADR (Alternative Dispute Resolution) system. (6 Hours)

Meaning, scope and types – distinction between laws of 1940 and 1996; UNCITRAL model law – Arbitration and expert determination; Extent of judicial intervention; International commercial arbitration; Arbitration agreements – essential and kinds, validity, reference and interim measures by court; Arbitration tribunal – appointment, challenge, jurisdiction of arbitral tribunal, powers, grounds of challenge, procedure and court assistance; Award including Form and content, Grounds for setting aside an award, Enforcement, Appeal and Revision; Enforcement of foreign awards – New York and Geneva Convention Awards; Distinction between conciliation, negotiation, mediation and arbitration, confidentiality, resort to judicial proceedings, costs; Dispute Resolution Boards; Lok Adalats.

Module V: Engagement of Labour and Labour & other construction-related Laws. (6 Hours)

Role of Labour in Civil Engineering; Methods of engaging labour- on rolls, labour sub-contract, piece rate work; Industrial Disputes Act, 1947; Collective bargaining; Industrial Employment (Standing Orders) Act, 1946; Workmen's Compensation Act, 1923; Building & Other Construction Workers (regulation of employment and conditions of service) Act (1996) and Rules (1998); RERA Act 2017, NBC 2017

Module VI: Law relating to Intellectual property. (6 Hours)

Introduction – meaning of intellectual property,main forms of IP, Copyright, Trademarks, Patents and Designs, Secrets; Law relating to Copyright in India including Historical evolution of Copy Rights Act, 1957, Meaning of copyright – computer programs, Ownership of copyrights and assignment, Criteria of infringement, Piracy in Internet – Remedies and procedures in India; Law relating to Patents under Patents Act, 1970 including Concept and historical perspective of patents law in India, Patentable inventions with special reference to biotechnology products, Patent protection for computer programs, Process of obtaining patent – application, examination, opposition and sealing of patents, Patent cooperation treaty and grounds for opposition, Rights and obligations of patentee, Duration of patents – law and policy considerations, Infringement and related remedies

COURSE/LEARNING OUTCOMES

At the end of the course students will be able to:

- CO1: To familiarise the students to what constitutes professional practice, introduction of various stakeholders and their respective roles; understanding the fundamental ethics governing the profession (Remembering)
- CO2: To give a good insight into contracts and contracts management in civil engineering, dispute resolution mechanisms; laws governing engagement of labour (Understanding)
- CO3: To give an understanding of Intellectual Property Rights, Patents (Applying)
- CO4: To make the students understand the types of roles they are expected to play in the society as practitioners of the civil engineering profession (Analysing)
- CO5: To develop good ideas of the legal and practical aspects of their profession (Evaluating)
- CO6: To develop some ideas of the legal and practical aspects of their profession (Creating)

Suggested Readings

1. B.S. Patil, Legal Aspects of Building and Engineering Contracts, 1974.
2. The National Building Code, BIS, 2017
3. RERA Act, 2017
4. Meena Rao (2006), Fundamental concepts in Law of Contract, 3rd Edn. Professional Offset
5. Neelima Chandiramani (2000), The Law of Contract: An Outline, 2nd Edn. Avinash Publications Mumbai
6. Avtar Singh (2002), Law of Contract, Eastern Book Co.
7. Dutt (1994), Indian Contract Act, Eastern Law House
8. Anson W.R. (1979), Law of Contract, Oxford University Press
9. Kwatra G.K. (2005), The Arbitration & Conciliation of Law in India with case law on UNCITRAL Model Law on Arbitration, Indian Council of Arbitration
10. Wadhera (2004), Intellectual Property Rights, Universal Law Publishing Co.
11. T. Ramappa (2010), Intellectual Property Rights Law in India, Asia Law House
12. Bare text (2005), Right to Information Act

13. O.P. Malhotra, Law of Industrial Disputes, N.M. Tripathi Publishers
14. K.M. Desai(1946), The Industrial Employment (Standing Orders) Act
15. Rustamji R.F., Introduction to the Law of Industrial Disputes, Asia Publishing House
16. Vee, Charles & Skitmore, Martin (2003) Professional Ethics in the Construction Industry, Engineering Construction and Architectural management, Vol.10, Iss2, pp 117-127, MCB UP Ltd
17. American Society of Civil Engineers (2011) ASCE Code of Ethics – Principles Study and Application
18. Ethics in Engineering- M.W.Martin & R.Schinzinger, McGraw-Hill
19. Engineering Ethics, National Institute for Engineering Ethics, USA
20. www.ieindia.org
21. Engineering ethics: concepts and cases – C. E. Harris, M.S. Pritchard, M.J.Rabins
22. CONSTRUCTION CONTRACTS, http://www.jnormanstark.com/contract.htm
23. Internet and Business Handbook, Chap 4, CONTRACTS LAW, http://www.laderapress.com/laderapress/contractslaw1.html
24. Contract & Agreements http://www.tco.ac.ir/law/English/agreements/General/Contract%20Law/C.htm
25. Contracts, http://206.127.69.152/jgretch/crj/211/ch7.ppt
26. Business & Personal Law. Chapter 7. "How Contracts Arise", http://yucaipahigh.com/schristensen/lawweb/lawch7.ppt
27. Types of Contracts, http://cmsu2.cmsu.edu/public/classes/rahm/meiners.con.ppt

MTPO0106: PRODUCTION AND OPERATIONS MANAGEMENT (3 credits – 45 hours) (L-T-P:3-0-0)

***Objective**: This course aims at acquainting the students with the functions of production and operations management and basic issues and tools of managing production and operation functions of an organization. The course also intends to provide the students a system theoretic view on project management and helps develop an understanding on why today's organizations are cultivating a formal project management process to gain competitive advantage. The syllabus has an in-depth coverage of the most critical topics found in PMBOK (Project Management Body of Knowledge) Guide.*

Module I: Introduction and Work Study (10 hours)

a) Introduction to Production and operations management
b) Meaning and scope, subdivisions of work study – Method/Motion study and Work Measurement
c) Method/ Motion study- its meaning and scope, steps in method/motion study, Tools and techniques of method/motion study, Principles of motion economy
d) Micro-motion study – Meaning and scope, therbligs, use of motion camera in micro- motion study
e) Work measurement – concept of observed time, rating/leveling factor, average worker and standard time for jobs. Use of stop watch and work sampling techniques in the determination of standard time.

Module II: Plant Location and layout (10 hours)

a) Objectives, Locational factors, Economics of plant location
b) Meaning, objectives and types of plant layout and their relevance to mass, batch and job- order production systems.
c) Systematic Layout Planning (SLP) procedure
d) Use of computers for layout design
e) Group Technology (GT), Flexible manufacturing systems (FMS) and Computer integrated manufacturing (CIM)
f) Assembly Line Balancing (ALB) - meaning and objective, Heuristic methods for solution of ALB problems.

Module III: Product design and Development and PPC (10 hours)

a) Meaning of product, Product life cycle (PLC) and Product mix
b) Decisions to be taken during product development and design
c) Procedure for product development and design
d) Value of a product – its meaning, Value Analysis (VA) – its objectives, procedure and example, Simplification and Standardization.
e) Meaning and Objectives of PPC, Effects of types of production
f) Steps in PPC primarily stressing the needs of marketing research, Demand forecasting, process planning/routing, scheduling of flow-shop and job-shop productions, Use of Gantt chart, Machine loading, Make/Buy decision and Break-even analysis, Master production schedule, MRP and MRP-II, Capacity planning, Inventory management.
g) Production control – monitoring, expediting and re-planning, Planning and control of batch production. TOC, Use of L.P in Production Management, Product and service Reliability.

Module IV: Project Management (15 hours)

a) Project management framework, Scope management.
b) Project management processes, Cost and Time management, Project integration management, Project risk management, Project Quality management, Project communication management.

COURSE/LEARNING OUTCOMES

At the end of the course students will be able to:

CO1: Define a production system. (Knowledge)
CO2: Distinguish between production and operations. (Comprehension)
CO3: Use the tools and techniques to measure work study, motion study. (Application)
CO4: Apply the concepts of work sampling techniques in the determination of standard time. (Application)
CO5: Comprehend the significance of plant location and prepare systematic layout planning procedure. (Synthesis)
CO6: Explain product life cycle and product mix. (Comprehension)
CO7: Demonstrate the procedure for product development and design. (Application)
CO8: Compare between make or buy decisions. (Analysis)
CO9: Apply various tools of demand forecasting. (Application)
CO10: Determine inventory and inventory control techniques. (Application)
CO11: Synthesize project management framework. (Synthesis)
CO12: Compute project completion time and Analyse and evaluate project risk management techniques. (Application, Analysis & Evaluation)

Suggested Reading

1. M. Telsang, Industrial Engineering, S. Chand & Company Ltd.
2. Kanishka Bedi, Production and Operations Management, Oxford University Press.
3. O. P. Khanna, Industrial Engineering and Management, Dhanpat Rai & Sons.
4. M. Mahajan, Industrial engineering, Dhanpat Rai & Company.
5. L. Krajewski, L. Ritzman and M. Malhotra, Operations Management, Pearson Education.
6. Adam, Ebert, Production and Operations Management, PHI.
7. R. Panneerselvam, Production and Operations Management, PHI.
8. K. Aswathappa & K. Shridhara Bhat, Production and Operations Management, Himalaya Publishing

MTFC0107: FINANCIAL MANAGEMENT AND ACCOUNTING (2 credits - 30 hours)

Objective: *The objective of the course is to provide a broad exposure to the basic terminology, tools, and techniques of financial management and accounting which will enable the students to understand accounting issues as they arise in either the financial press or in the workplace. The knowledge gained through this subject can also be helpful in operational and strategic decision making.*

Module I (7 hours)

a) Introduction: Financial Management, Financial Planning and Capitalization- definitions, objectives, changing roles and functions, Financial Decision.
b) Capital Budgeting: Nature of Investment decision, Importance of Capital Budgeting, The Capital. Budgeting Process - Investment criterion, Pay-back period, Accounting, ROR (Rate of Return) Method, Discounting Cash flow method, Net - present value method, IRR (Internal Rate of Return) method.

Module II (7 hours)

a) Management of Working Capital: Various concepts, Elements, Classification, Financing and importance of working capital, Investment analysis, Cash flow determination, cost of capital, capital budgeting methods.

Module III (8 hours)

Cost - Volume - Profit Analysis: Classification of costs, Allocation, apportionment and absorption, Cost centers, different costing systems, Cost analysis for managerial decisions, Meaning of Linear CVP analysis, Objectives, Assumptions, Break - Even analysis, determining the Break-Even point profit, Volume graph profit, Volume ratios margin of Safety.

Module IV (8 hours)

a) Introduction to Accounting: basic accounting concepts, important definitions, uses; types of accounting, financial statements, introduction to journal accounting; different types of vouchers, double entry bookkeeping, different types of transactions related to financial accounting.
b) Financial Control: Ledgers and preparation of trial balance, preparation of balance sheet and profit and loss accounts, controlling other departments by financial accounting.

COURSE/LEARNING OUTCOMES

At the end of the course students will be able to:
CO1: Describe the term financial management (Understanding)
CO2: State the different tools and techniques of financial management. (Analysing)
CO3: Describe in detail about capital budgeting. (Applying)
CO4: Define Internal Rate of Return (Remembering)
CO5: Illustrate investment analysis (Understanding)
CO6: Define cost analysis for marginal decision (Understanding)

CO7: Estimate break-even point and explain what break even analysis is. (Evaluating)
CO8: Estimate margin of safety (Evaluating)
CO9: Prepare journals, ledger, Trial Balance (Applying)
CO10 Prepare and assess financial statement (Evaluating)

Suggested Readings
1. P.K. Jain, Financial Management and Accounting, S. Chand and Co.
2. R.K. Sharma and S.K. Gupta, Management and Accounting: Principles and Practice, Kalyani Publishers.
3. R.S. Kaplan and A.A. Atkinson, Advanced Management Accounting, PHI.
4. Van Horne, Fundamentals of Financial Management, Pearson

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4
CO 1	M			
CO 2		H		M
CO 3	L		H	
CO 4	H	L		

BTUH0001: STUDENT INDUCTION PROGRAM
(P/NP)
The following list presents the topics covered in the Mandatory Student Induction Program conducted in the Assam Don Bosco University School of Technology:

1. Physical activity – Yoga and sports activity (indoor and outdoor)
2. Creative arts through Extra-curricular clubs e.g., music & singing, dance, drama, debating
& quiz, art & craft, photography
3. Universal Human Values – group discussions on the following topics:
   a) Aspirations and family expectations
   b) Gratitude
   c) Competition and cooperation
   d) Competition and excellence
   e) Peer pressure
   f) Self-confidence
   g) Relationships in family
   h) Trust and respect
   i) Anger management
   j) Happiness and prosperity
   k) Dealing language barriers – tests on communication skill for future follow up.
   l) Sexual orientation / courting / sexual harassment
4. Literary exposure through Literary Club
5. Proficiency Modules – Psychological tests and orientation, introduction to Co-curricular clubs and innovations.
6. Lectures by eminent people – in-campus invited Guests and over SKYPE
7. Visit to local areas – visit to industry and institutions of repute
8. Familiarization to departments and common facilities
9. Mentoring system – introduction and assignment of mentors
10. Selection / election of Class Representatives for college association
11. Health check-up for all with documentation for future reference
12. Library Orientation, Introduction to ERP and e-Resources, filling up “Online anti-ragging affidavit” by all.

BTUH0002: UNIVERSAL HUMAN VALUES II: UNDERSTANDING HARMONY
(3 Credits – 45 hours)
Objective*: The objective of the course is four fold:*
1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Module I: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education (9 hours)

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I
2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.
7. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

Module II: Understanding Harmony in the Human Being - Harmony in Myself! (8 hours)

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
2. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
4. Understanding the characteristics and activities of 'I' and harmony in 'I'
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
6. Programs to ensure Sanyam and Health.
7. Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

Module III: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship (9 hours)

1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.
6. Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

Module IV: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence (9 hours)

1. Understanding the harmony in the Nature
2. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature
3. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space
4. Holistic perception of harmony at all levels of existence.
5. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Module V: Implications of the above Holistic Understanding of Harmony on Professional Ethics (10 hours)

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
5. Case studies of typical holistic technologies, management models and production systems
6. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations
7. Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. Discuss the conduct as an engineer or scientist etc.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

CO1: recognize the nature of themselves, and their surroundings (family, society, nature); (understanding)

CO2: identify their responsibility in life, and handle problems with sustainable solutions, while keeping human relationships and human nature in mind. (understanding)

CO3: demonstrate their critical ability and also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). (applying)

CO4: execute what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction. (applying)

Suggested Readings

Text Book

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English

Mapping of CO to Syllabus

	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	M	M			
CO 2		H			
CO 3			H		
CO 4				M	H

PYTK0103: ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

(2 Credits)

Description of the Course

This paper is an introduction to some of the basic concepts, themes and questions in traditional Indian insights. We shall begin with a brief *darshan* and the *jijñāsā* ('desire to know') of the *rsis* ('Sage') on the dominant concepts, themes and queries that developed into a system of thinking. This shall be followed by a discourse on the principal themes and concepts, which emerged as the basis of belief systems and ethics of life. And, finally we shall reflect on the ethics and goals of life with its present day challenges, and see if the wisdom of the past – *Indian darshan* could offer a way forward for philosophising the essence of life.

Objective

The objective of this course is twofold:

1. To gain insight of and appreciate the richness of ancient Indian philosophical traditions; and
2. To inculcate *jijñāsā* (desire to know) and develop the art of philosophising with the essence of Indian tradition.

Course Outcome:

On completion of this course the students shall be able to:

1. name the Indian schools of thought and relate the concepts associated with the schools. **(Knowledge/Memory)**
2. differentiate the schools of thoughts and explain the characteristic of the schools. **(Comprehension/Understanding)**
3. identify and locate the school of thought and concepts in contemporary thinking. **(Application/Usage)**
4. compare and analyse the schools of thought with the current day thinking **(Analysis/Enquiry)**

5. generalise and summarise the influence of concepts and schools of thought in our present day thinking. **(Synthesis/amalgamation)**
6. assess and determine the importance philosophising and thinking in human life. **(Evaluation/Appraisal)**

UNIT I: Introduction (4)

1. Introduction to Indian thinking
2. The Vedas and Upanisads: Ritual to critique of ritual and the doctrine of the self

UNIT II: Astika Schools (10)

1. Sāṃkhya: *Prakṛti* and *Puruṣa*, Theory of Evolution
2. Yoga – Body, Mind and Self
3. Nyāya-Vaiśeṣika - Nature of Knowledge
4. Mīmāṃsā - Vedanta – Knowledge and Knowledge of Reality

UNIT III: Nastika Schools (6)

1. Cārvāka: Metaphysics and Epistemology
2. Early Buddhism: Four Noble Truths (*Arya Satyas*) and Doctrine of Dependent Origination (*Pratītyasamutpāda*)
3. Jainism: *Anekāntavāda* and *Syādvāda* (Theory of relativity)

UNIT IV: INDIAN ETHICS (10)

1. Bhagavad-Gita: *Niṣkāmakarma*
2. *Ashrama* : *Brahmacharya*, *Grihastha* , *Vanaprastha* and *Sannyasa*
3. *Puruṣārthas*: *Dharma , Artha, Kāma*, and *Mokṣa*
4. Conception of *Satya* and *Ahiṃsā*
5. Environmental Ethics and Sustainability

Suggested Readings:

1. Chakravarty, N. (1992), *Indian Philosophy: The Path Finder's and System Builders*. New Delhi: Allied Publishers.
2. Chatterjee, S.C. & Datta, D.M. (1984). *An Introduction to Indian Philosophy, (reprint*).Calcutta: University of Calcutta.
3. Dasgupta, S.N. (2004). *A History of Indian Philosophy (vol.1).* Delhi: Motilal Banarasidass Publishers, Pvt. Ltd.
4. Hiriyana, M. (1951). *Outlines of Indian Philosophy*. London: Allen & Unwin.
5. Radhakrishnan, S. (2008) *Indian Philosophy (Vol. 1 & Vol. 2)*. 2nd Edition. Oxford University Press.
6. Narayan, R. and Kumar, J. (2003) *Ecology and Religion: Ecological Concepts in Hinduism, Buddhism, Jainism, Islam, Christianity and Sikhism*, Deep and Deep Publications: New Delhi.
7. Singh, V. (2012). *The Human Footprint on Environment: Issues in India*. Macmillan India: New Delhi. 2012

CBUI104T: UNDERSTANDING INDIA

Credit – 1 (0-0-1) – 15 Hours

Course Outcomes

CO 1: At the end of this course, students will be able to explain the social, cultural and religious diversity of India and its impact on Indian psyche.

CO 2: At the end of this course, students will be able to evaluate the political and economic system of India.

Module 1: India and its Diversity (18 hours)

- Overview of India’s geography, diversity, demographics and development indicators
- A brief survey of India's history, highlighting key events, personalities and movements that shaped its identity and destiny
- An exploration of India's rich and varied cultural heritage, including its languages, religions, arts, literature and philosophy
- An overview of India's social structure, institutions, norms and values, with a focus on issues such as caste, gender, class and ethnicity

Module 2: Indian Political System (12 hours)

- A study of India's political system, institutions, parties and ideologies
- India's role in regional and global affairs
- A review of India's economic performance; the challenges and opportunities for growth;
- An overview of sectors such as agriculture, industry, services, and trade.
- A discussion of India's environmental problems & the solutions for sustainable development

- A discussion on India's journey towards a developed nation.

Suggested Readings

1. Thapar, R. (2015). The Penguin History of Early India: From the Origins to AD 1300. India: Penguin Books Limited.
2. Kosambi, D. D. (2022). The Culture and Civilization of Ancient India in Historical Outline. United Kingdom: Taylor & Francis.
3. Zimmer, H. R. (2020). Philosophies of India. United States: Princeton University Press.
4. Mohanty, M. (2004). Class, Caste, Gender. India: SAGE Publications.
5. Mitra, S. K. (2017). Politics in India: Structure, Process and Policy. United Kingdom: Taylor & Francis.
6. Kothari, R. (1970). Politics in India. India: Orient Longman.
7. Balasubramanyam, V. N. (2019). The Economy of India. United Kingdom: Taylor & Francis.
8. Fisher, M. H. (2018). An Environmental History of India: From Earliest Times to the Twenty-First Century. United Kingdom: Cambridge University Press.

SCHOOL OF TECHNOLOGY
DEPARTMENT OF COMPUTER APPLICATIONS
MASTER OF COMPUTER APPLICATIONS (MCA)

VISION

Imparting knowledge of Computer Applications, to mould individuals into IT professionals, researchers and entrepreneurs who are innovative, versatile and committed to society.

MISSION

To prepare students for professional career and higher studies by providing conducive teaching, learning and research environment.

- To produce skilled individuals and entrepreneurs in emerging areas of technologies by academia-industry collaboration.
- To instill in individuals a sense of commitment to work for the betterment of society using technology.

PROGRAMME – MASTER OF COMPUTER APPLICATIONS (MCA)

PROGRAM OUTCOMES – MCA

PO 1: Computational Knowledge: Apply knowledge of computing fundamentals, computing specialisation, mathematics, and domain knowledge appropriate for the computing specialisation to the abstraction and conceptualisation of computing models from defined problems and requirements.

PO 2: Problem Analysis: Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines.

PO 3: Design /Development of Solutions: Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PO 4: Conduct investigations of complex Computing problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: Modern Tool Usage: Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.

PO 6: Professional Ethics: Understand and commit to professional ethics and cyber regulations, responsibilities, and norms of professional computing practices.

PO 7: Life-long Learning: Recognise the need, and have the ability, to engage in independent learning for continual development as a computing professional.

PO 8: Project management and finance: Demonstrate knowledge and understanding of the computing and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 9: Communication Efficacy: Communicate effectively with the computing community, and with society at large, about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions.

PO 10: Societal and Environmental Concern: Understand and assess societal, environmental, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practices.

PO 11: Individual and Team Work: Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary environments.

PO 12: Innovation and Entrepreneurship: Identify a timely opportunity and using innovation to pursue that opportunity to create value and wealth for the betterment of the individual and society at large.

PROGRAM SPECIFIC OUTCOMES – MCA

PSO 1: Ability to understand and apply knowledge on analysis, design and development of software applications.

PSO 2: Utilize skills and knowledge for computing practice with commitment on social, ethical and legal values.

PSO 3: Ability to work with latest computing technologies and pursue careers in IT industry/ consultancy/ research and development, teaching and allied areas.

LIST OF COURSES -MCA

Mapping Code	Course Name
1.1	Mathematical Foundation for Computer Science
1.2	Theory of Computation
1.3	Operating Systems
1.4	Data Structures and Algorithms
1.5	Programming Through Java
1.6	Operating Systems Lab
1.7	Data Structures and Algorithms Lab
1.8	Programming Through Java Lab
2.1	Software Engineering
2.2	Data Communication and Computer Networks
2.3	Advanced Database Management Systems
2.4	Internet Technology and Applications
2.5	Sensor Networks and Internet of Things
2.6	Data Communication and Computer Networks Lab
2.7	Internet Technology and Applications Lab
2.8	Advanced Database Management Systems Lab
2.9	Constitution of India
3.1	Cyber Law and IT Security
3.2	Machine Learning
3.3	Enterprise Resource Planning
3.4	Research Methodology and IPR
3.5	Elective I *Specialization I: Artificial Intelligence* OR *Specialization II: Data Science*
3.6	Elective II *Specialization I: Artificial Intelligence* OR *Specialization II: Data Science*
3.7	Machine Learning Lab
3.8	Minor Project - MCA
3.9	Communication Skills
3.10	Entrepreneurship
4.1	Major Project - MCA
4.2	Elective III

MAPPING of COURSES to PO/PSOs –MCA

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1.1	H	M		L											L
1.2	H	M		L									M		L
1.3		L	H		M								H		
1.4	M	H	M										H		L
1.5	M		H		H								H		M
1.6		L	H		M								H		
1.7	M	H	M										H		L
1.8	M		H		H								H		M
2.1			H					M					H		M
2.2	H		M		M							L		L	M
2.3	H		M		M							L		L	M
2.4			H						L			M		L	H
2.5	M		H		H					M		M			H
2.6	H		M		M							L		L	M
2.7			H						L			M		L	H
2.8	H		M		M							L		L	M
2.9										M				M	
3.1						H	M			L				H	
3.2	H		M		M							L	M		H
3.3					H			M				L	M		

3.4					M		L					H			H
3.5	H	M		M	L									M	H
3.6	H	M		M	L									M	H
3.7	H		M		M							L	M		H
3.8	M	L	H		H		M	M			M	H	H	M	M
3.9									H	M	L			M	
3.10										M	L	H			
4.1	M	L	H		H		M	M			M	H	H	M	M
4.2	L		M			M		H	L						M

THEORY COURSES

CAOS0016: OPERATING SYSTEMS

(4 credits – 60 hours)

Objective

The main objective of this course is to introduce the students to a layer of software called Operating Systems, whose job is to manage all the devices of a computer system and provide user programs with a simple interface to the hardware. This course will familiarize the students with the concepts of processes, memory management, file management, Input/Output management and the potential problem of deadlocks. The students will also learn about the Linux operating system, which is a full-blown Unix clone and is fast gaining popularity worldwide.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

1. Elaborate what operating systems are, what they do and how they are designed and constructed. (Creating)
2. Define process concepts like process scheduling, inter-process communication, process synchronization and concurrency. (Remembering)
3. Explain different memory management schemes, relate various approaches to memory management and effectiveness of a particular algorithm. (Understanding)
4. Identify different page replacement algorithms to solve problems. (Applying)
5. Determine the concepts learned with case studies of Linux and Windows. (Evaluating)

Module I: Concepts, Processes and Threads (14 Hours)

Operating system as an Extended Machine and as a Resource Manager, Operating system concepts (Files, Deadlocks, Memory Management, Input/Output, Processes, The Shell, Security), The evolution of Operating Systems (Serial Processing, Simple Batch Systems, Multiprogrammed Batch Systems, Mainframe Operating Systems, Server Operating Systems, Time Sharing Systems, Multiprocessor Operating Systems, Real-Time Systems, Embedded Operating Systems, Smart Card Operating), System Calls (Process Management, File Management, Directory management), Introduction to Processes (The Process Model, Process Creation, Process Termination, Process Hierarchies, Process States, Implementation of Processes, Process Control Block), Threads (The Thread Model, Thread Usage, Implementing Threads(In User Space and Kernel), Scheduler Activation, Pop Up Threads, Interprocess Communication (Race conditions, Critical Sections, Mutual Exclusion with Busy Waiting, Sleep and wakeup, Semaphores, Mutexes, Monitors, Message Passing), Classical IPC problems (The Dining Philosophers Problem, The Sleeping Barber Problem), Process Scheduling (Scheduling in Batch Systems, Scheduling in Batch Systems, Scheduling in Interactive Systems, Scheduling in Real-Time Systems, Thread Scheduling)

Module II: Deadlocks and Memory Management (14 Hours)

a. Resources, Deadlock (Conditions for Deadlock, Deadlock modeling), Deadlock detection and recovery, Deadlock avoidance, Deadlock prevention
b. Memory management without swapping or paging (Monoprogramming without swapping or paging, Multiprogramming with fixed partitions, Relocation and Protection), Swapping, Virtual Memory (Paging, Page Tables), Page Replacement Algorithms (Not-recently-used, First in first out, Second Chance page replacement algorithm, The Clock Page Replacement Algorithm, Least Recently used page replacement algorithm, The Working Set Page Replacement Algorithm, Modeling Paging Algorithms (Belady's Anomaly, Stack Algorithms, Predicting page fault rates), Design issues for Paging Systems, Implementation issues, Segmentation (Implementation of pure segmentation, Segmentation with Paging: MULTICS)

Module III: Input/output and File Systems (16 Hours)

a. Principles of I/O hardware (I/O devices, Device Controllers, Direct memory access), Principles of I/O software, I/O Software Layers, Disks (Disk hardware, disk formatting, disk arm scheduling algorithms, Error handling, Track-at-a-time caching, RAM disks) Clocks (Clock hardware, Clock software), Terminals (Terminal hardware, Input software, Output software)
b. Files (File Naming, File structure, File types, File access, File attributes, File operations, Memory mapped files), Directories, File System layout (Implementing files, Implementing directories, Shared files), Security (The security environment, Generic Security Attacks, Design Principles For Security, User Authentication), Protection mechanisms (Protection Domains, Access Control Lists, Capabilities, Multilevel Security, Covert Channels), Type of File Systems (FAT, VFAT, FAT32, NTFS)

Module IV: Introduction to Linux OS design – Case study (16 Hours)

Overview of Unix, Processes in Unix (Fundamental Concepts, Process Management System Calls in Unix, Implementation of Processes in Unix), Memory Management in Unix, Input/Output in Unix, The Unix File System, Security in Unix

Suggested Readings

1. Andrew S Tanenbaum, Modern Operating Systems , (Second Ed.), Prentice Hall of India, New Delhi,
2. William Stallings, Operating Systems, Fourth Edition, Prentice Hall of India, New Delhi.
3. Silberschatz, Galvin, Operating System Concepts, Fifth Edition, John Wiley and Sons (Asia) Pte.
4. HM Deitel, Operating Systems, Second Edition, Pearson Education.
5. Pramod Chandra P. Bhatt, An Introduction to Operating Systems Concept, Prentice Hall of India.
6. Maurice J. Bach, The Design of the Unix Operating System, Prentice Hall of India, New Delhi.
7. Kernighan and Pike, The Unix Programming Environment, Prentice Hall of India, New Delhi.

Mapping of COs with Syllabus

Course Outcomes	Module1	Module2	Module3	Module4
CO1	H	M	L	
CO2	M	H	L	
CO3	M	H	M	
CO4		M	H	
CO5		L	H	M

CAPJ0018: PROGRAMMING THROUGH JAVA

(4 credits–60 hours)

Objective

The course is designed to impart the knowledge and skill required to solve real world problems using an object-oriented approach utilizing Java language constructs. This course covers the two main parts of Java i.e. Java Language and Java Library (JDK 5). After completion of the course, a student is expected to be able to

- Do Object Oriented Programming using Java
- Implement Exception handling and Multithreading in Java.
- Create Java I/O Applications and Applets.
- Set up a GUI using Swing components
- Do Network Programming in Java.
- Access relational databases from the Java program and use Java Beans and Servlets.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

1. Recall the various features of Object Oriented programming by utilizing the JAVA language construct. (Remembering)
2. Explain the standard library, scope and lifetime of a variable and various control statements used in JAVA programs. (Understanding)
3. Interpret the concept of classes and object in JAVA and apply exception handling to solve various exceptions (Applying)
4. Contrast the different type of inheritance and polymorphism and Analyse it in resolving various problems (Analysing)
5. Select the appropriate GUI and will be able to justify their decision to use a particular GUI by evaluating the required parameters depending on the domain and requirement. (Evaluating)
6. Develop algorithms based on the knowledge they have gained to design cost effective and user friendly applications. (Creating)

Module I: Core Java Programming (14 Hours)

a. Java Overview: Genesis, Java Philosophy, Java and Internet, Object-Oriented Programming features, Java Applet and Application, Java Environment and Java Development Kit (JDK) and Java Standard Library (JSL),
b. Java language fundamentals: The scope and lifetime of variable, Type conversion and casting, Control statements, Arrays
c. Classes and objects: The this keyword, Garbage collection, Overloading constructor, Using object as parameters, Argument passing, Returning objects, Recursion, Introducing Access control (public, private and protected), static, final, nested classes, String class, Command- line argument

Module II: Inheritance, Exception handling, Multithread and Applets (12 Hours)

a. Inheritance: Member access and inheritance, method overriding, dynamic method dispatch, using abstract classes, using final with inheritance, the Object class; Packages, Interface, classpath
b. Exception handling: Fundamentals, Exception types, Java’s built-in exceptions, user defined exceptions.
c. Multithreaded Programming: The Java thread model (thread priorities, synchronization and inter-thread communication); Deadlock, Thread Group
d. I/O Basics: Streams, the stream classes, the predefined streams, Reading console input, writing console output, the

transient and volatile modifiers, using instance of native methods

Module III String handling, Utility classes, java.lang and java.io (12 Hours)

a. String handling: String constructors, methods for character extraction, string searching and comparison, data conversion using valueof (), String Buffer.
b. Exploring java. lang: Simple type wrappers, System class, class Class, Math functions
c. The utility classes: Vector, Stack, Hash Table, String Tokenizer, Bit set, Date, Calendar, Gregorian Calendar, Random, Observable
d. Input/Output - Exploring java.io: The java.io classes and interface, File class and methods for creating, renaming, listing and deleting files and directories, I/O stream classes (File Input Sream, File Output Stream, Buffered Input Stream, Buffered Output Stream, Push Back Input Stream, Input Stream Reader, Buffered Reader, Buffered Writer, Print Stream, Random Access File)

Module IV: Networking, Images, Applet class and Swing (12 Hours)

a. Networking: Socket overview, Stream Sockets, Datagram sockets, Manipulating URLs, Establishing a simple Server/Client using Stream Sockets, Connectionless Client/Server Interaction with Datagrams
b. Images: File formats, image fundamentals, creating, loading and displaying images, ImageObserver, MediaTracker
c. The Applet class: applet architecture, passing parameters to applets, getDocumentBase, getCodeBase, and showDocument, AppletContext and AudioClip interfaces, Graphics class and methods for drawing lines, rectangles, polygons and ovals
   I. Swing: Component and Container classes, Layout managers (Flow Layout, Grid Layout, Border Layout), Handling events, Adapter classes, Anonymous inner classes
   II. Swing GUI components: JLabel, JTextField, JTextArea, JButton, JCheckBox, JRadioButton, JList, JComboBox, JScrollBar, JScrollPane, JToolTip, JPanel, JFrame
   III. Menus: JmenuBar, JMenu, JMenuItem, JSeparator

Module V: Java Beans, JDBC, Java Servlets (10 Hours)

a. Java Beans: Introducing JavaBeans Concepts and Bean Development Kit (BDK), Using the Bean Box, Writing a simple Bean, Bean Properties (simple properties), Manipulating events in the Bean Box
b. Java database connectivity (JDBC): Introduction to JDBC, type of JDBC connectivity, Establishing database connections, Accessing relational database from Java programs

Suggested Readings

1. Deitel, H. M.; P. J. Deitel, Java : How To Program (Sixth Edition), New Delhi: Prentice-Hall India, 2005
2. Schildt, H., The Complete Reference Java 2 (Fifth Edition), New Delhi: Tata McGraw-Hill, 2005
3. Moss, K., Java Servlets (Second Edition), New Delhi: Tata McGraw-Hill
4. Russel, Java Programming for the absolute Beginner , New Delhi: Prentice-Hall India
5. Hanagan D., Java Examples in a Nutshell (Third Edition), New Delhi: O' Reilly, 2001

Mapping of COs with Syllabus

Course Outcome	Module I	Module II	Module III	Module IV	Module V
CO1	H	H	M		
CO2	H	H	M		
CO3	H				
CO4		H			
CO5				H	H
CO6			M	M	M

CASE0019: SOFTWARE ENGINEERING

(4 credits–60 hours)

Objective

The field of software engineering aims to find answers to the many problems that software development projects are likely to meet when constructing large software systems. The objective of this paper is to make students aware of the problems incurred by large-scale software development and the solutions proposed. It covers a framework for studying and evaluating software tools, and stresses the importance of theory in the development of software.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

1. Define the life cycle models of software. (Remembering)
2. Explain, identify and differentiate various software life cycle models (Understanding)

3. Analyse and design the software requirement specification and perform risk management and testing. (Analysing)
4. Develop and create various design diagrams and find solutions to problems. (Creating)

Module I (10 Hours)

a. The Product and The Process: The Product - Evolving Role of Software, Software (Characteristics, Components and Applications;
b. The Process – Software Engineering A Layered Technology, The Software Process, Software Process Models, The Linear Sequential Model, The Prototyping Model, The RAD Model, Evolutionary Process Models (The Incremental Model, The Spiral Model, The Component Assembly Model, The Concurrent Development Model), The Formal Methods Model, Fourth Generation Techniques;
c. Project Management Concepts – The Management Spectrum (People, the Problem, the Process and the Project);
d. Software Process and Project Metrics – Measures, Metrics and Indicators, Metrics in the Process and Project Domains, Software Measurement, Reconciling Different Metrics Approaches, Metrics for Software Quality;
e. Software Project Planning – Observation on Estimating, Project Planning Objectives, Software Scope, Resources, Project Estimation Technique – Empirical estimation techniques (Expert Judgement Technique, Delphi Cost Estimation), Heuristic estimation techniques (COCOMO Model), Halstead Software Science (An Analytical Technique), The Make-Buy Decision;

Module II (10 Hours)

a. Project Scheduling and Tracking - Basic Concepts, The Relationship between People and Effort, Defining a Task set for the Software Project, Selecting Software Engineering Tasks, Defining a Task Network, Scheduling, The Project Plan;
b. Software Projects Risks, Quality Assurance and Configuration Management: RiskManagement- Reactive Vs. Proactive Risk Strategies, Software Risk, Risk Identification, Risk Projection, Risk (Mitigation, Monitoring and Management), Safety Risks and Hazards, The RMMM Plan;
c. Software Quality Assurance - Quality Concepts, The Quality Movement, Software Quality Assurance, Software Reviews, Formal Technical Reviews, Statistical Quality Assurance, Software Reliability, The SQA Plan, The ISO 9000 Quality Standards;
d. Software Configuration Management - Software Configuration Management, The SCM Process, Identification of Objects in the Software Configuration, Version Control, Change Control, Configuration Audit, Status Reporting;
e. System Engineering - Computer Based Systems, Product Engineering

Module III (20 Hours)

a. Analysis and Design: Analysis Concepts and Principles - Requirements Analysis, Communication Techniques, Analysis Principles, Software Prototyping, Specification, Specification Review;
b. Analysis Modeling- The Elements of the Analysis Model, Data Modeling, Functional Modeling and Information Flow, Behavioral Modeling, the Mechanics of Structured Analysis, the Data Dictionary;
c. Design Concepts and Principles - Software Design and Software Engineering, the Design Process, Design Principles, Design Concepts, Effective Modular Design, Design Heuristic for Effective Modularity, the Design Model, Design Documentation;
d. Design Methods - Data Design, Architectural Design, the Architectural Design Process, Architectural Design Optimization, Interface Design, Human-Computer Interface Design, Interface Design Guidelines, Procedural Design;
e. Design For Real Time systems - Real Time Systems;
f. Case studies on diagram - Use case, Class, Activity, Sequence

Module IV (10 Hours)

a. Software Testing: Software Testing Methods - Software Testing Fundamentals, Test Case Design, White Box Testing, Basis Path Testing, Control Structure Testing, Black Box Testing, Testing for Specialized Environments;
b. Software Testing Strategies - A Strategic Approach to Software Testing, Strategic Issues, Unit Testing, Integration Testing, Validation Testing, System Testing, The Art of Debugging;
c. Technical Metrics For Software - Software Quality, A Framework For Technical Software Metrics, Metrics for the Analysis Model, Metrics for the Design Model, Metrics for Source Code, Metrics for Testing, Metrics for Maintenance

Module V (10 Hours)

a. Object Oriented Software Engineering: Object Oriented Concepts and Principles - The Object Oriented Paradigm, Object Oriented Concepts, Identifying the Elements of an Object Model, Management of Object Oriented Software Projects
b. Object Oriented Analysis - Object Oriented Analysis, Domain Analysis, Generic Components of the Object Oriented Analysis Model, the OOA Process, the Object Relationship Model, the Object Behavior Model
c. Object Oriented Design - Design for Object Oriented Systems, The Generic Components of the OO Design Model, The Systems Design Process, The Object Design Process, Design Patterns, Object Oriented Programming
d. Advanced Topics in Software Engineering: Cleanroom Software Engineering- The Cleanroom Approach, Functional Specification, Design Refinement and Verification, Cleanroom Testing
e. Software Reuse - Management Issues, the Reuse Process, Domain Engineering, Building Reusable Components, Classifying and Retrieving Components, Economics of Software Reuse

f. Reengineering - Software Reengineering, Reverse Engineering, Restructuring, Forward Engineering, Economics of Reengineering
g. Computer Aided Software Engineering - Case Definition, Building Blocks of Case, Taxonomy of Case Tools, Integrated Case Environments, the Integration Architecture, the Case Repository

Suggested Readings

1. Roger S. Pressman, Software Engineering A Practitioner's Approach, Fourth Edition, Tata McGraw Hill.
2. Rajib Mall, Fundamentals of Software Engineering, Second Edition, Prentice Hall of India Private Limited.
3. Ian Sommerville, Software Engineering, Sixth Edition, Addison Wesley, Pearson Education.
4. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, Fundamentals Of Software Engineering, Second Edition, Prentice Hall of India Private Limited, New Delhi, 2002.
5. Jeffrey A. Hoffer, Joey F. George, Joseph S. Valacich, Modern Systems Analysis and Design, Second Edition, Pearson Education.
6. Richard E Fairley, Software Engineering Concepts, Tata McGraw Hill Publishing Company Limited, New Delhi, 1997.
7. Hans Van Vilet, Software Engineering Principles and Practice, Second Edition, John Wiley and Sons, Ltd.

Mapping of COs with Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO1	H	L			
CO2	H	M	H		
CO3		H	M	H	
CO4			H		M

CAIT0022: INTERNET TECHNOLOGY AND APPLICATIONS

(4 credits – 60 hours)

Objective

The objective of the course is to familiarize the students with a discussion on Internet and its growth. It also provides the students a study on the basic services provided by the Internet. A familiarization on the markup languages, scripting languages and web application development are also being discussed to make the student competent to design websites. It has been taken into consideration that this paper assumes that the students must know well in advance about the various protocols of the Internet and the knowledge of HTML and databases.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:
1. Recall and examine the growth of Internet and identify the history behind it. (Remembering)
2. Identify and differentiate the various services provided by the internet. (Understanding)
3. Experiment with various mark-up languages and scripting languages. (Applying)
4. Analyse and design a website of their own and can also identify the faults in the design. (Analysing)
5. Develop and create a website of their own. (Creating)
6. Summarize and validate a practical solution towards a web application development and also deploy a website of their own. (Evaluating)

Module I: Introduction to Internet (10 Hours)

History of the Internet; History of the World Wide Web; W3C (World Wide Web Consortium); Levels of Internet Connectivity (Dial-up, Leased Line, DSL, VSAT); Requirements for Internet connectivity; Use of Browsers; Different types of browsers (IE, Opera, Netscape, Firefox); Search engines; FTP; Electronic Mail; Instant Messaging; DHCP; DNS; HTTP; URL; Proxy Servers.

Module II: Internet Markup Languages (12 Hours)

a. XHTML: What is XHTML? Components of XHTML; Elements of XHTML (Headers, Paragraphs,
b. Linking, Images, Special Characters, Lists, Tables, Forms, Framesets)
c. Cascading Style Sheets: Inline Styles; Embedded Style; Conflicting Style; Linking External Styles; W3C CSS Validation Service; Use of CSS (Positioning Elements, Backgrounds, Text flow)
d. XML: What is XML? Structuring Data; XML Namespaces; Document Type Definitions and Schemas; XML Vocabularies; Document Object Model (DOM and its methods); Extensible Style Sheet Language (XSL)

Module III: Web servers, Databases and Scripting Languages (18 Hours)

a. Web servers: What is a web server; HTTP Request Types; System Architecture of a Web server; Client-side Scripting versus Server-side Scripting; Accessing Web servers; Apache Web Server.
b. Databases: Introduction to each one of the following: SQL, MYSQL, DBI
c. Scripting Languages: Javascript: Operators, Data Types, Control Structures, Functions, Arrays, String Manipulation.

JQuery, ASP.NET. Introduction to Perl and CGI (Common Gateway Interface). JSP: Introduction; JSP Overview; Scripting; Standard Actions; Directives

d. Java Servlets: Servlet overview and architecture, Servlet Interface and Servlet life cycle, HttpServlet Class, HttpServletRequest Interface, HttpServletResponse Interface, Handling HTTP get Requests, deploying a web application, Handling HTTP get requests containing data, Handling HTTP post requests.

Module IV: Web Application Development Using PHP (20 Hours)

a. Web Site Design Considerations: Using Logical Design: Planning your website, drawing a map, using a top-down approach, flexibility, other web design metaphors. Creating templates. Creating a Compatible Design: Designing for different color depths, resolutions, different browser considerations, accommodating limited bandwidth. Validating your work.

b. PHP: Introduction to PHP; Data Types; Control Structures; Functions; Strings; Arrays; Querying Web Databases using PHP; Writing to Web Databases; Errors, Debugging and Deployment; Reporting in PHP; Validation Techniques in PHP.

Suggested Readings

1. Deitel and Deitel, Internet and World Wide Web: How to Program, 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi
2. Hugh E. Williams and David Lane, PHP and MySQL, 2nd Edition, O'Reilly, Shroff Publishers and Distributors Pvt. Ltd.
3. Moss, K., Java Servlets (Second Edition), New Delhi: Tata McGraw-Hill
4. Internet Complete, 2nd Edition, BPB Publications, New Delhi
5. Douglas E. Comer, The Internet Book: Everything you need to know about Computer Networking and how the Internet works, 3rd Edition, Prentice Hall of India Pvt. Ltd., New Delhi

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2	H			
CO 3			H	
CO 4		M		H
CO 5		M		H
CO 6		M		H

CAEP0024: ENTERPRISE RESOURCE PLANNING

(4 credits–60 hours)

Objective

To help the student understand the conceptual elements of ERP and its theory and implementation. This is especially poignant in view of large number of organizations implementing ERP applications in recent years. The student will appreciate the impact that ERP brings into the daily operations of firms with respect to their productivity, integration, communication, etc.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

1. Recall the conceptual elements of ERP. (Remembering)
2. Demonstrate the Influence of ERP in Large Organizations. (Understanding)
3. Identify the impact of ERP into the daily operations of firms with respect to their productivity, integration, communication etc. (Applying)
4. Analyse the practical side of ERP implementation with different vendors. (Analysing)
5. Discuss and evaluate the best practices of ERP with various case studies and real time examples. (Creating, Evaluating)

Module I: ERP Basics (15 hours)

a. Evolution and structure of ERP, ERP concepts, growth of the ERP market, conceptual model of ERP, 2-tier and 3-tier architecture, elements in ERP architecture, advantages/benefits of ERP, overview of an enterprise, integrated management information, business modeling, integrated data model

b. ERP and related technologies: Business Process Reengineering (BPR), Management Information Systems (MIS), Decision Support Systems (DSS), Data Warehousing, Data Mining, Online Analytical Processing (OLAP), Supply Chain Management.

Module II: ERP Modules (15 hours)

Item types in ERP, Manufacturing, distribution and Financial requirements, item control module in ERP, Finance module, Manufacturing and Production Planning module, Sales and Distribution module, Plant Maintenance module, Quality Management module, Materials Management module, Capital Requirement Planning module, Purchase Control module, Human Resources modules; concept of Bill of materials, concept of formula management.

Module III: Profiling ERP Vendors (10 hours)

a. SAP AG: R/3 –, overview of R/3 system, R/3 modules, R/3 and the internet
b. BAAN: Baan ERP modules, Baan ERP Tools
c. Oracle: Oracle modules – Financials, Human Resources, Projects, Manufacturing, Supply chain.
d. PeopleSoft: Accounting and control, Treasury Management, Performance Management, Sales and Logistics, Procurement.

Module IV: ERP Implementation Lifecycle (10 hours)

Elements of implementation methodology, Pre-evaluation Screening, Package evaluation, project planning phase, Gap Analysis, Business Process Re-engineering, configuration, Implementation team training, testing, product migration and support, Problems in ERP implementation, cost of ERP.

Module V Best Practices in ERP (10 hours)

a. Concept of Best Practices, concept of Customer Order Decoupling Point(CODP), Demand Management – Sales and Operations Planning, ERP scenario in India, future directions in ERP.
b. Case studies should also be introduced to highlight situations where ERP projects are implemented, and the success stories/benefits/difficulties of these implementations.

Suggested Readings

1. O'Leary, Daniel E, Enterprise Resource Planning Systems: systems, life cycle, electronic commerce and risk, Cambridge University Press.
2. Alexis Leon, Enterprise Resource Planning, 14th reprint, Tata McGraw Hill, New Delhi 2005
3. Rahul V Altekar, Enterprise Resource Planning (Theory and Practice), Prentice Hall India, New Delhi 2004
4. Alexis Leon, ERP Demystified, Tata McGraw Hill Pub. Co. Ltd, 2000
5. Kent Sandoe, Enterprise Integration, John Wiley and Sons
6. Garg and Venkitakrishnan, Enterprise Resource Planning : Concepts and Practice, 2nd edition, Prentice Hall India
7. Garg and Venkitakrishnan, ERPWARE: ERP Implementation Framework, Prentice Hall India
8. ERP – Concepts and Cases, ICFAI University Press, 2004

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		M	H		
CO 3		H	M		
CO 4		L		H	
CO5					H

CAPA0030: PRINCIPLES OF ARTIFICIAL INTELLIGENCE

(4 credits – 60 hours)

Objective

Artificial Intelligence has embraced the larger scientific goal of constructing information- processing theory of intelligence. If such a science of intelligence could be developed, it could guide the design of intelligent machines as well as explicate intelligent behaviour as it occurs in humans and other animals. This paper describes the fundamental AI ideas that underlie many of the AI applications and provides a base for understanding natural intelligence.

Module I: General Issues and Overview of AI (12 Hours)

Introduction to AI: The AI problems, the underlying assumption, AI techniques, the level of the model, criteria for success, AI applications. Problem solving, search and control strategies: defining the problem as a state space search, production systems, control strategies, breadth-first search, depth-first search, problem characteristics, production system characteristics, issues in the design of search programs.

Module II: Search Strategies for AI Production Systems (16 Hours)

Heuristic search techniques: generate-and-test, hill climbing, simple hill climbing, steepest- ascent hill climbing simulated annealing, best-first search, OR-graphs, the A* algorithm, problem reduction, AND-OR graphs, the AO* algorithm, constraint satisfaction, means-end analysis. game playing: overview, the minimax search procedure, adding alpha-beta cutoffs, additional refinements, iterative deepening.

Module III: Knowledge Representation (16 Hours)

Knowledge representation issues: representations and mappings, representing simple facts in logic, knowledge representation attributes, computable functions and predicates, resolution, conversion to clause form, the basics of resolution, resolution in propositional logic, procedural vs. declarative knowledge, logic programming, forward vs. backward reasoning, matching, control knowledge. statistical reasoning: probability and Bayes' theorem, certainty factors and rule-based systems, Bayesian networks, Dempster-Shafer theory, basic notions and concepts of fuzzy sets, fuzzy set operations, information - based characterization of fuzzy sets, fuzzy relations and their calculus.

Module IV: Advanced AI (16 Hours)
Natural language processing: overview, morphological analysis, syntactic analysis, semantic analysis, discourse integration, pragmatic analysis, parsing techniques, top-down parsing, bottom- up parsing, augmented transition networks (ATN). Learning: rote learning, learning by taking advice, learning by induction, explanation-based learning. Expert system: representing and using domain knowledge, expert system shells, explanation, knowledge acquisition.

COURSE / LEARNING OUTCOMES
At the end of this course students will be able to:
1. Recall and identify the need of incorporating human intelligence into machine and define the basic terms related to the concept of knowledge and representation, learning and reasoning, communication and language processing. (Remembering)
2. Define problem state space, design algorithms to solve problems, generalized schema for knowledge interpretation and planning and language processing. (Understanding)
3. Compute and demonstrate the problem in terms of state space and apply different AI algorithms to solve problems and construct logic to represent knowledge in the computational domain and also to interpret the natural language. (Applying)
4. Compare and analyse the performance of algorithms based on problem domain. (Analysing)
5. design and create new intelligent algorithms for application development by integrating experience based learning. (Creating)
6. Judge and assess the algorithms based on completeness, optimality, and space and time complexity for solving a problem in an intelligent manner. (Evaluating)

Suggested Readings
1. Rich, E.; K. Knight, Artificial Intelligence, (Second Edition), New Delhi: Tata McGraw-Hill, 1997
2. Nilson, N. J., Principles of Artificial Intelligence, New Delhi: Narosa Publishing House, 2002
3. Pedrycz, W.; F. Gomide, An Introduction to Fuzzy Sets: Analysis and Design, New Delhi: Prentice- Hall India, 2004.
2. Winston, P. H., Artificial Intelligence, New Delhi: Pearson Education Asia, 2002
3. Charniak, E.; D. McDermott, Introduction to Artificial Intelligence, New Delhi: Pearson Education, 2002
4. Russell, S.; P. Norvig, Artificial Intelligence: A Modern Approach (Second Edition), New Jersey: Prentice-Hall, 2003

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H		M	L
CO 2	M	H	L	
CO 3	L	M	H	
CO 4		H	M	M
CO 5			H	M
CO 6		M	M	H

CACL0033: CYBERLAW and IT SECURITY (4-0-0)
(4 credits – 60 hours)

COURSE/LEARNING OUTCOMES:
1. Apply fundamental concepts of Information Security threats and vulnerabilities to adopt right security measures and design real time scenarios. (Applying)
2. Determine and analyze software vulnerabilities and security solutions to reduce the risk of exploitation. (Analyzing)
3. Analyze and evaluate the cyber security needs of an individual/organization. (Analyzing, Evaluating)
4. Design operational and strategic cyber security strategies and policies. (Creating)
5. Analyze various types of cybercrime and formulate procedures for real world cybercrime Investigations. (Analyzing)

Module I: (12 hours)
Object and Scope of the IT Act - Genesis, Object, Scope of the Act. Encryption -Symmetric Cryptography, Asymmetric Cryptography, RSA Algorithm, Public Key Encryption

Module II: (14 hours)
Digital Signature- Technology behind Digital Signature, creating a Digital Signature, Verifying a Digital Signature, Digital

Signature and PKI, Digital Signature and the Law. E-Governance and IT Act 2000- Legal recognition of electronic records, Legal recognition of digital signature, Use of electronic records and digital signatures in Government and its agencies, Certifying Authorities. Need of Certifying Authority and Power. Appointment, function of Controller. Who can be a Certifying Authority? Digital Signature Certifications. Generation, Suspension and Revocation of Digital Signature Certificate.

Module III: (12 hours)
Domain Name Disputes and Trademark Law: Concept of Domain Names, New Concepts in Trademark, Jurisprudence, Cyber-squatting, Reverse Hijacking, Meta tags, Framing, Spamming, Jurisdiction in Trademark Dispute

Module IV: (12 hours)
Cyber Regulations Appellate Tribunal: Establishment & Composition of Appellate Tribunal, Powers of Adjudicating officer to Award Compensation, Powers of Adjudicating officer to impose Penalty.

Module V: (10 hours)
The Cyber Crimes (S-65 to S-74): Tampering with Computer Source Documents(S-65), Hacking with Computer System(S-66), Publishing of Information Which is Obscene in Electronic Form(s-67), Offences: Breach of Confidentiality & Privacy (S-72), Offences: Related to Digital Signature Certificate (S-73 & S-74)

Suggested Readings

1. Farooq Ahmad, Cyber Law in India, Pioneer Books
2. Vakul Sharma, Information Technology Law and Practice, Universal Law Publishing Co. Pvt. Ltd.
3. Suresh T Vishwanathan, The Indian Cyber Law, Bharat Law house New Delhi.
4. P.M. Bakshi and R.K.Suri, Hand book of Cyber and E-commerce Laws, Bharat Law house New Delhi.
5. Rodney D. Ryder, Guide to Cyber Laws, Wadhwa and Company Nagpur.
6. The Information Technology Act, 2000, Bare Act, Professional Book Publishers, New Delhi.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H			
CO 3			H		M
CO 4				H	M
CO 5				M	H

CAMF0043: MATHEMATICAL FOUNDATION OF COMPUTER SCIENCE
(4 Credits)

Objective
- To introduce the concepts of mathematical logic.
- To introduce the concepts of sets, relations, and functions and relate practical examples to the appropriate set, function, or relation model, and interpret the associated operations and terminology in context.
- To perform the operations associated with sets, functions, and relations.
- To understand combinatorics and apply in solving problems.
- To use Graph Theory for solving problems

COURSE/LEARNING OUTCOMES
1. Ability to apply mathematical logic to solve problems (Remembering, Understand)
2. Recall some basic concept of set theory and understand the concept of graph theory and Group theory. (Remembering)
3. Interpret logic sentence in terms of predicates, quantifiers, and logical Connectives (Understanding)
4. For a given a discrete problem, classify its algebraic structure (Analyzing)
5. Derive the solution of a problem using deductive logic and prove the solution based on logical inference (Applying)
6. Evaluate Boolean functions and simplify expressions using the properties of Boolean algebra (Evaluating)
7. Develop the given problem as graph networks and solve with techniques of graph theory. (Creating)

Module I (13 hours)
Mathematical Logic: Statements and notations, Connectives, Well-formed formulas, Truth Tables, tautology, Logical equivalence: The Laws of logic, Logical Implication, Normal forms, Quantifiers, universal quantifiers. Predicates: Predicative logic, Free & Bound variables, Rules of inference, Consistency, proof of contradiction.

Module II (20 hours)
Set theory: Introduction, Basic Concepts of Set Theory, Representation of Discrete Structures, Relations and Ordering, Matrix

representation of relations and partial ordered sets, representation of relations by Graphs; Lattices as Partially Ordered Sets, Boolean algebra; Functions. Algebraic Structures: Introduction, Algebraic Systems, Semi groups and Monoids; Groups, Congruence Relation and Quotient Structures, permutation groups, Lagrange’s Theorem; Normal subgroups. Algebraic Structures with two Binary Operation, Rings, Integral Domain and Fields. (Definition, basic properties and examples)

Module III (12 hours)
Elementary Combinatorics: Basics of counting, Combinations & Permutations with repetitions, Constrained repetitions, Binomial Coefficients, Binomial and Multinomial theorem, Pigeonhole Principle, principles of Inclusion – Exclusion.

Module IV (15 hours)
Graph Theory: Basic Concepts, Sub graphs, Multi graphs Representation of Graphs, Isomorphism, Paths and Circuits, Traversing a Graph, DFS, BFS, Eulerian and Hamiltonian graphs, Shortest path algorithms, Planar Graphs, Chromatic Numbers. Tree and Spanning Trees. Applications of Graph Theory.

Suggested Readings
1. Discrete Mathematical Structures with Applications to Computer Science by J. P. Tremblay and R Manohar, Tata McGraw-Hill Publications, 1997.
2. Graph Theory by Narsingh Deo, Prentice-Hall of India publications, 2004.
3. Discrete Mathematical Structures, Theory and Applications. D.S. Malik, Thomson Learning, I Edn
4. Discrete Mathematics for Computer Science, Haggard, Thomson Learning, I Edn
5. Discrete Mathematics and Its Applications by Kenneth H Rosen. Tata McGraw-Hill Publications
6. Mathematical foundation of Computer Science by Y. N Sings. New Age international Publishers
7. Bernard Kolman, Robert. C.Busby & Sharon Ross, "Discrete Mathematical structures" Prentice Hall of India,2001.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M		
CO 2		H		
CO 3	H			
CO 4		H		
CO 5		H		
CO 6		H	M	
CO 7				H

CADA0044: DATA STRUCTURES AND ALGORITHMS
(4 Credits – 60 Hours)

Objectives
- To introduce first level topics covering basics in algorithms and data structures.
- To enable students to choose appropriate data structures, understand the ADT/libraries, and use of it to design algorithms for a specific problem.
- To understand the necessary mathematical abstraction to solve problems.
- To apply important algorithmic design paradigms and methods of analysis.

COURSE/LEARNING OUTCOMES
At the end of the course, students would be able to:
1. Know the formal definition of algorithms, importance of analysis of an algorithm and get familiar with different types of problem and their solutions. (Remembering and Understanding)
2. Choose appropriate data structure as applied to specified problem definition. (Applying)
3. Understand different design strategies such as brute force, divide-and-conquer, dynamic programming, greedy technique and backtracking used for the design of algorithms. (Understanding)
4. To design and analyse algorithms for given problems. (Applying)
5. Compare and analyse different design strategies and assess an algorithm in terms of correctness, computation cost and memory space used. (Analysing and Evaluating) .
6. Design new algorithms for given problems by using most appropriate algorithmic strategy considering the problem domain. (Creating)

Module I (14 Hours)
Introduction to Algorithms, Fundamentals Stages of Problem Solving, and Classification of Algorithms - Based on Implementation, Based on Design, Based on Area of Specialization, Based on Tractability, Basics of Algorithms Analysis,

Asymptotic Analysis, Mathematical Analysis of Iterative and Recursive Algorithms, Empirical Analysis of Algorithms, Models of Computations - RAM model, Turing Machine.

Module II (12 Hours)
Data Structures: Abstract Data Types (ADTs), Stacks, Queues, Circular Queues, Implementation of Stacks using Queues, Implementation of Queues using Stacks, Priority Queues, Heaps, Linked Lists, Search and Update Operations on Varieties of Linked Lists, Graphs, Binary Trees, Tree Traversals, Binary Search Trees (BSTs), AVL Trees, Red Black Trees, Splay Trees, B-Trees, Disjoint Sets.

Module III (12 Hours)
Analysis of Sorting and Searching Algorithms: The sorting problem, Brute Force Approach - Sequential Search, Bubble Sort, Selection Sort, Decrease-and-Conquer Approach - Insertion Sort, Binary Search, Divide-and-Conquer Approach - Quick Sort, Merge Sort, Transform-and-Conquer Approach - Heap Sort, Linear Sorting Algorithms - Counting Sort, Radix Sort, Bucket Sort, Hashing - Hash Function, Collisions in Hashing, Separate Chaining, Open Addressing, Analysis of Search Operations.

Module IV (14 Hours)
Graph Algorithms: Graphs and their Representations, Graph Traversal Techniques - Breadth First Search (BFS) and Depth First Search (DFS), Minimum Spanning Trees (MST), Greedy Techniques - Prim's and Kruskal's algorithms for MST, Dijkstra's Algorithm for Single Source Shortest Paths, Dynamic Programming - Warshall's Algorithm for finding Transitive Closure of a Graph, Floydd's Algorithm for All-Pairs Shortest Paths Problem.
Algorithmic Design Techniques: Greedy Algorithms - Coin Change Problem, Scheduling Problem, Knapsack Problem, Huffman Trees, Divide-and-Conquer Approach - Strassen Matrix Multiplication, Closest-pair Problem, Tiling Problem, Dynamic Programming – Longest Common Subsequence (LCS) problem, Optimal Binary Search Trees, Travelling Salesperson Problem, Chain matrix multiplication.

Module V (8 Hours)
Tractable and Intractable Problems: Computability of Algorithms, Computability Classes – P, NP, NP-Complete, NP-Hard.
Basics of Backtracking, Branch-and-bound methodologies for Algorithm design, Approximation algorithms, Randomized algorithms.

Suggested Readings

1. Mark Allen Weiss, Data Structure and Algorithm Analysis in C++, Fourth Edition, Pearson, 2014.
2. S. Sridhar, Design and Analysis of Algorithms, Oxford University Press, 2014.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, Third Edition, The MIT Press, 2009.
4. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, Fundamentals of Computer Algorithms, Universities Press, 2008.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H			
CO 3			H		
CO 4			H	H	
CO 5		M	M	H	
CO 6					H

CACC0045: DATA COMMUNICATION AND COMPUTER NETWORKS
(4 credits)

Objective
This course introduces students to computer networks and concentrates on building a firm foundation for understanding Data Communications and Computer Networks. It deals with the Data link layer, the Network layer, the Transport layer and the Application Layer. This course also introduces the concepts of network security and cryptography.

Module I: Digital Communications
Signals, noise, Nyquist rate, Shannon capacity; Analog transmission: modulation techniques, FDM; Digital transmission: PCM, TDM, line coding, xDSL,; Transmission media: Guided (twisted pair, coaxial, fiber optic) and unguided media; Local area networks: Ethernet, Fast Ethernet, introduction to Gigabit Ethernet and WLANs; Repeater, Hubs, Bridges, Switches, Router and Gateway.

Module II: Media Access Control and Data Link Layer
Data Link Layer Fundamentals: Framing, Error Control, Flow Control, Error Detection and Correction; Data link protocols: Stop-&-Wait ARQ, Go-Back-NARQ, Selective Repeat ARQ, Piggybacking
Multiple Access Protocols: Advantages of Multiple-Access Sharing of Channel Resource, Pure ALOHA, Slotted ALOHA, Carrier Sense Multiple Access (CSMA), CSMA with Collision Detection (CSMA/CD), Asynchronous Transfer Mode (ATM)

Module III: Network Layer
IPv4 Addresses: Address space, Notations, Classful addressing, classless addressing, NAT; IPv6 Addresses: advantages, structure, address space, packet format, extension header; Transition from IPv4 to IPv6; Address Mapping, Delivery, Forwarding, Unicast Routing Protocols, Multicast Routing Protocols.

Module IV: Transport Layer and Application Layer
Process to Process Delivery: Client Server paradigm, Connectionless vs Connection Oriented Service, Services provided to upper layers, Transport Service primitives. UDP: Introduction, User Datagram, Checksum, UDP operations, use of UDP, Remote Procedure call TCP: Introduction, TCP Service Model, TCP Protocol, segment header, Connection Establishment and release, Transmission Policy, Congestion Control, Timer Management, Wireless TCP and UDP . Application Layer: Domain Name System, Simple Mail Transfer Protocol (SMTP), POP3, IMAP, File Transfer Protocol (FTP) Network Security: Cryptography, Symmetric Key Algorithms, Public Key Algorithms, Digital Signatures, Communication Security, Web Security

COURSE/LEARNING OUTCOMES:
At the end of the course the students will be able to:
1. Understand and explain Data Communications System and its components (Understand, Explain)
2. Understand and identify different networking terminologies and network architecture. Design issues in network and network transition. (understand)
3. Students would be able to distinguish between IPV4 and IPV6 network together with MAC layer transmission and modulation schemes. (Analyze)
4. Students would be able to understand and analyze what type of network to implement and decide what protocols to configure(Analyze)
5. Students would be able to know why different layers are embodied with different protocols and different network architecture for different network needs. (Evaluate)
6. Have a basic knowledge of the use of cryptography and network security; (Apply)

Suggested Readings
1. Andrew S. Tenenbaum, Computer Networks (Fourth Ed.), Prentice Hall of India, 2002
2. W Richard Stevens, UNIX Network Programming – Volume I (2nd Ed.), Prentice Hall of India, 2002
3. William Stallings, Data and Computer Communications (Sixth Ed.), Prentice Hall of India, 2000
4. Fred Halsall, Data Communication, Computer Networks and Opens Systems, (4th Ed.), Pearson Education, 2000
5. William Stallings, Cryptography and Networking Security - Principles and Practice, Pearson

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		
CO 3			H	
CO 4		M	M	M
CO 5			H	M
CO 6				H

CADM0046: ADVANCED DATABASE MANAGEMENT SYSTEMS
(4 Credits - 60 hours)

Objective
The objective of this course is to introduce the basic conceptual background necessary to design and develop simple database systems. The course stresses on database modeling and design, physical file storage techniques and SQL query language facilities provided by database management systems. The course also presents some advanced database management concepts like query processing and optimization, transaction processing, concurrency control, recovery and security issues in database management systems.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

1. Explain the core terms, concepts, and tools of relational database management systems (Understanding)
2. Understand Normalization and Design ER-diagrams and corresponding schema diagrams for handling database projects (Creating)
3. Recall and identify the techniques used by a DBMS to process, optimize and execute high level queries. (Remembering)
4. Describe fundamentals of transaction processing system, including ACID properties of a transaction. (Understanding)
5. Illustrate concurrency control & analyze several concurrency control techniques for ensuring serializability, locking, timestamping. (Analysing)
6. Discuss some of the techniques that can be used for database recovery from failures and summarize the control measure for securing databases against a variety of threats. (Understanding)

Module I: Introduction (3 Hours)

Introduction: Introduction to databases, characteristics of the database approach, database users and designers, role of a DBA, advantages of using a DBMS, data models, schemas, instances, DBMS architecture (Three-Schema Architecture), Database systems- Network, Hierarchical, Relational, Data Independence

Module II: Relational Data Model and ER Models (12 Hours)

Relational Model: Domains, Attributes, Tuple and Relation; Super keys Candidate keys and Primary keys for the Relations. Relational Constraints: Domain Constraint, Key Constraint, Integrity Constraint.

Relational Algebra: basic relational algebra operations-SELECT, PROJECT, UNION, INTERSECTION, SET DIFFERENCE, Cartesian PRODUCT, JOIN, Aggregate functions.

Entity Relationship (ER) Model: Entities, Attributes, Relationships. More about Entities and Relationships, E-R Diagram, Conversion of E-R Diagram to Relational Database, Case Study.

Module III: Functional Dependencies and Normalization (10 Hours)

Functional Dependencies, First Normal Form, Second Normal Form, Third Normal Form, Boyce-Codd Normal Form, Multivalued Dependencies.

Module IV: Data Storage, Indexing, Query Processing and Query Optimization (11 Hours)

Overview of physical storage media, Magnetic Disks, RAID, File Organization: Fixed-length records, variable-length records. Organization of records in Files - Heap Files, Sequential File, Hashed Files. Indexing: Types of Single-level Ordered Indexes (Primary Indexes, Clustering Indexes, Secondary Indexes), Multilevel Indexes, Multilevel indexing using B tree and B+ tree, Indexing on multiple keys. Query Processing: Overview of query processing, Algorithms for query processing, Query Optimization

Module V: Transaction Processing and Concurrency Control (14 Hours)

Transaction Processing: Transaction, ACID properties of transaction, transaction states, schedules, serializability, tests for serializability, recoverability, transaction definition in SQL. Concurrency Control: Concurrent execution of transaction, Lock-based techniques for concurrency control, Graph-based protocol, Timestamp based protocol, Deadlock, Deadlock prevention methods, Deadlock detection Deadlock recovery.

Module VI: Recovery and Security (10 Hours)

Recovery system: Types of failure, types of storage, recovery and Atomicity, Log-based recovery, shadow paging, recovery with concurrent transactions, buffer management, logical undo logging, transaction rollback, checkpoints, restart recovery, fuzzy checkpointing.

Security: Security and Integrity-security violations, authorization and views, granting of privileges, security specifications in SQL, encryption, and statistical databases.

Suggested Readings

1. Silberschatz, HF Korth, S Sudarshan, Database System Concepts, Tata- McGraw Hill, 1997.
2. R Elmasri, SB Navathe, Fundamentals of Database Systems, Addisson, Wesley (Third Edition) 2000
3. DM Kroenke, Database Processing: Fundamentals, Design and Implementation, Prentice-Hall of India, (Eighth Edition) 2002.
4. GW Hansen, JV Hansen, Database Management and Design, Prentice-Hall of India, (2nd Edition) 2001.
5. Thomas M Connolly, Carolyn E Begg, Database Systems, A Practical Approach to Design, Implementation and Management, Addison Wesley Longman Ltd. 1999.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H	M	M	M	M	M
CO 2		H	H			

CO 3				H		
CO 4					H	
CO 5					H	
CO 6						H

CASI0047: SENSOR NETWORK AND INTERNET AND INTERNET OF THINGS

(3 Credits – 45 Hours)

Objective

This course will introduce the students to the Internet of Things(IoT) and basic structure of communication protocols in sensor networks. The course is designed to build up basic understanding of how to set up an application specific IoT network with better orientation and representation of sensor nodes.

Module I (8 hours)

Introduction to IoT: Sensing, Actuation, Networking basics, Communication Protocols, Sensor Networks, Machine-to-Machine Communications, IoT Definition, Characteristics; IoT Functional Blocks, Physical design of IoT, Logical design of IoT, Communication models & APIs.

Module II (12 hours)

M2M to IoT-The Vision-Introduction, From M2M to IoT, M2M towards IoT-the global context, a use case example, Differing Characteristics. Definitions, M2M Value Chains, IoTValue Chains, An emerging industrial structure for IoT

M2M vs IoT An Architectural Overview–Building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. Reference Architecture and Reference Model of IoT.

Module III (18 hours)

IoT Architecture: Introduction, Reference Model, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

IoT with Arduino: Hands on Experience with Arduino (Firmware development & RTOS) - General Purpose I/O(GPIO), Serial Communication Interfaces: RS-232/485, Synchronous Peripheral Interfaces: I2C, SPI Sensors interfacing with Arduino.

IoT with Raspberry PI: Hands on Experience with Raspberry PI (Firmware development) - Setting up Raspberry PI SD Card, Raspberry PI booting up & Initialization; General Purpose I/O(GPIO), Serial Communication Interfaces: RS-232/485, Synchronous Peripheral Interfaces: I2C, SPI; Sensors Interfacing with Raspberry PI

Domain specific applications of IoT:Home automation, Industry applications, Surveillance, applications, Other IoT applications.

Module IV (7 hours)

Wireless Sensor Networks & Protocols: Wireless Sensor Networks (WSNs), Introduction to WSNs Topologies in WSNs; Wired Communication Protocols – Ethernet, Serial Communications; Wireless Communication protocols Wifi, RF, IPV4/V6, 6LOWPAN, ZigBee(IEEE802.15.4), BLE, GSM(2G/3G/LTE).

COURSE/LEARNING OUTCOMES

1. Explain the definition and usage of the term “Internet of Things” in different contexts and understand the key components that make up an IoT system (Remembering)
2. Understand why it is necessary to build a separate model for IoT and what parameters influences the operation of IoT network. (Understanding)
3. Apply the knowledge in designing IoT network for addressing real life issues for easing the day to day life activities. (Applying))
4. Apply the knowledge and skills acquired during the course to build and test a complete, working IoT system involving prototyping, programming and data analysis. (Applying)
5. Know what type of sensor protocols and architecture to adopt for efficient communication and what services offline and online to be used for problem solving. (Analyzing)

Suggested Readings

1. Adrian McEwen and Hakim Cassimally, Designing the Internet of Things, Wiley, 2013.
2. Qusay F. Hassan, Internet of Things A to Z: Technologies and Applications, Wiley-Blackwell, 2018.
3. Peter Waher, Mastering Internet of Things: Design and Create Your Own IoT Applications Using Raspberry Pi 3, Packt Publishing, 2018.
4. Kazem Sohraby, Minoli Daniel and Znati Taieb, Wireless sensor networks: technology, protocols, and applications. John Wiley & Sons, 2007.
5. Waltenegus Dargie, Christian Poellabauer, Fundamentals of Wireless Sensor Networks: Theory and Practice (Wireless Communications and Mobile Computing), Wiley-Blackwell, 2010.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		
CO 3			H	M
CO 4			H	
CO 5				H

CATC0048: THEORY OF COMPUTATION

(4 credits – 60 hours)

Objective

The objective of the Theory of Computation is to introduce and study abstract, mathematical models of computation (such as finite state, pushdown and Turing machines), and to use the abstract machine models to study the ability to solve computational problems. At the complete course students will be able to use regular expressions effectively and appropriately, construct derivations and parse trees, write simple programs for a Turing machine, understand the equivalence of grammars, languages and automata and translate between grammars, languages and automata.

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

1. Define basic terminology like Deterministic and Non deterministic automata, Pushdown Automata, Parse Tree, Regular Languages, Turing Machines etc. (Remembering)
2. Make use of techniques, components and tools of a typical automated machine and apply it in designing new machines (Applying)
3. Design deterministic and non-deterministic context-free grammars and understand their capabilities and limits. (Creating)
4. Design deterministic and non-deterministic pushdown automata and Turing Machine. (Creating)
5. Demonstrate the understanding of complexity classes and current unsolved problems in theoretical computer science. (Understanding).

Module I Theory of Automata (15 Hours)

Definition of an Automaton, Description of a Finite Automaton, Transition Systems, Properties of Transition Functions, Acceptability of a String by a Finite Automaton, Nondeterministic Finite State Machines, The Equivalence of DFA and NDFA, Mealy and Moore Models, Minimization of Finite Automata.

Module II Formal Languages, Regular Sets and Regular Grammars (15 Hours)

Definition of formal languages, Chomsky Classification of Languages, Languages and Their Relation, Recursive and Recursively Enumerable Sets, Operations on Languages, Languages and Automata; Regular Expressions, Finite Automata and Regular Expressions, Pumping Lemma for Regular Sets, Application of Pumping Lemma, Regular Sets and Regular Grammars.

Module III Context-free Languages (15 Hours)

Context-free Languages and Derivation tree, Ambiguity in Context-free Grammars, Simplification of Context-free Grammars, Normal Forms for Context-free Grammars, Pumping Lemma for Context-free Languages, Decision Algorithms for Context-free Languages.

Module IV Pushdown Automata Turing Machines and Linear Bounded Automata (15 Hours)

Basic Definitions, Acceptance by PDA, Pushdown Automata and Context-free Languages, Parsing and Pushdown Automata; Turing machine Model, Representation of Turing Machine, Language Acceptability by Turing Machines, Design of Turing Machines, Universal Turing Machine and Other Modification, The Model of Linear Bounded Automaton, Turing Machines and Type 0 Grammars, Linear Bounded Automata and Languages, Halting Problem of Turing Machines, NP-Completeness.

Suggested Readings

1. K.L.P. Mishra, N. Chandrasekaran, Theory of Computer Science, BPB Publication, Prentice-Hall of India, Second Edition.
2. H.R. Lewis and C.H.Papadimitriou, Elements of the Theory of Computation, Second Edition, Prentice Hall of India.
3. H.E. Hopcraft and J.D. Ullamn, Introduction to Automata Theory, Languages and Computation, Narosa Publications.
4. J.C. Martin, Introduction to Languages and the Theory of Automata, Tata McGraw-Hill.
6. C.H. Papadimitriou, Computation Complexity, Addison-Wesley.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	M	M	M	M

CO2	M	M	M	M
CO3			H	
CO4				H
CO5			M	H

CAML0049: MACHINE LEARNING

(4-0-0) (4 Credits – 60 Hours)

COURSE/LEARNING OUTCOMES:

1. Learn mathematical principles used in learning algorithms and relate them to learning principles. (Understanding)
2. Construct and classify learning algorithms used in different problems. (Applying)
3. Know what and how to perform pre-processing to make dataset ready for learning algorithms(Analysing)
4. Create learning models and evaluate the effect of it in a given problem domain. (Evaluation)

Module I: (15 hours)

Mathematical Foundations of Machine Learning: Linear Algebra-Linear equations & vector spaces,matrix decomposition: determinant, Eigen values, singular value decomposition, matrix approximation, Calculus: Differentiation & partial differentiation, gradient of matrices, Probability & Distributions: Discrete and Continous probabilities, Gaussian distribution, Continous optimization:Gradient descent, Lagrange Multiplier.

Module II: (10 hours)

Learning: supervised and unsupervised learning,necessary of supervised learning, KNN,regression models,Naive Bayes' classifier, decision trees,random forest classifier, SVM:linear, non-linear.

Module III: (11 hours)

Data preprocessing & Scaling: Different kinds of preprocessing, Data transformations, Scaling: training data & testing data, Types of unsupervised learning, dimensionality reduction, clustering: k-Means, Fuzzy C -Means, DBSCAN, Comparing and evaluating clustering.

Module IV: (13 hours)

Neural Network: Biological to Artificial neurons, Logical computations with neurons, perceptron, MLP & backpropagation, Tuning neural network hyperparameters, vanishing and exploding gradient problems,momentum optimization:AdaGrad, Adam optimization, Regularization: L1 & L2, Convolutional property of neural network.

Module V: (11 hours)

Deep learning: Convolutional Neural Network: AlexNet, GoogleNet, ResNet, RNN: Training a RNN, deep RNN, LSTM cell, Auto encoders: stacked auto encoders, sparse auto encoder.

Suggested readings:

1. Hands-On Machine Learning with Scikit-Learn & TensorFLow. Second edition, Aurelien Geron,2017, O' Reilly Media.
2. Machine Learning-An Algorithmic Perspective, second edition, Stephen marshland,2015, CRC Press.
3. Deep Learning, John D. Kelleher,2019, Massachusetts Institute of Technology(MIT).

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H	M		
CO 3			H	M	
CO 4				H	H

CAHC0050: HUMAN COMPUTER INTERACTION (HCI)

(4-0-0) (4 Credits – 60 Hours)

COURSE OUTCOMES:

Upon completion of the course, the student should be able to:

1. Learn the basic physiological, perceptual, and cognitive components of human learning and memory and gain theoretical knowledge of the fundamental aspects of designing and implementing user interfaces (Remembering)
2. Explain the HCI implications for designing various applications such as multimedia/apps/ ecommerce/ e-learning Web sites. (Understanding)
3. Design effective HCI for individuals. (Applying)

4. Analyze the quality of user interface (Analyzing)
5. Assess the importance of user feedback. (Evaluating)
6. Develop meaningful user interface. (Creating)

Module I: Introduction to HCI And History (10 Hours)
What is HCI? Historical evolution of the field. Human brain and computer: The Human sensation and perception–Human Memory – Reasoning and problem solving; The computer and its I/O Devices – Memory – processing and networks; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms- Problems and challenges.

Module II: Design and Software Process (22 Hours)
Interactive Design basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process – software life cycle – usability engineering – Prototyping in practice – design rationale. Design rules – principles, standards, guidelines, rules. Design Evaluation Techniques – Experimental evaluation and Empirical Methods: Hypothesis testing, Choosing participants and sample size, Variables: independent and dependent measures, Types of experimental designs, Data analysis.

Module III: Models and Theories (9 Hours)
Cognitive models –Socio-Organizational issues and stake holder requirements –Communication and Collaboration models- Hypertext, Multimedia and WWW. Design Case studies: Multi-Key press Hindi Text Input Method on a Mobile Phone, Employment Information System for unorganized construction workers on a Mobile Phone.

Module IV: Mobile HCI (7 Hours)
Mobile Ecosystem: Platforms, Application frameworks- Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile
Design, Tools.

Module V: Brain-Computer Interaction (BCI) and Neuroprosthetics/Sensory substitution (12 HOURS)
What is BCI? BCI and brain plasticity-Neuroergonomics and Neurocognitive Engineering-Medical applications of BCI: Neuroprosthetics, Commercial Applications of BCI, Ethical implications of these interfaces, Neuroprosthetics vs. sensory substitution, Most sensory substitution devices compensate for loss of vision: discussion of visual to tactile and visual to auditory devices, Components of sensory substitution devices, Underlying theories and why it works?

Suggested Readings:

1. “Human Computer Interaction”, 3rd Edition , Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, 2004, Pearson Education.
2. “Designing the User Interface: Strategies for Effective Human-Computer Interaction”, 5th Edition, Shneiderman, Plaisant, Cohen, and Jacobs, 2009, Addison Wesley.
3. “Introduction to Human Factors Engineering”, 2nd Edition, Wickens, Lee, Liu, and Gordon-Becker, 2004, Pearson.
4. “Human Computer Interaction”, Preece J., Rogers Y., Sharp H., Baniyon D., Holland S. and Carey T., 1994, Addison-Wesley.
5. “Designing the User Interface”, B. Shneiderman; 2000, Addison Wesley(Indian Reprint).
6. “Mobile Design and Development”, First Edition, Brian Fling, 2009, O’Reilly Media Inc.
7. “Designing Web Interfaces”, First Edition, Bill Scott and Theresa Neil, 2009, O’Reilly.

Mapping of Course outcomes

Course outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H	L			H
CO 2	L	H	M	M	L
CO 3		H	H	M	
CO 4		H	H	L	
CO 5		M	H	H	
CO 6			H	H	M

CABI0051: BIOINFORMATICS
(4-0-0) (4 Credits – 60 Hours)

Course Outcomes:
1. Relate the different mathematical principles that are necessary in sequence analysis and searching. (Remembering).
2. Explain the different protein structure and use algorithm models for alignment analysis. (Understanding)
3. Design phylogenetic tree for discovering pattern in sequence analysis. (Creating)
4. Analyze , predict and model protein structure and assess the structures.(Evaluating)

Module I: (16 hours)
Introduction to bioinformatics, opportunity and challenges in bioinformatics, protein sequence, analyzing protein sequences, analyzing DNA sequences, palindromes in DNA sequences, coding DNA sequences, RNA structures and sticky strands, pubmed, Expasy, Assessment of structure prediction, protein engineering.

Module II: (15 hours)
Genome organization, picking out genes in genomes, genome of homosapiens, database indexing, nucleic acid sequence database,genome database, protein sequence database, database of protein families, structures, protein identification resource, sequence alignments and dotplots, sequence similarity quantification, scoring schemes, dynamic programming for optimal pairwise alignment, multiple sequence alignment, editing and publishing alignments.

Module III: (14 hours)
phylogenetic tree, taxonomic relationships, clustering and cladistic methods, ancestral sequences and its reconstruction, evolution and varying rates of evolution, preparing data for phylogenetic tree, BLAST search, building the tree specific to a problem, phylip and open source tools for generating tree, maximum likelihood tree.

Module IV: (15 hours)
Folding and protein stability, sidechains, denaturation in relation to protein stability, coiled-coiled proteins, helical model, structural elements and superposition, mustang, dali, protein structure evolution, SCOP classification, prediction of protein structure and modeling, assessment of structure prediction, secondary structure and prediction, homology modeling and fold recognition. Three dimensional profiles to assess quality of structures.

Suggested readings:
1. Bioinformatics for dummies, second edition, Jean-Michel, Cedric Notredame, 2007, Wiley publishing
2. Introduction to bioinformatics, fourth edition, Arthur M. Lesk,2014, Oxford University Press.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2		H		M
CO 3			H	
CO 4				H

CADL0052: DEEP LEARNING
(4-0-0) (4 Credits – 60 Hours)

Course Outcomes:
1. Recall the various deep learning related terms, tools, and technologies (Remembering)
2. Compare and contrast the various types of neural networks (Analysing)
3. Test, explore and estimate all the parameters for neural networks. (Evaluating)
4. Illustrate the various deep unsupervised learning techniques for solving specific real-world problems. (Understanding)
5. Experiment how to deploy neural network algorithm to solve real-world problems. (Applying)

Module I: Basics of Deep Learning (14 Hours)
Introduction: Basics of Artificial Intelligence, Machine learning, and Deep learning; History and Capabilities of Deep Learning, Deep Learning primitives – Soft Max Function, Sigmoid, Tanh and ReLU Neurons, Functions and Gradient Descent, Linear/Logistic regression, Vectorizing Logistic regression,
Neural Network: Basic concepts of artificial neurons, single and multi-layer perceptrons, perceptron learning algorithm, perceptron convergence theorem, gradient descent and backpropagation algorithm, the vanishing gradient problem, gradient descent, regularization, dropout

Module II: Types of Neural Networks (18 Hours)
Convolutional Neural Networks (CNN): Introduction to CNN, CNN Architectures, Convolution / pooling layers, Correlation, Filtering, CNN architectures, Detection and Segmentation, Advanced CNNs for computer vision
Advanced Deep Architectures: Recurrent Neural Networks, Long Short-Term Memory Units (LSTM), Gated Recurrent Unit (GRU), Encoder Decoder architectures, Generative Adversarial Networks (GANs)

Module III: (10 Hours)
Deep Unsupervised Learning: Autoencoders (standard, sparse, denoising, contractive, etc), Variational Autoencoders, clustering learning, Adversarial Generative Networks, Learn-from-data model, Autoencoder and DBM Attention and memory models,

Maximum Entropy Distributions, Unsupervised learning of visual representations from image patches and locality, Unsupervised Learning of Visual Representations using Videos

Module IV: Deep Learning in Practice (18 Hours)
Deep Learning for Computer Vision: Introduction to convnets, training a convnet on small datasets, using a pretrained convnet, Applying Deep Learning for Object detection, face recognition, and automatic image classification
Deep Learning for Natural Language Processing (NLP): Introduction to NLP, Vector Space Model of Semantics, Word Vector Representations: Continuous Skip-Gram Model, Continuous Bag-of-Words model (CBOW), Glove, Evaluations and Applications in word similarity, analogy reasoning, Named Entity Recognition, Opinion Mining using Recurrent Neural Networks, Parsing and Sentiment Analysis using Recursive Neural Networks, Sentence Classification using Convolutional Neural Networks

Suggested Readings
1. Nielsen, Michael A. *Neural networks and deep learning*. Vol. 25. San Francisco, CA: Determination press, 2015.
2. Goodfellow, Ian, et al. *Deep learning*. Vol. 1. No. 2. Cambridge: MIT press, 2016.
3. Deng, Li, and Yang Liu, eds. *Deep learning in natural language processing*. Springer, 2018.
4. Wani, M. Arif, et al. *Advances in deep learning*. Springer, 2020.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		
CO 3	L	H		M
CO 4			H	
CO 5		M		H

CASC0053: SOFT COMPUTING
(4-0-0) (4 Credits – 60 Hours)

Course/Learning Outcomes
At the end of the course, students would be able to:
1. Identify and describe soft computing techniques and their roles in the development of smart machines. (Remembering and Understanding)
2. Apply fuzzy logic and reasoning to deal with uncertainty and solve various problems. (Applying)
3. Analyze the architecture and algorithms of Neural networks to meet the challenges of soft computing problems. (Analyzing)
4. Analyze genetic algorithms to combinatorial optimization problems. (Analyzing)
5. Evaluate and compare solutions to a given problem using various soft computing approaches. (Evaluating and Creating)
6. Effectively use existing software tools to solve real problems using a soft computing approach. (Applying)

Module I (6 Hours)
Introduction to Soft Computing, Characteristics of Soft Computing, Soft Computing Versus Hard Computing, Soft Computing Constituents, Applications of Soft Computing techniques, Evolutionary Computing, Machine Learning Basics.

Module II (11 Hours)
Fuzzy Logic: Introduction to Fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy sets and membership functions, Operations on Fuzzy sets, Fuzzy relations, Rules, Propositions, Implications and Inferences, Fuzzification and Defuzzification, Fuzzy ogic controller, Fuzzy Expert Systems, Fuzzy Decision Making, Applications of Fuzzy logic.

Module III (15 Hours)
Neural Networks: Biological neurons and its working, Introduction to Artificial Neural Network, Artificial Neural Networks Versus Biological Neural Networks, Activation functions, ANN architectures : McCulloch & Pitts model, Perceptron, ADALINE, MADALINE, Activation functions, Supervised Learning: Introduction, Neuron as a simple computing element, The perceptron, Backpropagation Networks: Architecture, Multilayer Perceptron, Back propagation learning-input layer, Radial Basis Function Networks. The Hopfield Network, Unsupervised Learning Neural Networks: Hebbian Learning, Self-Organizing Computational Maps: Kohonen Network, Applications of ANNs.

Module IV (13 Hours)
Genetic Algorithms: Introduction to Genetic Algorithm (GA), Working Principle, Difference between traditional algorithms and GA, Phases of Genetic Algorithm, Basic GA framework and different GA Architectures, Convergence of GA, Applications of GA case studies. Introduction to genetic programming-basic concepts.

Module V (15 Hours)
Deep Learning: Basics of Deep Learning, Convolutional Neural Network, Recurrent Neural Network. Matlab/Python Lib: Study of Neural Network Toolbox and fuzzy logic toolbox, Simple implementation of ANN and fuzzy logic.

Suggested Readings
1. R. Rajasekaran and G. A Vijayalakshmi Pai, Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, Prentice Hall of India. 2003.
2. Timothy J. Ross, Fuzzy Logic with Engineering Applications, Wiley, 2011.
3. N.P.Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press. 2005.
4. Simon O. Haykin, Neural Networks and Learning Machines, Pearson, 2009.
5. MATLAB Toolkit Manual.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H			
CO 3			H		
CO 4				H	
CO 5	M		M		M
CO 6					M

CADS0054: DATA SCIENCE
(4-0-0) (4 Credits – 60 Hours)

Course/Learning Outcomes:
At the end of this course, students will demonstrate the ability to
1. Understand the basic concepts and technologies related to Data Science. (Understanding)
2. Obtain, clean/process, and transform data and analyze the transformed data using an ethically responsible approach (Applying and Analyzing)
3. Relate which tools and methodologies can be applied to solve data science tasks. (Remembering)
4. Integrate Data Science capabilities into the formation of a situation analysis (Evaluating)
5. Formulate and use appropriate models of data analysis to solve hidden solutions to business-related challenges (Creating)
6. Interpret data findings effectively to any audience, orally, visually, and in written formats. (Understanding)

Module I: Introduction to Data Science, Preprocessing, and Data Visualization (14 Hours)
Introduction to Data Science: Why Learn Data Science, Data Analytics Life Cycle, Types of Data Analysis, Types of Jobs in Data Analytics, Data Science Tools, Fundamentals Areas of Study in Data Science
Data Preprocessing: Introduction to Data Preprocessing, Data Types and Forms, Possible Data Error Types, Various Data Preprocessing Operations - Data Cleaning, Data Integration, Data Transformation, Data Reduction, and Data Discretization
Data Plotting and Visualization: Introduction to Data Visualization, Visual Encoding, Data Visualization Libraries, Basic Data Visualization Tools (Histograms, Bar Charts, Scatter Plots, Line Charts, Area Plots, Pie Charts, Donut Charts); Specialized Data Visualization Tools (Box Plots, Bubble Plots, Violin Plots, Heat Map, Dendogram, Radar Chart, Venn Diagram, 3D Scatter Plots), Advanced Data Visualization Tools (Wordclouds, Chord Diagram, Waffle Charts, Choropleth Map, Bubble Map), Data Visualization Types

Module II: Statistical Data Analysis and Machine Learning (18 Hours)
Statistical Data Analysis: Role of Statistics in Data Science, Kinds of Statistics, Descriptive Statistics (Measures of Frequency, Central Tendency, Dispersion, and Position), Inferential Statistics, Parametric vs Non-Parametric Hypothesis Testing, Probability Theory, Four Perspectives on Probability, Bayesian Probability, Probability Distribution
Machine Learning for Data Science: Overview of Machine Learning, Supervised Machine Learning - Regression Methods (linear, polynomial, and logistic), Classification Methods (KNN Classification, Support Vector Machine (SVM) Classification, and Decision Tree Classification); Unsupervised Machine Learning - Clustering Methods (Fuzzy c-means Clustering and Principle Component Analysis (PCA) Clustering), Association Analysis - Apriori Algorithm and FP-Growth Analysis, Introduction to Reinforcement Learning

Module III: Time-Series Analysis and Deep Learning (12 Hours)
Time-Series Analysis: Overview of Time-Series Analysis, Components of Time-Series, Time-Series Forecasting Models using Stochastic Models (AR, MA, ARMA and ARIMA), Time-Series Forecasting using Support Vector Machines Based Models

Deep Learning for Data Science: Introduction to TensorFlow, Pytorch, Deep Learning Primitives, Convolutional Neural Network (Softmax, ReLU, Sigmoid or Logistic Activation function, and Pooling), TensorFlow and CNN, AutoEncoder (Convolutional Autoencoder and Sparse Autoencoder)

Module IV: Social Media Analytics, Business Analytics, and Big Data Analytics (16 Hours)
Social Media Analytics: Overview of Social Media Analytics, Seven Layers of Social Media Analytics, Social Network Analysis (Link Prediction, Community Detection, and Influence Maximization), Text Analytics/Mining (Text Categorization, Document or Text Summarization, and Sentiment Analysis), Trend Analytics
Business Analytics: An Overview of Business Analytics, The Business Analytics Life Cycle, Basic Tools Used in Business Analytics, Financial Analytics, Market Analytics, Customer Analytics, and Employee Analytics
Big Data Analytics: An Overview of Big Data, Hadoop, Hadoop Distributed File System, Interacting with HDFS from Python Applications, Introduction to Snake, Pig and Spark

Suggested Readings
1. J. Grus, Data Science from Scratch: First Principles with Python, O'Reilly, 2nd Edition, 2019
2. Silberschatz, H. F. Korth, S Sudarshan, Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, 1st Edition, Dreamtech, 2016
3. C. Neil, R. Schutt, Doing Data Science: Straight Talk from the Frontline, O'Reilly, 1st Edition, 2019.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2	H			
CO 3		H	M	M
CO 4			M	M

CAVS0055: DATA VISUALIZATION FOR DATA SCIENCE
(4-0-0) (4 Credits – 60 Hours)

Course/Learning Outcomes
1. Learn what data visualization is, how it's used, and how computers display information. Also explore different types of visualization and how humans perceive information. (Remembering)
2. Apply principles of design and colour to make visualizations more engaging and effective. (Applying).
3. Learn how to visualize graphs that depict relationships between data items. (Understanding)
4. Designing your own visualization system for large datasets and dashboards. (Creating)
5. Create and interpret the visualization from the data set, and apply techniques from user-interface design to create an effective visualization system. (Creating, Evaluating)

Module I: (12 hours)
Introduction to Data Visualization: Overview of Visualization, Defining data visualization; Visualization workflow: describing data visualization workflow, process in practice; Data representation: chart types: categorical, hierarchical, relational, temporal & spatial.

Module II: (15 hours)
Visualization Tools: 2-D: bar charts, clustered bar charts, dot plots, connected dot plots, pictograms, proportional shape charts, bubble charts, radar charts, polar charts, Range chart, Box-and-whisker plots, univariate scatter plots, histograms word cloud, pie chart, waffle chart, stacked bar chart, back-to-back bar chart, all relevant 2-D charts. 3-D: surfaces, contours, hidden surfaces, pm3d coloring, 3D mapping; multi-dimensional data visualization; manifold visualization; graph data visualization; Annotation; Word Clouds, Seaborn and Regression Plots.

Module III: (12 hours)
Visualization of Numerical Data**:** Data, Mapping, Charts, Glyphs, Parallel Coordinates, Stacked Graphs, Tufte's Design Rules.

Module IV: (10 hours)
Visualization of Non-Numerical Data**:** Graphs and Networks**,** Embedding Planar Graphs**,** Graph Visualization**,** Creating Maps and Visualizing Geospatial Data, Introduction to Folium, Maps with Markers, Choropleth Maps, Tree Maps**,** Principal Component Analysis**,** Multidimensional Scaling**,** Packing.

Module V: (11 hours)
The Visualization Dashboard: Introduction, Visualization Systems, the Information Visualization, Database Visualization, Visualization System Design.

Suggested Readings

1. Andy Kirk, Data Visualization A Handbook for Data Driven Design, Sage Publications, 2016
2. Philipp K. Janert, Gnuplot in Action, Understanding Data with Graphs, Manning Publications, 2010.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H	M		
CO 3			M	M	
CO 4				H	
CO 5					H

CABD0056: BIG DATA MANAGEMENT

(4-0-0) (4 Credits – 60 Hours)

COURSE / LEARNIG OUTCOMES:

1. List the components of Hadoop and Hadoop Ecosystem. (Remembering)
2. Understanding of big data basics and problems over big data. (Understanding)
3. Identify Big Data and its Business Implications. (Applying)
4. Make use of Hadoop and MapReduce programming to tackle big data problems. (Applying)
5. Demonstrate Machine Learning Techniques using R/Python. (Understanding)

Module I (12 Hours)

Introduction to Big Data and Hadoop Types of Digital Data: Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Ecosystem, IBM Big Data Strategy, Introduction to Infosphere Big, Insights and Big Sheets.

Module II (12 Hours)

HDFS (Hadoop Distributed File System): The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.

Module III (10 Hours)

Map Reduce: Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.

Module IV (14 Hours)

Hadoop Ecosystem: Pig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive: Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. HBase : HBasics, Concepts, Clients, Example, HBase Versus RDBMS.

Module V (12 Hours)

Machine Learning: Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Introduction to Big Data Analytics with BigR.

Suggested Readings

1. Hadoop: The Definitive Guide, Third Edition, Tom White, 2012, O'reily Media.
2. Big Data Analytics, Seema Acharya, Subhasini Chellappan, 2015, Wiley.
3. Machine Learning (in Python and R), First Edition, J. P. Mueller, L. Massaron, 2016, Wiley.

Mapping of Course Outcomes:

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H			H	
CO 2	H	M			
CO 3			M	H	
CO 4			H	H	
CO 5				M	H

CAWA0057: WEB ANALYTICS AND DEVELOPMENT

(4-0-0) (4 Credits – 60 Hours)

Course Outcomes:

1. Recall the various Web Analytics--related terms, tools, and technologies (Remembering)
2. Illustrate the various web data capturing procedures and the various important web metrics (Understanding)
3. Experiment how to deploy web intelligence to improve the outcomes of marketing or business plan. (Applying)
4. Compare and contrast the various web analytics tools (Analysing)
5. Analyze, test, and judge results based on search analytics, competitive intelligence analytics and Google analytics. (Analyzing, Evaluating)

Module I: Basic Concepts of web Analytics and Web Data Collection (14 Hours)

Introduction: Web Analytics – brief history, evolution, importance and need; advantages and limitations of web analytics, site references, Basic Terms - keywords and key phrases, onsite web, offsite web, visit characterization terms, content characterization terms, conversion metrics; Web analytics platform

Data Collection: Clickstream Data - Web logs, Web Beacons, JavaScript tags, Packet Sniffing; Outcomes Data: E-commerce, Lead generation, Brand/Advocacy and Support; Research data: Mindset, Organizational structure, Timing; Competitive Data: Panel-Based measurement, ISP-based measurement, Search Engine data.

Module II: Web Data Capturing and Web Metrics (16 Hours)

Capturing data: Web logs, data capture, Type and size of data, Innovation, Integration, selecting optimal web analytic tool, Understanding click stream data quality, identifying unique page definition, Using cookies, Link coding issues

Web Metrics: Common metrics: Hits, Page views, Visits, Unique visitors, Unique page views, Bounce, Bounce rate, Page/visit, Average time on site, New visits; Optimization (e-commerce, non-ecommerce sites): Improving bounce rates, optimizing adwords campaigns; Real time report, Audience report, Traffic source report, Custom campaigns, Content report, Google analytics, Introduction to KPI, characteristics, Need for KPI, Perspective of KPI, Uses of KPI.

Module III: Search Analytics and Qualitative Analysis of Web Data (12 Hours)

Search Analytics: Performing Internal Search Site Analytics, Search engine optimization, Measuring SEO Efforts, Analyzing Pay per Click effectiveness,

Qualitative Analysis: Essence of customer eccentricity, Heuristic evaluations, Site Visits: Conducting a site visit, Benefits of site visits; Surveys - Website surveys, Post-visit surveys, creating and running a survey, Benefits of surveys .

Module IV: Web Analytics Tools, Competitive Intelligence and Google Analytics (18 Hours)

Web Analytics tools: Click Stream Analysis, A/B testing, Online Surveys

Competitive Intelligence (CI) analysis: CI data sources, Toolbar data, Panel data, ISP data, Search engine data, Hybrid data, Website traffic analysis: Comparing long term traffic trends, Analyzing competitive site overlap and opportunities.

Google Analytics: Brief introduction and working, Adwords, Benchmarking, Categories of traffic: Organic traffic, Paid traffic; Google website optimizer, Implementation technology, Limitations, Performance concerns, Privacy issues.

Suggested Readings

1. Kaushik, Avinash. Web Analytics: An Hour a Day. United States, Wiley, 2007.
2. Clifton B., Advanced Web Metrics with Google Analytics, Wiley Publishing, Inc.2nd ed
3. Kaushik A., Web Analytics 2.0, The Art of Online Accountability and Science of Customer Centricity, Wiley Publishing, Inc. 1st ed.
4. Sterne J., Web Metrics: Proven methods for measuring web site success, John Wiley and Sons

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			L
CO 2		H		
CO 3		L	H	M
CO 4				H
CO 5			H	H

ECRM0042 RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHT (L-T-P: 2-0-0)

(2 credits-30 hours)

Objective:

This course is designed to help students to identify research problems in various fields. It aims at giving potential researchers the knowledge of effectively analysing and interpreting results and presenting the findings to the scientific and technological community of the world. This course also aims at motivating students to bring about their creative ideas for innovation and establishing research impact in the global for a through intellectual ownership.

Course Outcomes

1. Find research problems in various fields (Remembering).
2. Illustrate the concepts related to patents, trademark and copyright (Understanding).
3. Apply scientific investigations to find solutions for research problems of interest (Applying).
4. Develop technical writing and presentation skills (Applying).
5. Analyze the available literature and compile literature review for knowing the state of the art in the areas of interest (Analyzing/ Creating).
6. Formulate a research problem for a given engineering domain (Creating)

Module I (12 Hours)

Meaning, sources, scope and objective of a research problem; Good research problem criteria and characteristics, errors in selecting a research problem; Research problem solutions– approaches for investigation; Approaches to effective literature studies; Data collection, analysis, interpretation and instrumentation; Plagiarism and ethical practices.

Module II (10 Hours)

Effective writing; Research proposal development and its format; Different report types.

Module III (8 Hours)

a. Nature of intellectual property: Patent, design, trade and copyright; Patenting and development process; Patent grant under PCT and procedure; Geographical indications.
b. Patent rights: Administration of patent systems, scope, information and databases, technology licensing.
c. New developments and case studies.

Suggested Readings

1. Goddard Wayne, Melville Stuart, Research Methodology: An Introduction For Science And Technology Students, Juta & Co. Ltd.
2. Kumar Ranjit, Research Methodology A Step By Step Guide For Beginners, SAGE publications Inc.
3. Halbert J. Debora, Resisting Intellectual Property, CRC press.
4. Menell S. Peter, Lemley A. Mark, Merges P. Robert, Intellectual Property In New Technological Age, Clause 8 Publishing.
5. C.R. Kothari, Research Methodology Methods and Techniques, New Age International

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H		L
CO 2	M		H
CO 3	H	L	
CO 4	L	H	M
CO 5	H	M	L
CO6	H	M	L

LABORATORY COURSES

CAOS6012: OPERATING SYSTEMS LAB

(2 credits)

COURSE / LEARNING OUTCOMES

At the end of the Lab experiments students will be able to:

1. Recall and label the basic commands in Linux. (Remembering)
2. Classify system calls, library functions calls to write on standard output device. (Understanding)
3. Experiment with shell programs. (Applying)
4. Construct programs on process scheduling, page replacement algorithms. (Creating)
5. Evaluate free space management using programs. (Evaluating)

Module1

Introduction to Linux

File System (Types of file, Filename, parent-child relationship, absolute and relative pathname, file and directory permissions) Introduction to vi editor (start vi, the three modes, create, save and open a text file, positioning by character, positioning by line, positioning by word, positioning in the word, positioning on a numbered line, inserting text, deleting text), Simple Linux commands, Shell Programming

Module2:

Semaphores, Shared Memory and Message Queues: Semaphore (Binary semaphore, Linux Semaphore Facilities, Using Semaphores), Shared Memory, Message Queues

Module3:

Processes and Signals : Process Structure, Starting a new Process, Replacing a Process Image, Duplicating a Process Image, Waiting for a process, Zombie Processes, Terminating a Process, Signals (Signal handling, Sending signals, Signal interface, Signals sets).

Module4:

POSIX Threads: Creating threads, Simultaneous execution of threads, Synchronization and Critical sections, Synchronization with Semaphores, Synchronization with Mutexes, Thread Attributes, Cancelling a thread.

Inter-Process Communication: Pipes, Process Pipes, and The Pipe Call, Parent and Child processes, FIFOs (Accessing a FIFO, opening a FIFO, Reading and Writing FIFO).

Mapping of COs with Syllabus:

Course Outcomes	Module1	Module2	Module3	Module4
CO1	H	M		
CO2		H	M	
CO3		M	H	L
CO4	L	M	H	
CO5		L	M	H

CAPJ6014: PROGRAMMING THROUGH JAVA LAB

(2 credits)

COURSE / LEARNING OUTCOMES

At the end of this course students will be able to:

1. List various GUI and thus will be able to select the suitable GUI to resolve a given problem. (Remembering)
2. Distinguish among the various utility class like vector, stack, Hash Table, String Tokenizer, etc. (Understanding)
3. Apply their knowledge to solve practical problems like reading from a dataset, writing into a file and develop games using JAVA program. (Applying)
4. Evaluate the performance of various swing GUI components and design various applications using Swings depending on the domain and requirement. (Evaluating)

At the end of the experiments, students will be able to

1. Program to illustrate class, objects and constructors
2. Program to implement overloading, overriding, polymorphism etc
3. Program to implement the usage of packages
4. Program to create our own exception
5. Program for handling file operation

6. Implement the concept of thread programming
7. Program to implement Generic class and generic methods
8. Program for event-driven paradigm in Java
9. Program that uses Menu driven Application
10. Program to implement JDBC in GUI and Console Application
11. Socket programming to implement communications
12. Develop a multi-threaded GUI application of your choice.

E-resource for learning
Java, www.spoken-tutorial.org

Mapping of COs with Syllabus:

Course Outcomes	1,2,3,4,5	6,7	8,9,10,11,12
CO1		M	H
CO2	H		
CO3		M	H
CO4	M	M	H

CAIT6017: INTERNET TECHNOLOGY AND APPLICATIONS LAB
(2 credits)

COURSE / LEARNING OUTCOMES
At the end of this course students will be able to:
1. Utilise and experiment with mark-up languages such as XHTML and style sheets such as CSS to design static web pages. (Applying)
2. Design and validate a website and can also identify the faults in the design. (Analysing)
3. Create and develop a web application using various available frameworks and scripting languages such as JavaScript and PHP. (Creating)
4. Validate and examine a dynamic web application using database handling and various other services and deploy them after proper validation (Evaluating and creating)

Module I
a. XHTML: Components of XHTML; Elements of XHTML (Headers, Linking, Images, Special Characters, Lists, Tables, Forms, Framesets)
b. Cascading Style Sheets: Inline Styles; Embedded Style; Conflicting Style; Linking External Styles; W3C CSS Validation Service; Use of CSS (Positioning Elements, Backgrounds, Text flow)
c. Web Site Design Considerations: Using Logical Design: Planning your website, drawing a map, using a top-down approach, flexibility, other web design metaphors. Creating templates. Creating a Compatible Design: Designing for different color depths, resolutions, different browser considerations, accommodating limited bandwidth. Validating your work.

Module II
a. Web servers: HTTP Request Types; System Architecture of a Web server; Client-side Scripting versus Server-side Scripting; Accessing Web servers; Apache Web Server. b) Databases: Introduction to each one of the following: SQL, MYSQL, DBI
b. Scripting Languages: JavaScript: Operators, Data Types, Control Structures, Functions, Arrays, String Manipulation. VBScript Introduction to Perl and CGI (Common Gateway Interface).
c. PHP: Introduction to PHP; Data Types; Control Structures; Functions; Strings; Arrays; Querying Web Databases using PHP; Writing to Web Databases; Errors, Debugging and Deployment.

Suggested Readings
1. Deitel and Deitel, Internet and World Wide Web: How to Program, 2nd Edition, Prentice Hall of India Pvt. Ltd. , New Delhi
2. Hugh E. Williams and David Lane, PHP and MySQL, 2nd Edition, O'Reilly, Shroff Publishers and Distributors Pvt. Ltd.
3. Internet Complete, 2nd Edition, BPB Publications. , New Delhi
4. Douglas E. Comer, The Internet Book: Everything you need to know about Computer Networking and how the Internet works, 3rd Edition, Prentice Hall of India Pvt. Ltd., New Delhi

Mapping of COs to Syllabus

Course Outcomes	**Module 1**	**Module 2**
CO 1	H	
CO 2	H	
CO 3	L	H
CO 4		H

CADA6033: DATA STRUCTURES AND ALGORITHM LAB
(2 Credits)

Objectives
1. To introduce first level topics covering basics in algorithms and data structures.
2. To enable students to choose appropriate data structures, understand the ADT/libraries, and use of it to design algorithms for a specific problem.
3. To understand the necessary mathematical abstraction to solve problems.
4. To apply important algorithmic design paradigms and methods of analysis.

COURSE/LEARNING OUTCOMES
At the end of the course, students would be able to:
1. Get introduced to existing algorithms and how to analyse them using graph notation. (Remembering)
2. Demonstrate the existing standard algorithms. (Understanding)
3. Apply existing algorithms in developing different applications. (Applying)
4. Analyse the time complexity of standard algorithms. (Analysing and Evaluating)
5. Create efficient applications by using the right algorithm depending on input pattern and size. (Creating).

List of Programs
1. Implement the linear search and binary search algorithm to search for a given element e from a list of n numbers. Analyze the algorithms.
2. Prove that the Bubble Sort algorithm has time complexity of $O(n^2)$ by showing the graph notation.
3. Prove that the Selection Sort algorithm has time complexity of $O(n^2)$ by showing the graph notation.
4. Implement the Insertion Sort algorithm and analyse the algorithm using the graph notation.
5. Implement the Divide-and-Conquer technique and analyze the algorithm showing the graph notation.
6. Implement the Greedy Programming technique and analyze the algorithm showing graph notation.
7. Implement the Dynamic Programming technique and analyze the algorithm showing graph notation.
8. Design a small file compressor and decompressor by using Huffman coding technique.

Suggested Readings
1. Alfred V Aho, John E Hopcroft and Jeffrey D Ullman, The Design and Analysis of Computer Algorithms. Addision Wesley, 2001. (Modules I, II, III and IV)
2. Alfred V Aho, John E Hopcroft and Jeffrey D Ullman, Data Structures and Algorithms.. Addision Wesley, 2000. (Modules I and V)
3. Thomas H Corman, Charles E Leiserson, Ronald L Rivest and Clifford Stein, Introduction to Algorithms, 2nd PHI, 2004
4. V Manbar, Introduction to Algorithms - A Creative Approach, Addision Wesley, 2000.
5. Ellis Harwitz, Sartaz Sahani, Fundamentals of Computer Algorithms.. ,Computer Science Press, 2000.
6. Peter Linz, An Introduction to Formal Languages and Automata. Narosa Publishing House 2001

Mapping of COs with Syllabus

Course Outcomes	1	2	3	4	5	6	7	8
CO1	H	H	H	H				
CO2	H	H	H	H				
CO3					H	H	H	
CO4	H	H	H					
CO5								H

CACC6034: DATA COMMUNICATION AND COMPUTER NETWORKS LAB
(2 Credits)

Objective
Network programming involves writing programs that communicate with other programs across a computer network. Most operating systems provide pre-compiled programs that communicate across a network. This course envisages providing an introduction to such networking programming, whereby students will learn to write their own network programs. At the end of this course in network programming, the students are expected to have elementary ideas about the socket programming and their usage in setting up TCP and UDP communications.

COURSE / LEARNING OUTCOMES
At the end of the Lab experiments students will be able to:
1. List various network related commands. They will get introduced to socket programming in TCP and UDP environments. (Remembering)

2. Illustrate the functions used in TCP and UDP client server communication. (Understanding)
3. Apply their knowledge of socket programming to perform various types of communications, address conversions and so on. (Applying)
4. Analyze the efficiency of TCP and UDP client –server communication. (Analysing)
5. Design and evaluate code for conducting chat or communication between client and server in UDP environment. (Creating, Evaluating)

Module I

a. Introduction to Network Programming: Introduction to Sockets; Address Structure – IPv4, IPv6; Value-Result Arguments; Byte Order Functions; Byte Manipulation Functions; inet_aton, inet_addr, inet_ntoa, inet_pton, inet_ntop, readn, written, readline, isfdtype functions
b. Elementary TCP Sockets: Introduction; socket, connect, bind, listen, accept, fork, exec, close, getsockname, getpeername functions; TCP Client Server example; signal, sigaction, wait, waitpid functions; Connection Termination; SIGPIPE signal
c. i/O Multiplexing: I/O models; select function; Batch input; shutdown, pselect, poll functions; Example – TCP Echo Server.
d. Socket Options: getsockopt, setsockopt, fcult, ioclt functions; Socket status – generic socket options
e. Elementary UDP Sockets: Introduction; recvfrom, sendto functions; UDP Examples; connect function with UDP; UDP socket receive buffer; Example – UDP Echo Server

Module II

a. Elementary Name and Address Conversion: Introduction; gethostbyname function; RES_USE_INET6 resolver option; gethostbyaddr, uname, gethostname, getservbyname, getservbyport functions.
b. IPv4 and IPv6 Interoperability: Introduction; IPv4 Client - IPv6 Server, IPv6 Client – IPv4Server; IPv6 Address Testing Macros, IPV6_ADDRFORM.
c. Advanced Name and Address Conversions: Introduction; getaddrinfo, gai_strerror, freeaddrinfo, getnameinfo functions; Reentrant functions.
d. Daemon Processes: Introduction; syslogd daemon; syslog, daemon_init functions; inetd daemon; daemon_inetd function.

Suggested Readings

1. W Richard Stevens, UNIX Network Programming – Volume I, Second Edition, Prentice Hall of India Pvt. Ltd., 2002
2. Douglas E Comer, Internetworking with TCP/IP: Principles, Protocols, and Architectures Volume I, Fourth Edition, Prentice Hall of India Pvt. Ltd.
3. Douglas E Comer, David L Stevens, Internetworking with TCP/IP: Design, Implementation, and Internals – Volume II, Third Edition, Prentice Hall of India Pvt. Ltd.
4. Douglas E Comer, David L Stevens, Internetworking with TCP/IP: Client Server Programming and Applications – Volume III, Second Edition, Prentice Hall of India Pvt. Ltd.

Mapping of COs with Syllabus

Course Outcomes	Module I	Module II
CO1	H	M
CO2	H	M
CO3	H	
CO4	H	
CO5		H

CADM6035: ADVANCED DATABASE MANAGEMENT SYSTEMS LAB

(2 Credits)

Objectives:

1. Learn to create and use a database
2. Be familiarized with a query language.
3. Have hands on experience on DDL Commands
4. Have a good understanding of DML Commands and DCL commands
5. Familiarize advanced SQL queries.
6. Be Exposed to different applications

COURSE / LEARNING OUTCOMES

At the end of the Lab experiments students will be able to:

1. Identify basic SQL operations and fetch results with respect to specific requirement. (Remembering/Evaluating)
2. Describe PL/SQL program structure like conditional constructs, iterative construct, and exception handling. (Understanding)
3. Use different program structures and apply them to solve problems. (Applying)

4. Apply and analyze PL/SQL procedures, functions, packages, triggers to practice assignments. (Analysing)
5. Create applications using Oracle forms and Oracle report. (Creating)

Module I: Query handling with SQL in Oracle

a. Creation, altering and dropping of tables and inserting rows into a table (use of constraints while creating tables) examples using SELECT command.Queries using ANY, ALL, IN, EXISTS, NOTEXISTS, UNION, INTERSECT, Constraints.
b. Queries using Aggregate functions (COUNT, SUM, AVG, MAX and MIN), GROUP BY, HAVING and Creation and dropping of Views.Queries implementing various joins (left,right,full). Implementation of complex queries: nested queries,sub queries.
c. Queries using Conversion functions (to_char, to_number and to_date), string functions (Concatenation, lpad, rpad, ltrim, rtrim, lower, upper, initcap, length, substr and instr), date functions

Module II: PL/SQL Programming

a. Language fundamentals - PL/SQL block structure, character set, identifiers, literals, delimiters, comments, data types in PL/SQL
b. Program Structure - Conditional constructs, Iterative constructs, Exception handling
c. SQL in PL/SQL- DML and Transaction Management (Commit and Rollback), Data Retrieval, Cursors (Explicit and Implicit), error handling with Cursors
b. d) Procedures, Functions, packages, Triggers- creating and managing functions, procedures, packages and triggers
a. Built-in functions - String functions (ascii, chr, concat, greatest, instr, least, length, lower, lpad, ltrim, replace, rpad, rtrim, substr, trim, upper) Numeric functions (bitand, ceil, exp, floor, ln, mod, power, round, sign, sqrt, trunk) , Date and time functions (add_months, current_date, current_timestamp, last_day, months_between, next_day, round, sysdate, systimestamp, trunk) Conversion functions (to_number, to_char, cast, to_date, to_timestamp)

Module II: Forms Builder and Reports Builder

Components of application development in Oracle Forms (Form modules, menus, PL/SQL libraries, Object libraries, Database objects), Features of the Report Builder, defining a data model for a report, specifying the layout of the report using the Oracle Reports Wizard.

Suggested Readings

1. Ivan Bayross, Commercial Application Development Using Oracle Developer 2000 Forms 6i, BPB Publications, 2nd Revised Edition, 2005
2. John Day, Craig Van Slyke, Starting out with Oracle, Dreamtech Press, 2004
3. Steven Feuerstein, Oracle PL/SQL Programming, O'Reilly Publications, 3rd Edition.

Mapping of COs with Syllabus

Course Outcomes	Module I	Module II
CO1	H	M
CO2	M	H
CO3	M	H
CO4	M	H
CO5	M	H

CAML6036: MACHINE LEARNING LAB

(0-0-2) (2 Credits – 30 Hours)

COURSE/LEARNING OUTCOMES:

1. Explain the implementation procedures for the machine learning algorithms. (Understanding)
2. Design Java/Python programs for various Learning algorithms. (Creating)
3. Apply appropriate data sets to the Machine Learning algorithms. (Applying)
4. Identify and apply Machine Learning algorithms to solve real world problems (Applying)

Experiments:

1. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
2. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
3. Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.
4. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.

5. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
6. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API.
7. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.
8. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.
9. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.

Suggested Readings:

1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems – 2nd edition, Aurelien Geron, O'Reilly.
2. Building Machine Learning Systems with Python, Willi Richert and Luis Pedro Coelho, Packt Publishing.

Mapping of COs with Syllabus

Course Outcomes	1	2	3	4	5	6	7	8	9
CO1	H	H	H						
CO2	M	M	M	M	M	M	M	M	M
CO3				H	H	H	H	H	H
CO4	M	M	M	M	M	M	M	M	M

CAMN6038: MINOR PROJECT – MCA (5 CREDITS)

***Objective**: The objective of the Minor project is to consolidate the concepts and practices that were learned during the course and to serve as a record of competence. It should enable a student to apply concretely in a small package the concepts gained from Software Engineering.*

COURSE / LEARNING OUTCOMES

At the end of this Minor Project students will be able to:

- CO1: Recall and distinguish client end programming from a server end programming, web based application from a smart phone based application, approach to an application based project from a research based project. (Remembering, Understanding)
- CO2: Identify different API and development environment tools for building the project, research terminologies for research-based projects. (Applying)
- CO3: Apply the knowledge of programming to develop application specific but not limited to Web, Android, IoT etc., for research-based projects the different algorithm design techniques. (Applying)
- CO4: Analyse the advantage and limitation of different development languages, APIs, platforms, algorithms. (Analysing)
- CO5: Create applications to meet real time needs (Creating)
- CO6: Judge the efficiency of the project using various evaluation parameters and testing methodologies, efficiency of the algorithm for research-based complexity measure. (Evaluating)

E-resource for learning

LaTeX, www.spoken-tutorial.org

CAMP6039: MAJOR PROJECT – MCA

(18 Credits)

Objective

The primary objective of the Major Project is to enable students to have a thorough understanding of the theoretical principles learnt in earlier five semesters through a prolonged practical experience. The major project is oriented towards developing requisite skills, knowledge of latest technologies and an entrepreneurial attitude in a student which are needed to make an effective start as a computer/IT professional.

COURSE / LEARNING OUTCOMES

At the end of Major Project students will be able to:

1. Identify different API and development environment tools for building the project, research terminologies such as scaling, sampling, information gathering etc for research-based project. (Understanding, Applying)

2. Learn different programming languages/research tools needed to meet different objectives of the project based on the company/institutional requirements. (Remembering)
3. Apply the knowledge of programming to develop application specific but not limited to Web, Android, IoT etc. For research based projects, the different algorithm design techniques, classification & clustering techniques, etc. will be applied. (Applying)
4. Analyse the advantages and limitations of different development languages, APIs, platforms, algorithms (for research) (Analysing)
5. Create applications to meet real time needs. For research-based projects, students will be able to design novel or hybrid research techniques to meet the problem statement objectives (Creating)
6. Judge the efficiency of the project using various evaluation parameters and testing methodologies, efficiency of the algorithm for research based (complexity measure) (Evaluating)

VALUE ADDED COURSES

CARP6051: ROBOTIC PROCESS AUTOMATION

(30 Hours)

COURSE/ LEARNING OUTCOMES

1. Explain the RPA Developer enablement journey and an introduce to the role. (Understanding)
2. Explain the three constructs that are fundamental in any software process: variables, arguments and control flow. (Understanding)
3. Address what selectors are, the UI Explorer, the Property Explorer, Selector types, where to use them and how to fine-tune Selectors when encountering difficult situations. (Remembering)
4. Creating UI input and output actions. (Creating)
5. Learn about the many email tasks that can be automated to help you save valuable time. Cover an essential aspect of development, identifying and solving bugs in your projects and learn about how to get automation production-ready: how to anticipate, detect and resolve errors in your workflows. (Applying)

Module I: (8 Hours)

RPA Overview: Overview of Robotic Process Automation (RPA), Benefits of RPA in industries and business processes, Introduction to the RPA Developer Role, Variables, Data Types and Control Flow, Version Control, Data Manipulation, Excel and Data Tables, Selectors.

Module II: (22 Hours)

Bot Building: UI Automation, Introduction to Logging in Studio, IMDB Movie Rating, Contact Details, RPA Challenge.

Amazon Data Scraping, Recording Demo.

Calculate Client Hash, PDF Automation, Error and Exception Handling, Debugging.

Email Automation, Connecting Robot to Orchestrator, Publishing workflow to Orchestrator, Orchestrator Demos.

Suggested Readings

1. The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems by Tom Taulli, Publisher: Apress
2. Learning Robotic Process Automation: Create Software Robots and Automate Business Processes with the Leading RPA Tool – UiPath by Alok Mani Tripathi, Publisher: Packt Publishing; 1st edition
3. Robotic Process Automation Projects: Build Real-world RPA Solutions Using UiPath and Automation Anywhere by Arun Kumar Asokan and Nandan Mullakara, Publisher: Packt Publishing Limited

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II
CO1	H	
CO2	H	
CO3		H
CO4		H
CO5		H

CABC6052: BLOCKCHAIN

(30 Hours)

COURSE/ LEARNING OUTCOMES

1. To understand what Blockchain is and why it is used. (Remembering)
2. To be able to explain the different components involved within Blockchain. (Understanding)
3. To know when and why you may want to use Blockchain within your environment. (Remembering)

Module I: (7 Hours)

Introduction to Blockchain Technology and its Importance; Evolution of the Blockchain Technology,

Module II: (7 Hours)

Elements of a Blockchain, Basic Crypto Primitives – Cryptographic Hash, Digital Signature

Module III: (16 Hours)

Blockchain Consensus I – Permissionless Models, Blockchain Consensus II – Permissioned Models, Smart Contract Hands On I – Ethereum Smart Contracts (Permissionless Model), Blockchain Applications

Suggested Readings

1. Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition, Imran Bashir, Packt Publishing, 2020,
2. Hyperledger Tutorials - https://www.hyperledger.org/use/tutorials
3. Ethereum Development Resources - https://ethereum.org/en/developers

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO1	H		
CO2	M	H	
CO3		M	H

CAAW6053: ADVANCED WEB APPLICATION DEVELOPMENT TECHNIQUES

(30 Hours)

COURSE/ LEARNING OUTCOMES

1. Explain the JavaScript and an introduce to the role in client server architecture.(Understanding)
2. Explain the importance of data validation and understand the process of data sanitization. (Understanding)
3. Address the threat handling mechanism while development. (Remembering)
4. Creating User interface, service design pattern, and remote connection. (Creating)
5. Learn about the recent trend in web development architecture based on micro service design pattern. Cover an overview of recent trend in management of load balancing and service scalability. (Applying)

Module I: (18 Hours)
JavaScript Overview: Form events, Client Side Validation (Length check, Numeric field check, Alphanumeric field check, Empty Field, special character, password format, All field entry check), Server Side validation (Data sanitization), SQL Injection, Overview of session management, Cross site scripting, URL validation, Importance of Asynchronous JavaScript and XML (Ajax), loading page content using AJAX, Database connection, Back end data update using AJAX.

Module II: (12 Hours)
Micro Service Applicability: Micro Service design pattern, Overview of Service Oriented Architecture, Principles of Web Service, SOAP / RESTful Web Service, Overview of Containerization: Kubernetes with Docker.

Suggested Readings

1. Beginning JavaScript with DOM Scripting and Ajax – Russ Ferguson and Christian Heilmann, Publisher: Apress ; 2nd edition
2. Ajax programming for the absolute beginner, Jerry Lee Ford, Jr. Publisher: Course Technology, 1st Edition
3. Kubernetes Microservices with Docker by Deepak Vohra, Publisher: Apress, 1st Edition

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II
CO1	M	
CO2	M	
CO3		M
CO4		H
CO5		H

CASL0200: SERVICE LEARNING

(2 Credits)

Objective
The objective of this course is to understanding of the theory and practice of community university engagement. The students provide an insight on the theme of Social Responsibility of Higher Education Institution and to introduce community based participatory research and the tools to facilitate engaged research.

COURSE/LEARNING OUTCOMES
At the end of this course, students will demonstrate the ability to

1. Define and explain the understanding of Community-University Engagement (CUE) and outline CUE in relation to higher education policy in India. (Remembering)
2. Analyze and identify the social responsibility of higher education institutions to facilitate engaged teaching, research & service. (Analyzing)
3. Determine the various methods and tools on Community-Based Participatory Research (CBPR). (Evaluating)
4. Evaluate how Higher education institutions can undertake community engagement post COVID-19. (Evaluating)
5. Design a plan for the engagement of students with the community through engaged teaching, research and service. (Creating)

Module I: Community University Engagement (CUE) (7 Hours)
History and Role of Community University Engagement (CUE) in Indian Higher Education Policy, Fostering Social Responsibility by Higher Education, Current status and possible interventions, Recent initiatives related to CUE, Principles of community engagement and its principles, Forms of community engagement

Module II: Social Responsibility of HEIs. (8 Hours)
Understanding Social Responsibility of HEIs – Engaged Teaching, Research & Service, Community Engaged teaching and research, community-based participatory research, practice-based learning, Community service, Reforming Existing and developing new courses, Engaged service on educating students to become active citizens, Effective Methods and Tools for Engaging Community in Research

Module III: Community Based Participatory Research (CBPR) (8 Hours)
Understanding Community Based Participatory Research (CBPR), Engaged research, Knowledge and research, Development and use of CBPR, Building Partnerships in Research, data collection and Analysis Multi modal, Knowledge sharing and Mobilisation, Practical challenges, littered dignity, Solutions for sustainable livelihoods, Capacities of panchayats and small nagarpalikas for disaster preparedness

Module IV: Service Learning-based Assignments (7 Hours)
Carrying out group assignments on service-learning for community university engagement
Sample use cases:
Digitally literate the unemployed youth/women/rural area-based students to train them to learn the basics of computer and digital transactions
Identify an area of need in the nearby community and design a project related to it addressing their social well-being.
Build awareness in the community about various social and ethical issues in Information Technology.
Launch digital campaign to raise awareness around – Personal hygiene and cleanliness, metal health, environment, food and nutrition.

Suggested Readings
1. W. James Jacob, Stewart E. Sutin, John C. Weidman, John L. Yeager, “Community Engagement in Higher Education: Policy Reforms and Practice”, Springer, 2015.
2. David Coghlan, Mary Brydon-Miller, “The SAGE Encyclopedia of Action Research”, SAGE, 2014.
3. Kronick, Robert F., “Emerging Perspectives on Community Schools and the Engaged University”, IGI Global,2019
4. Tami L. Moore, “Community-University Engagement: A Process for Building Democratic Communities”, John Wiley & Sons, 2014.
5. Marshall Welch, “Engaging Higher Education: Purpose, Platforms, and Programs for Community Engagement”, Stylus Publishing, 2016.
6. Barbara Jacoby, “Building Partnerships for Service-Learning”, John Wiley & Sons, 2003.
7. Becca Berkey, Emily A. Eddins, Patrick M. Green, Cara Meixner, “Reconceptualizing Faculty Development in Service-Learning/Community Engagement: Exploring Intersections, Frameworks, and Models of Practice”, Stylus Publishing, 2018.

AUDIT COURSES

EGCS0110: COMMUNICATION SKILLS (Audit Course)

Objective*: The objective of this audit course is to prepare students to be effective in their career in the corporate world where they will use their professional expertise. This course enables students*

- *To understand the difference between hard skills and soft skills*
- *To learn the importance of communication skills as part of the soft skills,*
- *To be familiar with the various features of effective communication, which includes verbal, non-verbal, written communication and body language.*

COURSE/LEARNING OUTCOMES

At the end of this course students will be able to:

CO 1: *Recognise* the difference between hard and soft skills
CO 2: *Understand* the importance of communication skills
CO 3: *Analyse* features of effective communication
CO 4: *Apply* the soft skills in the corporate world

CMES0023: ENTREPRENEURSHIP (AUDIT COURSE)

Objective*: The objective of the course is to introduce students to the concept of entrepreneurship, entrepreneurial skills and their use in a variety of situations. The students are examined on the personal skills to help them define entrepreneurial opportunity and are taught to develop a criteria to judge a situation to develop into a venture, plan and prepare business plans considering the market, technical, financial and legal requirements.*
The various topics that are generally covered in the course are:

- *Meaning of entrepreneur and entrepreneurship and its relation with problem - solving, characteristics of an entrepreneur, factors influencing entrepreneurship*
- *Identify and explain entrepreneurial opportunities, generating a list of entrepreneurial opportunities in a number of commercial and non-commercial situations*
- *Preliminary Project appraisal methods - Selecting the right opportunity, market*
- *Survey and research, techno-economic feasibility, financial feasibility- sources of finance – identify various sources of capital, ways to access the capital. Legal environment – identify the types of the regulatory systems and predict their effects on the creation of the entrepreneurial venture, role of government and government agencies.*
- *Creating the business model – business plan preparation.*
- *Recognize and assess the expected life of a venture, break-even analysis, recognize the common causes of failure of business ventures, how to deal with seven business crisis- planning for survival and growth.*

SCHOOL OF COMMERCE AND MANAGEMENT

SCHOOL OF COMMERCE AND MANAGEMENT

DEPARTMENT OF COMMERCE

MASTER OF COMMERCE

Course Structure of MASTER OF COMMERCE

SEMESTER I				
Type of Course/Category	**Course Code**	**Course Name**	**Credits T-L-P**	**Page**
Core Course (Theory)	CMOT0041	Organizational Theory and Behavior	4-0-0	564
Core Course(Theory)	CMBD0042	Business Statistics and Decisions	4-0-0	565
Core Course(Theory)	CMFY0043	Financial Statement Analysis	4-0-0	566
Core Course (Theory)	CMMG0044	Managerial Economics	4-0-0	566
Core Course (Theory)	CMAG0045	Cost and Management Accounting	4-0-0	567
Total Credits			**20**	
SEMESTER II				
Core Course (Theory)	CMRC0046	Research Methodology In Commerce	4-0-0	568
Core Course (Theory)	CMBE0047	Business Environment	3-0-0	569
Core Course (Theory)	CMBL0048	Business Law	3-0-0	570
Core Course (Theory)	CMFI0049	Corporate Finance	4-0-0	571
Core Course (Theory)	CMPG0050	Principles of Marketing	4-0-0	572
Core Course (Theory)	CMBS0051	International Business	4-0-0	573
Total Credits			**22**	
SEMESTER III				
Core Course (Theory)	CMSH0052	Strategic Human Resource Management	4-0-0	574
Core Course (Theory)	CMCR0053	Consumer Behaviour	4-0-0	575
Project Work	CMDS6006	Dissertation - I	4-0-0	588
Specialisation: Accounting and Taxation(Theory)	CMTM0054	Corporate Tax Management	4-0-0	576
	CMAF0055	Accounting Theory and Financial Reporting	4-0-0	577
Specialisation: Finance and Investment(Theory)	CMCR0056	Advance Corporate Finance	4-0-0	578
	CMBK0057	Investment Banking	4-0-0	578
Specialisation: Management(Theory)	CMIG0058	International Marketing	4-0-0	579
	CMBC0059	Business Ethics and Corporate Governance	4-0-0	580
Total Credits			**20**	
SEMESTER IV				
Core Course (Theory)	CMEM0060	Entrepreneurship Management and E-Commerce	4-0-0	581
Project Work	CMDS6007	Dissertation – II	6-0-0	588
Specialisation: Accounting and Taxation(Theory)	CMMD0061	Modern Accounting	4-0-0	582
	CMAV0062	Advanced Accounting	4-0-0	583
Specialisation: Finance and Investment(Theory)	CMFI063	Financial Institution Management	4-0-0	584
	CMPN0064	Portfolio Management	4-0-0	585
Specialisation: Management(Theory)	CMIL0065	Management of Industrial Laws	4-0-0	586
	CMSM0066	Supply Chain Management	4-0-0	587
Total Credits			**18**	
Total Programme Credits			**80**	

Note: Mandatory Course EDPC0201: Indian Polity and Constitution

DEPARTMENT OF COMMERCE
MASTER OF COMMERCE
(Specialisations in Accounting and Taxation, Finance and Investment and Management)

PROGRAMME OUTCOMES (POs)
PO 1: **Critical Thinking**: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO 2: **Effective Communicatio**n: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

PO 3: **Social Interaction:** Elicit views of others, mediate disagreements and help reach conclusions in group settings.

PO 4: **Ethical and responsible citizen:** Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them. : Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO 5: **Environment and Sustainability:** Understand the issues of environmental contexts and sustainable development.

PO 6: **Leadership, Self-directed and Life-long Learning:** Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes

PROGRAMME SPECIFIC OUTCOMES (PSOs)
PSO 1: **Knowledge of Commerce:** To accustom the students with conventional as well as contemporary areas in the discipline of Commerce. To inculcate the knowledge of business and the techniques of managing the business with special focus on accounting and taxation, finance and investment and management

PSO 2: **Research, Innovation and Advancements:** To serve industry and society with contemporary knowledge and skills in the area of Commerce and Management and the ability to create new knowledge which can be added on to the existing knowledge on emerging fields and to pursue advanced education in the domain of Commerce

PSO 3: **Entrepreneurial Ability:** To enable them to start their own business by enhancing the horizon of knowledge in various field of commerce through teamwork, effective communication, ethical decision-making ability

LIST OF COURSES IN MCOM
COURSES
1.1 Organizational Theory & Behavior
1.2 Business Statistics & Decisions
1.3 Financial Statement Analysis
1.4 Managerial Economics
1.5 Cost & Management Accounting
2.1 Research Methodology iIn Commerce
2.2 Business Environment
2.3 Business Law
2.4 Corporate Finance
2.5 Principles of Marketing
2.6 International Business
3.1 Strategic Human Resource Management
3.2 Consumer Behaviour
3.3 Dissertation - I
COURSES
3.4 (A) Corporate Tax Management
3.5 (A) Accounting Theory and Financial Reporting
3.4 (F) Advance Corporate Finance
3.5 (F) Investment Banking
3.4 (M) International Marketing
3.5 (M) Business Ethics and Corporate Governance
4.1 Entrepreneurship Management and E-Commerce
4.2 Dissertation – II
4.3 (A) Modern Accounting

4.3 (A) Advanced Accounting
4.4 (F) Financial Institution Management
4.4 (F) Portfolio Management
4.4 (M) Management of Industrial Laws
4.4 (M) Supply Chain Management

MAPPING OF COURSES WITH POS/PSOS

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1.1	L	L	M	L	L		L		M
1.2		H	M	M					H
1.3	H	L	M		M		H	M	M
1.4		L	M		L	H			
1.5	H	L	M	M	M		M	H	M
2.1	H	H	H	M	M		H		H
2.2	M		M		L		H		L
2.3	M		M	M	H		M		
2.4	H	M	H	H	M		L	M	H
2.5	M	M	M	M		L	M		M
2.6	H	M			H		H		L
3.1	M			M		M	M		L
3.2	M	H	H		M	L	M		M
3.3	M	H	H	H		L	H	L	H
3.4 (A)	H		M	M	M		H	M	M
3.5 (A)	H	H	M				H	H	M
3.4 (F)	M		M	H		L	M	H	H
3.5 (F)	H	H	H			L	H	M	H
3.4 (M)	H	M	M		H	M	H		L
3.5 (M)	M	L				H	H	L	
4.1	H	L	L		H	H	H		L
4.2	M	H	H	H		L	H	L	H
4.3 (A)	H	L	M	M		L	H	H	M
4.3 (A)	H	H	M	M		L	H	H	H
4.4 (F)	H	L	L	H		H	H	H	H
4.4 (F)	H	L	M	H		L	H	M	H
4.4 (M)	H	L	H	L		H	H		H
4.4 (M)	H		L	M	L	M	H		

DETAILED SYLLABUS

CMOT0041: ORGANISATIONAL THEORY AND BEHAVIOUR (4 CREDITS– 60 HOURS)

***Objective**: The objective of this paper is to provide the students an insight into the principles of organizational behaviour and its relation to other activities in an organization, and to introduce the students to the techniques of organisational behaviour used as a management tool.*

COURSE/LEARNING OUTCOMES

At the end of the course students will be able to:

CO 1: Define the concepts of Organisational Behaviour in the global context (Remembering)

CO 2: Explain the Cognitive processes of organizational behavior and its application in workplace (Understanding)

CO 3: Develop models of group dynamics, leadership theories, power & politics in terms of its application in workplace (Applying)

CO 4: Analyse the importance of communication and decision making techniques for improving productivity of employees (Analysing)

CO 5: Determine and develop models of Organizational culture, work stress and Conflict & negotiation in various workplace settings (Evaluating and Creating)

Module I: Introduction to Organizational Behaviour (8 Hours)

Defining Organisational Behaviour, historical background: the Hawthorne Studies; early development, conceptual development; the nature of people; theoretical frameworks; explaining and predicting behaviour; OB in the global context.

Module II: Cognitive processes of organizational behavior (12 Hours)

Nature and importance of Perception and attribution; perception and individual decision making; values, nature and dimensions of attitudes and job satisfaction; personality; aptitude; interests; learning; intelligence, motivation - theories of motivation.

Module III: Group Dynamics (14 Hours)

a) Understanding group dynamics, types of groups, group goals, group cohesiveness, group pressure and norms, teamwork; group structure - formal leadership, roles and norms; group member resources - abilities, personality, characteristics, stages in group development.
b) Leadership Theories - trait, behavioural, contingency, attributional, charismatic, transactional vs. transformational.
c) Power and politics: Contrasting leadership and power; power in groups; power tactics; politics-power in action.

Module IV: Communication and Decision Making (12 Hours)

Role of communication; Communication media and technology, communication networks - formal vs. informal; barriers to effective communication; communication skills; feedback information; persuasion in communication; active listening; participative decision-making techniques; groups vs. the individual; groupthink and group shift; the decision-making process

Module V: Organizational culture and Work Stress (14 Hours)

a) Definition of organizational culture; cultural typologies; organizational culture vs. national culture; functions of culture; formation of cultures; potential sources of stress - environmental factors, organizational factors; individual differences - perception, job experience, social support, locus of control, hostility; Stress – the emergence of stress, causes of stress; stress consequences - physiological symptoms, psychological symptoms, behavioural symptoms, stress management strategies : individual approaches, organizational approaches.
b) Conflict and negotiation: Definition of conflict; the conflict process; conflict in intergroup relations; creating functional conflicts; bargaining strategies; role of personality traits on negotiation; third party negotiations; intergroup relations and factors affecting intergroup relations.

Suggested Readings

1. Luthans Fred, Organisational Behaviour, 10th Edition, McGraw Hill India, 2005
2. Robbins Stephen P, Organizational Behaviour, 11th Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2004
3. Gilmer, Industrial Psychology, McGraw Hill.
4. Ghiselle and Brown, Personnel and Industrial Psychology, McGraw Hill.
5. Davis Keith, Human Relations at Work, Tata McGraw Hill.
6. Leavitt, Managerial Psychology, University of Chicago Press.
7. Bass B M , Leadership Psychology and Organizational Behaviour, Harper International.
8. Litterer, Analysis of Organizations, John Wiley.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	L			
CO 2		M	L	L
CO 3	M	M	M	
CO 4		H	H	M
CO 5				H

CMBD0042: BUSINESS STATISTICS AND DECISIONS (4 CREDITS-60 HOURS)

***Objective**: The objective of this course is to familiarize students with the applications of statistical techniques in business decisions. This purpose of this course is to provide students with statistical tools needed by managers. The course emphasizes understanding the process associated with statistical decisions, defining and formulating problems, Analysing the data, and using the results in decision making.*

COURSE/LEARNING OUTCOMES

After learning this course, the students will be able to:

CO 1: Find the techniques for decision-making under uncertainty.(Remembering)
CO 2: Demonstrate understanding of statistical thinking and data analysis. (Understanding)
CO 3: Apply methods of Correlation, Regression and also use Time based data. (Applying)
CO 4: Analyse from theoretical and practical perspectives, decision making concepts and processes in business settings. (Analysing)
CO 5: Estimate different kinds of Statistical methods like Mean, Median, Mode, Standard Deviation, Index Number. (Evaluating)
CO 6: Combine research concepts and methods in a business setting. (Creating)

Part A: BUSINESS STATISTICS

Module I: Uni-variate Analysis (15 hours)

Measures of Central Tendency including Arithmetic mean, Geometric mean and Harmonic mean: properties and applications; Mode and Median. Partition values - quartiles, deciles, and percentiles. Measures of Variation: absolute and relative. Range, quartile deviation and mean deviation; Variance and Standard deviation: calculation and properties.

Module II: Bi-variate Analysis (10 hours)

Simple Linear Correlation Analysis: Meaning, and measurement. Karl Pearson's coefficient and Spearman's rank correlation. Simple Linear Regression Analysis: Regression equations and estimation. Relationship between correlation and regression coefficients.

Module III: Time-based Data: Index Numbers and Time Series Analysis(15 hours)

Meaning and uses of index numbers; Construction of index numbers: Aggregative and average of relatives – simple and weighted, Tests of adequacy of index numbers, Construction of consumer price indices.
Components of time series; additive and multiplicative models; Trend analysis: Finding trend by moving average method and Fitting of linear trend line using principle of least squares.

Part B: BUSINESS DECISION

Module IV (10 hours)

Course introduction. Introduction to Evidence Based Management. Introduction to measurement theory and statistical inference. Simple decision tools; Rational choice, limited rationality and biases; Modern test theory. Rapid evidence assessment. Academic Survey design and testing.

Module V (10 hours)

Multiple-person decision making. Exploratory data analysis; Forecasting; roadmaps Optimisation; Big data, inference and dimension reduction. Forecasting, roadmaps.

Suggested Readings

1. Sharma J. K., Business Statistics, Pearson Education.
2. Gupta S.C., Fundamentals of Statistics, Himalaya Publishing House.
3. Gupta S.P. and Gupta A, Elementary Statistics, Sultan Chand and Sons, New Delhi.
4. Levin R and Rubin David S, Statistics for Management, Prentice Hall of India, New Delhi.
5. Spiegel M.R., Theory and Problems of Statistics, Schaum's Outlines Series, McGraw Hill Publishing

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	L	M			
CO 2	M	H	M		
CO 3			M	H	H

CMFY0043: FINANCIAL STATEMENT ANALYSIS (4 credits – 60 hours)

***Objective**: The course introduces the knowledge of decision makers information about a business enterprise for use in decision-making and to evaluate the economic situation of the firm and predicting its future course based on the financial statements.*

COURSE/LEARNING OUTCOMES

At the end of the course students will be able to:

CO 1: Define the role of standard setters and regulators in Financial Reporting (Remembering).
CO 2: Illustrate the information provided by Balance Sheet, Income Statement and Cash Flow Statement (Understanding)
CO 3: Identify and compare cash flow classifications of operating, investing and financing activities (Applying)
CO 4: Analysing the link between Income statement, Balance Sheet and Cash Flow Statement (Analysing)
CO 5: Criticise rations used to analyse a company's liquidity, profitability, solvency and efficiency (Evaluating)
CO 6: Build a strong base on financial statement analysis (Creating)

Module I: Introduction to Financial Statement Analysis (10 hours)

Scope of Financial Statement Analysis; Financial Statements and other information sources; Financial Statement Analysis Framework; Classification of Business Activities; Financial Reporting Standards; Regulatory Authorities; International Financial Reporting Standards Framework (IFRS); Comparison of IFRS with other Reporting Standards.

Module II: Analysis of Income Statement (15 hours)

Components and format of Income Statement; Revenue Recognition; Expense Recognition; Non- recurring and Non-operating items; Earnings Per Share(EPS) : Simple Vs complex capital structure, Basic EPS, Diluted EPS; Analysis of Income Statement: Common size analysis, Income Statement Ratios.Case Study I

Module III: Balance Sheet (10 hours)

Components and format of Balance Sheet; Measurement Bases of Assets and Liabilities; Equity: Components, Statement of Changes in Shareholders Equity; Uses and Analysis of Balance Sheet: Common size analysis, Balance Sheet Ratios.Case Study II

Module IV: Cash Flow Statement (15 hours)

Components and format of Cash Flow Statement; Linkages and Preparation: Cash Flow Statement with Income Statement and Balance Sheet, Preparation of Cash Flow Statement, Conversion from Indirect to Direct method; Cash Flow Statement Analysis: Evaluation of Sources and Uses of Cash, Common size analysis, Free Cash Flow to Firm and Free Cash Flow to Equity, Cash Flow Ratios.Case Study III

Module V: Financial Statement Analysis Techniques (10 hours)

Financial Analysis Process; Analysis tools and techniques; Common Ratios: Activity Ratios, Liquidity Ratios, Solvency Ratios, Profitability Ratios; Integrated Financial Ratio Analysis.Case Study IV

Suggested Readings

1. Thomas R. Robinson and Elaine Henry: International Financial Statement Analysis, Wiley.
2. Charles H. Gibson:Financial Statement Analysis, Cengage.
3. Subramanyam K R and Wild John J. :Financial Statement Analysis, McGraw Hill.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	L	L		M	
CO 2	M	H	H		
CO 3		M			H
CO 4			H		
CO 5			M		H
CO 6	M	H	H	H	

CMMG0044: MANAGERIAL ECONOMICS (4 CREDITS-60 HOURS)

***Objective**: The objective of the course is to acquaint students with the basic principles of micro and macroeconomics for developing the understanding of theory of the firm, markets and the macro environment. This will help them in managerial decision making processes.*

COURSE/LEARNING OUTCOMES

At the end of the course students will be able to:

CO 1: Understand the scope of managerial economics.
CO 2: State the difference between demand and supply.
CO 3: Outline the determinants of supply and estimate elasticity of supply.
CO 4: Summarize the concept of production function and relate it with economies and diseconomies of scale.
CO 5: Explain the various kinds of production functions.
CO 6: Estimate cost of production of firms.
CO 7: Summarize and evaluate fiscal policy and monetary policy to control inflation.
CO 8: Describe Balance of Payments and its various components.
CO 9: Outline various Open macro-economic concepts

Module I: Managerial Economics (10 Hours)

Introduction to Managerial Economics; Economic factors influencing decisions, Functions Role and Responsibilities of Managerial Economist; Principles in Managerial decision analysis; Micro-Macro Economics, Paradox of Micro Economics, Distinction between Micro and Macro Economics.

Module II: Demand Analysis (10 Hours)

Theories in Demand, Derivation of demand, types, Environment influencing demand; Elasticity of Demand; Advertising or promotional Elasticity; Demand forecasting ; Demand forecasting for new products, Demand Estimation for consumer durables and non-consumer durables.

Module III: Production And Cost Analysis (15 Hours)

Production Function; Law of variable proportions, Production with two variable inputs; Cost Analysis: concept, importance, types – Real opportunity, Money, Fixed, variable, Direct, indirect, Explicit, implicit, past, feature, controllable and uncontrollable, Escapable, inescapable, urgent, potable cost, Replacement and Historical cost, Total Average and Marginal cost in short Run – and Long Run curve; Revenue - Concepts, definition, types-Total, Average, Marginal and relationship with AR and MR

Module IV: Market Structure (13 Hours)

Concept, meaning and classification of Market; Perfect competition-features and price determination; Monopoly – definition, features, types and price determination; Monopolistic competition-meaning, concept, types, price determination and defects; Pricing - types, cost pulls, going rate, Intuitive, Imitative, Marginal cost, Pioneering, Transfer pricing; Price discrimination – Definition, Concept, meaning, types, conditions, Dumping and socio – economic consideration in pricing; Firm objectives, staff, sales and growth Maximization.

Module V: Business Cycle (13 Hours)

Business cycle–cobweb, Hick's Samuelson Theories of Trade cycle; Measures to control Business Cycle; Inflation; Deflation; Economic effects on production distribution and employment, remedies demand full v/s cost push Inflation; Monetary and fiscal policies objectives, role and impact on economic development, Concept of sustainable development, consumption and its inclusive growth.

Suggested Readings

1. Koutsyiannis, A., Modern Microeconomics, Macmillan Press Ltd.
2. Varian, Micro-Economic Analysis , Norton
3. Pindyck Robert S., Daniel L. Rubinfeld and Prem L. Mehta, Micro Economics, Pearson Education Asia, New Delhi.
4. Branson William H., Macro Economics Theory and Policy, First East – West Press.
5. Dornbusch, R. and S. Fischer Macro Economics , Publisher Tata McGraw Hill.
6. Oliver Blanchard ,Macro Economics, Pearson Education, LPE.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	L	L		
CO 2	M	M	H	
CO 3		H	M	M
CO 4			M	H

CMAG0045: COST AND MANAGEMENT ACCOUNTING (4 CREDITS-60 HOURS)

Objectives:

- *To understand the different concepts of cost, costing and cost accounting and their practical application in real world scenarios.*

- *To provide in-depth knowledge of the detailed procedure and documentation involved in cost ascertainment systems.*

COURSE/LEARNING OUTCOMES
At the end of the course students will be able to:
CO1: Define the meaning of cost, costing and cost accounting. (Remembering)
CO2: Illustrate the application of management accounting. (Understanding)
CO3: Identify the detailed procedure and documentation involved in the cost ascertainment system. (Applying)
CO4: Compare profit maximization and wealth maximization as an objective to financial management. (Analysing)
CO5: Interpret the effective techniques for inventory control. (Evaluating)
CO6: Estimate cost of production under different situations. (Creating)

Module I: Introduction to Cost and Management Accounting (10 Hours)
Concepts of Costs; Classifications and Elements of Cost; Cost Centre and Cost Unit; Methods and Techniques of Costing; Installation of a Costing System.

Module II: Management Accounting (10 Hours)
Tools and Techniques of Management Accounting; Relationship of Cost Accounting, Financial Accounting, Management Accounting and Financial Management; Conflicts in Profit Vs Value Maximisation Principle; Role of Management Accountant in Decision Making.

Module III: Material Cost (10 Hours)
Materials Control – Concept and Techniques; Stock Verification; Methods of Pricing of Material: FIFO, LIFO, Simple Average, Weighted Average; Inventory Management: Techniques of fixing of minimum, maximum and reorder levels, Economic Order Quantity, ABC Analysis ; Stock Verification and Perpetual Inventory.

Module IV: Activity Based Costing (Abc) And Cost Records (10 Hours)
ABC Vs Traditional Costing; Uses and Limitations; Cost Ledgers – Integrated Accounts and Non- Integrated Accounts; Reconciliation of Cost and Financial Accounts.

Module V: Costing Systems (20 Hours)
Unit and Output Costing; Job Costing: Job Cost Cards, Collecting Direct Costs; Batch Costing: Features and Applications; Contract Costing: Features, Distinction between Job and Contract Costing, Contract Accounts, Accounting for Material, Accounting for Plant Used in a Contract; Process Costing: Features, Applications and Types of Process Costing; Joint Products, By-Products; Service Costing: Features and Applications; Unit Costing and Multiple Costing.

Suggested Readings
1. Arora, M. N., "Cost and Management Accounting", Vikash Publishing House, New Delhi.
2. Zad, N. S., " Cost and Management Accounting", Taxman, New Delhi.
3. Aggarwal, P., "Cost and Management Accounting", Bharat Law House, New Delhi.
4. Banarjee, H., "Cost and Management Accounting", Prentice Hall India Pvt, Ltd, New Delhi.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	L	M		L	
CO 2	L	L			
CO 3			M	M	M
CO 4			H		
CO 5					H

CMRC0046: RESEARCH METHODOLOGY IN COMMERCE (4 CREDITS-60 HOURS)
***Objective**: This course is designed to provide students with the necessary skills and knowledge to determine the information necessary to address an identified research problem (basic or applied) and, using this understanding, develop and use an actionable research proposal. In this process, the students will gain an understanding of relevant approaches and elements of undertaking a research enquiry specifically to provide insights to solving a relevant problem.*

COURSE/LEARNING OUTCOMES
At the end of the course students will be able to:
CO1: Define and tell why research and its methodology are important. (Remembering)
CO2: Explain the use of methodology in understanding the process of research. (Understanding)
CO3: Identify the sources of data and apply various data collecting techniques. (Applying)

CO4: Classify, analyse and draw inferences from Data. (Analysing)
CO5: Justify the use of various methods in evaluating data. (Evaluating)
CO6: Design methodology specific to the study under consideration. (Creating)

Module I: Introduction to research (10 Hours)

Concept and nature, objectives, criteria of a good research, social science research, business research, approaches to research-qualitative and quantitative research, types of research; case study research, research methodology, difficulties of social science research in India.

Module II: Research design (8 Hours)

features of a good research design; research problem: definition, Components, selection and formulation of research problem; formulation of hypothesis, research design: types, research design for experimental exploratory and descriptive research.

Module III: Sampling design (8 Hours)

Meaning, significance; sampling process; principles of sampling essentials of a good sample, methods of sampling; determination of sample size.

Module IV: Data collection (8 Hours)

Meaning, types, methods; Sources of data-Use of secondary data-Methods of collecting primary data-Observation-Interviews-Questionnaires and Schedules.

Module V: Processing and Analysis of Data (8 Hours)

Processing Operations –Types of Analysis-Presentation and Interpretation of Data- Editing, Classification and Tabulation-Interpretation.

Module VI (8 Hours)

Preparation of a Report-Types of Report-Research Report-Format-Principles of Writing Reports- Documentation-Footnotes and Bibliography.

Module VII (10 Hours)

Quantitative Tools-Measures of Central Tendency-Dispersion-Measures of Correlation- Simple and Multiple Correlation-testing of Hypothesis-Tests based on t-P, Z and Chi square-Time Series Analysis-Trend Measurement-Moving Averages.

Suggested Readings

1. Kothari C.R , Research Methodology: Methods and Techniques, New Age International,
2. Srivastava, S. C. : Foundation of Social Research and Economics Techniques, Himalaya Publishing House, 1990.
3. Sharma H.D. and Mukherji S. P: Research Methods in Economics and Business, New York : The Macmillan Company, 1992.
4. Saunders M , Philip Lewis and Adrian Thornhill, Research Methodology for business students, Pearson Education
5. Michael V.P, Research Methodology in Management, Himalaya Publishing House

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M		M	
CO 2	M	H	H		
CO 3		M			H

CMBE0047: BUSINESS ENVIRONMENT (3 CREDITS– 45 HOURS)

***Objective**: To apply relevant knowledge, skills and exercise professional judgement in understanding the macro environment in which a business organisation operates. The course would also make the students capable of analysing and understanding policies of the government implemented from time to time and assess their impact on business.*

COURSE/LEARNING OUTCOMES

At the end of the course students will be able to:
CO1: Define economic systems in depth (Remembering)
CO2: Outline how an entity operates in a business environment (Understanding)
CO3: Identify the role of Public and Private sector in the business environment (Applying)
CO4: Examine the trade environment in details (Analysing)
CO5: Explain the impacts of Government policy on the economic environment (Evaluating)
CO6: Elaborate the various trade blocs and the role of WTO (Creating)

Module I: Business Environment (9 classes)

Concept, Components and importance; Indian Business Environment; Cultural, social, political, technological, economic and legal environment; scanning techniques of environmental forecasting; SWOT- Internal environment -their impact on policy formulation.

Module II: Economic trends (9 classes)

Economic reforms in India –Liberalization, privatization and globalization; Competitive Strength of Indian industry; Impact of liberalization policy on different sectors; Foreign Investments policy in India.

Module III: Multinational Corporations (8 classes)

Multinational corporations and their participation in India; strategies of multinational corporations;competitive strengths policies and performance.

Module IV: Business Ethics and Social Responsibilities (9 classes)

Business ethics and social responsibilities; relationship between business and society; Corporate power social accountability; Ethical issues and values in business; Corporate Social policies - issues and challenges; Ecological and environmental issues.

Module VI: Economic Development of North Eastern Region (10 classes)

Special package for economic development of the north eastern region; DONER and its role in economic development, infrastructure and industry; North East Industrial Policy- promotional measures for cross-border trade, Role of NEC and NEDFI. Problems and prospects of the industry in Assam, Brief study of the tea industry, paper industry, food processing industry, silk industry and bell metal industry; tourism industry.

Suggested Readings

1. Wheelen, Concepts of Strategic Management and Business policy, Pearson Education, New Delhi.
2. Islam Swabera & Kharkongor; Business Environment, Taxman's Publication, New Delhi.
3. Misra S.K., Puri V.K.; Indian Economy, Himalaya Publishing House, Mumbai.
4. Deepashree, Indian Economy, Tata McGraw Hill, New Delhi.
5. Dutta Rnddar and Sundaram KPM , S. Chand & Co. Ltd., New Delhi.
6. Agarwal A.N., Indian Economy, New Delhi.
7. Kazhmi Azhar, Business Policy,
8. Gupta, Liberalisation - its impact on Indian Economy, Macmillan.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	L	M	H		
CO 2	M	M	M		
CO 3		L		H	H
CO 4			M	M	H

CMBL0048: BUSINESS LAW (3 CREDITS- 45 HOURS)

***Objectives**: The objectives of this course is to enable students to have a detailed understanding of the Indian Contract Act, 1872, The Companies Act, The partnership act. The course also aims at giving the students in depth knowledge about the Negotiable Instruments Act 1881.*

COURSE/LEARNING OUTCOMES

At the end of the course students will be able to:

CO1: Relate with the legal environment that is influencing business functioning. (Remembering)
CO2: Illustrate a proper perspective about legal environment for better decision making. (Understanding)
CO3: Identify the legal provisions in the formation of a company and partnership. (Applying)
CO4: Examine the validity of any contract as per the law. (Analysing)
CO5: Interpret the uses and application of the various negotiable instruments. (Evaluating)
CO6: Formulate a valid contract with all legal provisions and conditions. (Creating)

Module I: The Indian Contract Act, 1872

a) Proposal- its communication, acceptance and revocation; Agreement vis-à-vis contract, void agreement & voidable contract
b) Consideration – essential elements, exception to rule- No consideration no contract; privity of contract and consideration
c) Capacity to contract; Free consent – coercion, undue influence, misrepresentation, fraud; Mistake – of fact and of law
d) Legality of object – agreements opposed to public policy and in restraint of marriage, trade & legal proceedings; Contingent contracts
e) Performance of contract–liability of joint promisor; Consequences of breach of contract–liquidated damages and penalty
f) Quasi contract; Indemnity guarantee–surety's liability
g) Bailment–Duties and liabilities of bailor and bailee, bailment of pledges;

h) Agency–types of agency, agents duty to principal and vice-versa, ratification and revocation of agent's authority

Module II: The Companies Act, 1956

a) Meaning, characteristics and kinds; Lifting the corporate veil; Registration and incorporation; Memorandum of Association–alteration therein
b) Doctrine of Ultra Vires–consequences of ultra vires transaction
c) Articles of Association–alteration therein, its relation with memorandum of Association; Rule of constructive notice; Doctrine of Indoor Management; Prospectus- liability for misstatement, statement in lieu of prospectus
d) Shares–statutory restrictions, kinds of share capital; Debentures
e) Directors- Position, Appointment, Removal, Power & Duties, their responsibility for offence under N.I. Act & I.T.Act,2000
f) Meetings; Majority Powers and Minority Rights; Prevention of Oppression and Mismanagement
g) Winding up-liability under N.I.Act, Winding up by order of court and subject to its supervision; Voluntary winding up; Conduct of winding up

Module III: The Partnership Act, 1932

a) Nature of Partnership; Relation of partners-inter se; Relation of partners to third parties; Incoming and outgoing partners
b) Dissolution of Firm; Registration of Firms-effect of non-registration
c) Offences by Firm- liability under N.I. Act & I.T. Act, 2000

Module IV: The Negotiable Instruments Act, 1881 - As Amended by The Negotiable Instruments(Amendment and Miscellaneous Provisions) Act, 2002

a) Notes, Bills and Cheques-Promissory notes, Bills of exchange and cheques (Demand drafts, payment orders etc.);Drawer, Drawee, Acceptor, Holder, Holder in due course, payment in due course
b) Endorsement-Endorsement in blank and endorsement in full, conversion of endorsement in blank into endorsement in full and its effects
c) Negotiation; Presentment-At sight, on presentment, after sight, presentment for payment; Maturity-Calculating its period; Noting and protest-Protest for better security; Presumption as to negotiable instruments-and estoppel; Cross Cheques-Cheques crossed generally and specially;Of penalties in case of Dishonour of certain cheques for insufficiency of funds etc.; Offences by companies

Suggested Readings

1. Majumdar A.K. & Kapoor G.K., Company Law & Practice, Taxmann Publication
2. Gupta Vijay, K.C. Garg ,Company Law, Kalyani Publishers
3. Auter, Company Law- Singh, Eastern Book Company, Lucknow.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M		
CO 2	M	H		
CO 3			H	H

CMFI0049: CORPORATE FINANCE (4 CREDITS – 60 HOURS)

***Objectives**: The main objective of the course is to provide the conceptual background for corporate financial analysis from the point of corporate value creation. The course develops a theoretical framework for understanding and analysing major financial problems of modern firms in the market environment.*

COURSE/LEARNING OUTCOMES

At the end of the course students will be able to:

CO1: Explain the basic tools and concepts necessary to understand modern financial theory and its application in corporations. (Understanding)
CO2: Apply capital budgeting tools for evaluating investments. (Applying)
CO3: Analyse the relationship between capital structure, risk and shareholder value using the Modigliani Miller Theorems. (Analysing)

Module I: Introduction to Corporate Finance (15 hours)

Objective of Corporate Finance; Role of finance manager in corporations; types of firms; stock markets; financial institutions; Financial Statement Analysis: Balance Sheet analysis, Income Statement analysis, Cash Flow statement; Case Study - Enron

Module II: Investment Decisions (10 hours)

Net Present Value (NPV) rule; Payback rule; Internal Rate of Return (IRR) rule; Modified Internal Rate of Return; Choosing between projects; Capital Budgeting process; Forecasting Incremental Earnings; Break even Analysis; Scenario analysis; Options in Capital Budgeting – Delay, Expand, Abandon

Module III: Stock Valuation (20 hours)
Models of Stock Valuation; Dividend Discount Model; Discounted Cash Flow Model; Comparable Companies Analysis; Systematic Risk vs Equity Risk; Measuring Systematic risks; Beta; Capital Asset Pricing Model (CAPM); Cost of Capital: Weighted Average Cost of Capital (WACC), Cost of Debt, Cost of Equity, Using WACC to value a project.

Module IV: Long Term Financing (15 hours)
Equity financing for Private Companies; Initial Public Offerings (IPO); Case Study – Google's IPO; Debt Financing: Private Debt and Public Debt, Bond Covenants, Repayment Provisions; Capital Structure: Capital Structure Choices, Capital Structure in Perfect Capital Markets, Modigliani and Miller (MM) Model, Debt and Taxes.

Suggested Readings
1. Berk and DeMarzo : Corporate Finance, Pearson.
2. Brealey, Richard/ Myers, Stewart C. / Allen, Franklin :Principles of Corporate Finance, McGraw Hill.
3. Aswath Damodaran : Investment Valuation, John Wiley.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			M
CO 2		M	H	
CO 3	M		M	
CO 4		H		
CO 5				H

CMPG0050: PRINCIPLES OF MARKETING (4 CREDITS – 60 HOURS)

***Objective**: To apply relevant knowledge, skills and exercise professional judgement in selecting and applying marketing principles and concepts in different business contexts and to contribute to the evaluation of the performance of an organisation and its strategic and operational development.*

COURSE/LEARNING OUTCOMES

At the end of the course students will be able to:

CO 1: Define and explain marketing mix models in workplace and contribute to organisational growth (Remembering and Understanding)
CO 2: Assess the impact of product and brand management decisions on organizational performance (Applying)
CO 3: Examine the effectiveness of pricing and promotion decisions (Analysing)
CO 4: Determine appropriate distribution and retailing strategies in improving organisational performance (Evaluating)
CO 5: Elaborate the Rural Marketing initiatives and Developments in Marketing (Creating)

Module I: Introduction to Marketing (12 classes)
Marketing in the Twenty-First Century; The Impact of the New Economy; Change in Customers; Changes in Business Scenario; Marketing Objectives; Marketing Environment; Marketing Mix; Elements of Marketing Mix, Product Mix, Price Mix, Promotion/Communication Mix, Place Mix/ Distribution Mix; Significance of Marketing Mix; Factors Affecting Marketing Mix; Growth & Future of marketing in India.

Module II: Product, and Product Brand Management (12 hours)
Definition, Features, Characteristics and Classification of Product; Product Life Cycle definitions, Stages of the Product Life Cycle; Implications of the Product Life Cycle Concept; Types of New Products; Challenges to New Product Development; Steps in the Development of the New Product; Introduction, Objectives, Problems and Process of Test Marketing; Introduction to Product Brand, Definition of Product Branding, Purpose of Branding, Features of Good Brands, Significance and Importance of Branding, Branding in a new economy.

Module III: Pricing and Promotion Decision (12 Classes)
a) Pricing Decisions; Concept of Price; Significance of Pricing; Factors Affecting Pricing Decisions; Major Pricing Methods; Pricing Policies and Strategies; Geographical Pricing, Product Line Pricing, Discounts and Rebates.
b) Meaning and Nature of Promotion, Importance of Promotion, Communication Process, Concept of Integrated Marketing Communication, Meaning of Promotion Mix, Elements of Promotion Mix (Methods of Promotion), Factors Influencing Promotion Mix Decisions, Promotion Mix Strategies, Communication Planning and Control.

Module IV: Distribution and Retailing (12 Classes)
a) Channels of Distribution: Meaning of a Channel of Distribution, Importance of Channels of Distribution, Types of

Distribution Channels, Choice of a Channel of Distribution, Functions of Distribution Middlemen, Distribution Strategies, Wholesaling.

b) Meaning of Physical Distribution, Importance of Physical Distribution, Elements of Physical Distribution, Marketing Logistics Decisions.
c) Meaning of Retailing, Functions and Services of Retailers, Types of Retailing; Malls and major markets; FDI in retail market; Management of Retailing Operations: An Overview, Retailing in India – Changing Scenario.

Module IV: Rural Marketing, Consumer Protection and Developments In Marketing (12 Classes)

a) Growing Importance of Rural Markets, Distinguishing Characteristics of Rural Markets, Understanding Rural Consumer and Rural Markets, Marketing Mix Planning for Rural Markets.
b) Consumer Protection, Need for Consumer Protection, Measures for Consumer Protection, Consumerism – Evolution, Meaning and Approaches, Laws to Protect Interests of Consumers.
c) Recent Developments in Marketing, Social Marketing, Direct Marketing, Online Marketing, Relationship Marketing, Green Marketing, Marketing Ethics, Sustainable Marketing, Marketing of Services.

Suggested Readings

1. Gupta C.B., Principles of Marketing, Sultan Chand & Sons.
2. Kotler Philip , Marketing Management, Pearson Education, New Delhi.
3. Sherlekar S. A., Marketing Management, Himalaya Publishing House, Mumbai.
4. Kumar A & Meenakshi, Marketing Management, Vikas Publishing House, New Delhi.
5. Saxena R, Marketing, Himalaya Publishing House, Mumbai.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	L			
CO 2		M	L	L
CO 3	M	M	M	
CO 4		H	H	M
CO 5				H

CMBS0051: INTERNATIONAL BUSINESS (4 CREDITS – 60 HOURS)

***Objective**: This course provides an overview of the environment, concepts, and basic differences involved in international business.*

COURSE/LEARNING OUTCOMES

At the end of the course students will be able to:

CO 1: Describe the foundation of international business.
CO 2: Describe international organizations and multinational corporations.
CO 3: Define forms of foreign involvement.
CO 4: Discuss international trade theory.

Module I: Introduction to Global Business (15 hours)

Global Business: Scope, Global Linkages today; Culture and Global Business: Elements of culture, Training Challenge; Global Trade and Investment Theory: Mercantilism, Classical Trade Theory, Factor Proportion Theory, International Trade and Product cycle theory, Theory of International Investments; Structure of Indian Foreign Trade: Composition & direction; EXIM Bank; Exit Policy of India; Regulation and Promotion of Foreign Trade.

Module II: Global Financial Markets (15 hours)

Foreign exchange markets; Fixed and Floating Foreign exchange rates; Significant monetary events; Exchange rates, interest rates and economic policy; Economic Integration; Government Trade Policies.

Module III: Global Business Environment (15 hours)

Private International Law; Public International Law; Risk to Global Business; Doctrine of Sovereign Immunity; Doctrine of Eminent Domain; Labour Law Differences; Theoretical foundations of International Business; Balance of Payments; International Liquidity; International Economic; Accounting and Tax differences; Multinational Corporations; Foreign Direct Investment.

Module IV: International Finance (15 hours)

Financing exports and imports; International Capital and Cash Management; Capital Structure: International Dimensions; International Capital Markets; International Banking and Security Markets; IMF; World Bank; IFC; ITA; ADB; WTO.

Suggested Readings

1. Joshi Rakesh Mohan: International Business, Oxford University Press.
2. Cherunilam F: International Business: Text and Cases, PHI Learning.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	L	M		H
CO 2	M		M	
CO 3		M	H	M
CO 4		H	M	H

CMSH0052: STRATEGIC HUMAN RESOURCE MANAGEMENT (4 CREDITS – 60 HOURS)

***Objective**: The objective of this course is to develop within the students the understanding of the student with relevant concepts, roles and challenges related to strategic human resource management practices in the workplace and design the requisite skills to be competent contributors in the organization's strategic decision-making process and make them competent to for various managerial and administrative positions in different organizations.*

COURSE/ LEARNING OUTCOMES:

After learning this course, the students will be able to:

CO 1: Define the hierarchy of strategy, classify between traditional HR and strategic HR. (Remembering)

CO 2: Explain the factors behind the emergence of strategic human resource management (Understanding)

CO 3: Choose the aims of strategic HRM, interpret the various approaches to strategic HRM and identify the barriers in implementing HR strategies (Applying)

CO 4: Analyse the concept of HR strategies, explain the approaches of developing HR strategies and analyse the ways in which HR strategies can be implemented (Analysing)

CO 5: Analyse the strategic role of the HR director, determine the strategic role of the HR specialists and design the new mandate for HR

CO 6: Evaluate the various approaches to motivation, develop the retention strategy and flexibility strategy that should be adopted by an organisation (Creating)

Module I: Introduction to Strategic Human Resource Management (12 hours)

Introduction, Strategy, Hierarchy of Strategy, Corporate Level Strategy, Business Level Strategy, Functional Level Strategy, Strategic HRM, Emergence of Strategic Human Resource Management (SHRM), The Evolutionary Stages of Strategic HRM, Difference Between Traditional HR and Strategic HR, Case study

Module II: Concepts of Strategic Human Resource Management (12 hours)

Introduction, Trends in Strategic Human Resource Management, HR Practitioners Role, Human Resource as Competitive Advantage, Aims of Strategic HRM, Approaches to Strategic HRM, Formulation of HR Strategies, The Classical Sequential Approach, The Empirical Need-based Approach, Achieving Strategic Fit, Problems in Achieving Strategic Fit, Benefits of Strategic HRM, Barriers to Strategic HRM, Case study

Module III: Human Resource Strategies and its Implementation (12 hours)

Introduction, HR Strategies, Types of HR Strategies, Overarching Strategies, Specific HR Strategies, Criteria for an Effective HR Strategy, Developing HR Strategies, Methodology for Formulating HR Strategies, Setting Out the Strategy, conducting a Strategic Review, Implementing HR Strategies Barriers to the Implementation of HR Strategies, Overcoming the Barriers, Case study

Module IV: Roles in Strategic Human Resource Management (12 hours)

The Strategic Role of Top Management, The Strategic Role of Front-line Management, The Strategic Role of the HR Director, The Strategic Role of the HR Specialists, The New Mandate for HR, The Specific Strategic Roles of HR, Business Partner, The Innovation Role, The Change Manager Role, The Implementer Role, Case study

Module V: Challenges in Strategic Human Resource Management (12 hours)

Introduction, The Challenges of Workplace Diversity, The Management of Workplace Diversity, Managing Diverse Workforce in an Organisation, Planning a Mentoring Program, Organising Talents Strategically, Retention Strategy, Talent Management Strategy and its components, Approaches to Human Resource Planning, Managing Executive Information Systems, Challenges for HR Managers, HRM Strategic Challenges, Case study

Suggested Readings

1. Deb Tapomoy , Strategic Approach to Human Resource Management Concept, Tools and Application, Atlantic Publishers & Distributors Pvt Ltd.
2. Nayantara Padhi, Strategic Human Resources Management: Theory and Practice, Atlantic Publishers and Distributors Pvt.

Ltd; 1 edition
3. Mello Jeffrey A., Strategic Management of Human Resources, Cengage Learning, 3rd edition
4. Sharma A, Khandekar A, Strategic Human Resource Management – An Indian Perspective, SAGE Publications
5. Schuler, R. S., & Jackson, S. E., 2009, Strategic Human Resource Management.2nd ed., Wiley-India
6. Sharma, A and Khandekar, A., 2006, Strategic Human Resource Management: an Indian perspective.1st ed., Response Books.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	L			
CO 2		M	L	L
CO 3	M	M	M	
CO 4		H	H	M
CO 5				H

CMCR0053: CONSUMER BEHAVIOUR (4 CREDITS – 60 HOURS)

***Objective**: The objective of this course is that the students should be able to understand the different concepts of consumer behaviour, implications of motivation, personality, perception, learning in marketing, role of social and cultural settings on consumer behaviour and consumer buying process and will make them competent for taking responsible positions in the area of marketing in different organizations.*

COURSE/ LEARNING OUTCOMES:

After learning this course, the students will be able to:

CO1: Define the consumer behaviour, relate the various marketing implications select the learning principles in marketing, find the influence of culture and subculture on consumer behaviour and define the stages of consumer buying process (Remembering)

CO2: Explain the models of consumer decision process, interpret the concepts of motivation, personality and perception with reference to consumer buying behaviour, relate the concept of conditioning in consumer buying (Understanding)

CO3: Apply the factors influencing consumer behaviour in developing marketing strategies, identify the impact of personality and perception on marketing strategies, choose the important aspects of information processing theory, make use of social stratification to develop marketing strategy, identify purchase decision and post purchase behaviour in varied marketing situations (Applying)

CO4: Analyse market segmentation and segmentation of consumer markets, classify the types of brand personality, analyse the split-brain theory, compare the various types group influence on consumer behaviour and analyse traditional and contemporary models of consumer behaviour (Analysing)

CO5: Assess the positioning strategies on buying behaviour, determine the relationship between personality and self image, evaluate the relationship between traditional and contemporary models of consumer behaviour (Evaluating)

CO6: Discuss the types of research methods, Elaborate the measures of consumer learning and design strategies for influencing family purchasing decision-making and the consumption related roles (Creating)

Module I: Contemporary Dimensions of Consumer Behaviour (12 hours)

Consumer Behaviour, Consumer Decision-Making, Models of Consumer Decision –Making, Types of Consumer Buying Behaviour, Factors influencing Consumer Behaviour, Market Segmentation, Segmentation of Consumer markets, Positioning, Differentiation and Marketing Mix, Marketing Research;Consumer Research Process, Types of Research Methods.

Module II: Marketing implications of Motivation, Personality and Perception (12 hours)

Motivation and its Marketing Implications, Personality and its Marketing Implications, Brand Personality, Personality and self Image, The Concept of Perception, Perception and its Impact on Marketing strategies

Module III: Application of Learning Principles in Marketing (12 hours)

Consumer Learning, Concept of Conditioning, Important Aspects of Information Processing Theory, Split-Brain Theory, Measures of Consumer Learning

Module IV: Implications Social and Cultural Settings on Consumer Behaviour (12 hours)

Influence of culture and Subculture on Consumer Behaviour, Influence of Social Class on Consumer Behaviour, Social Stratification and Marketing Strategy, Group Influence on Consumer Behaviour, Household and Family Influence on Consumer Behaviour, Socialisation of family Members, Family Purchasing Decision-Making and Consumption Related Roles, family Life Cycle.

Module V: Consumer Buying Process (12 hours)

Stages of Consumer Buying Process, Purchase Decision and Post Purchase Behaviour, Traditional and Contemporary Models of Consumer Behaviour; Case study

Suggested Readings

1. Blackwell, Roger D, Paul W Miniard and James F Engel, Consumer Behaviour, Thomson Learning Inc.,2002.
2. Duhan S.N., GarimaSahni N.K. , Consumer Behaviour, 1st edition, 2016, Kalyani Publishers
3. Loudon, David l., and Albert J. Della Bitta, Consumer Behaviour, Tata McGraw Hill, New Delhi
4. Schiffman, Leon G., and Leslie kanuk, Consumer Behaviour, Prentice Hall, New Delhi
5. Schiffman, Kanuk L L., S Ramesh Kumar, Consumer Behaviour, 10th edition, Pearson
6. Dheeraj Sinha, Consumer India Inside the Indian Mind and Wallet, 2011, Jain Book Depot

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	L			
CO 2		M	L	L
CO 3	M	M	M	
CO 4		H	H	M
CO 5				H

SPECIALISATION: ACCOUNTING AND TAXATION

CMTM0054: CORPORATE TAX MANAGEMENT (4 CREDITS-60 HOURS)

Objectives:

- *To familiarize students with corporate tax planning.*
- *To cram the process of computation of tax for companies.*
- *To identify the process of business reorganization in terms of tax planning*

COURSE/LEARNING OUTCOMES

At the end of the course the students will be able to:

CO1: Define the concept of tax management. (Remembering)
CO2: Compare between tax planning and tax management. (Understanding)
CO3: Identify the tax planning process of companies. (Applying)
CO4: Analyse various tax incentive plans for corporate sector. (Analysing)
CO5: Measure tax planning in case of amalgamation or de-merger. (Evaluating)
CO6: Adapt the concept of limited liability partnership. (Creating)

Module I: Introduction of Tax Planning and Management: (5 Hours)

Tax planning, tax management, tax evasion and tax avoidance; Nature and scope of tax planning and tax management in the corporate sector.

Module II: Assessment of Companies' Tax Management: (15 Hours)

Residential Status and incidence of tax, Computation of corporate tax: Carry forward and set off of losses in the case of certain companies under Sec. 79 of Income-tax Act, 1961; various deductions available to corporate assess.

Module III: Tax Computation of Companies (15 Hours)

Computation of taxable income of companies;Computation of amount of corporate tax liability; Minimum Alternate Tax; Tax on distributed profits of domestic companies; Tax on income distributed to unit holders.

Module IV: Tax Planning a Specific Tax Management Decisions (10 Hours)

Implications of Tax concessions and incentives for corporate decisions in respect of setting up a new business, location of business and nature of business.

Module V: Business Reorganisation (15 Hours)

Tax Planning in respect of amalgamation or de-merger of companies ,Slump sale, conversion of a firm into a company; Conversion of sole proprietorship into company, Conversion of company into limited liability partnership.

Suggested Readings

1. Srinivas, E.A, Corporate Tax Planning, Tata McGraw Hill, New Delhi.
2. Singhania,Vinod. K,Taxmann's Direct Taxes, Law & Practice, Taxman, New Delhi.
3. Ahuja. Girish & Gupta, Ravi, Bharat's Professional Approach to Direct Taxes, Law

& Practice, BharatLaw House Pvt. Ltd., New Delhi.
4. Bhagmati Prasad, Direct Taxes and Laws and Practice, WishwaPrakashan, New Delhi

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M		M	
CO 2	M	H	H		
CO 3		M			H
CO 4			H		

CMAF0055: ACCOUNTING THEORY AND FINANCIAL REPORTING (4 CREDITS-60 HOURS)

***Objectives**:*

- *To provide knowledge about the notion of accounting theory.*
- *To enable students to learn the reporting aspect of specific accounting standards.*
- *To identify the key issues in corporate financial reporting.*

COURSE/LEARNING OUTCOMES

At the end of the course the students will be able to:

CO1: Define the concept of accounting theory.(Remembering)
CO2: Compare various accounting standards (AS). (Understanding)
CO3: Apply the knowledge of IFRSs.(Applying)
CO4: Analyse the FASB and IASB. (Analysing)
CO5: Assess the issues in corporate reporting. (Evaluating)
CO6: Adapt the thought of segment reporting. .(Creating)

Module I: Accounting Theory (15 Hours)

Nature; Classifications of Accounting Theory; Different Approaches toTheory Construction; Factors Influencing Accounting Environment; Measurement in Accounting; Accounting Principles: Generally Accepted Accounting Principles; Indian Accounting Standards.

Module II: Reporting of Explicit Accounting Standards (10 Hours)

AS-1: Disclosure of Accounting Principles; AS-6: Depreciation accounting; AS-9: Revenue Recognition; AS-27: Financial Reporting of Interests in Joint Ventures; AS-29: Provisions, Contingent Liabilities and Contingent Assets.

Module II: Financial Reporting (10 Hours)

Nature, Objectives and Benefits; General purpose and Specific Purpose Report; Qualitative Characteristics of Accounting Information; Conceptual Framework: Financial Accounting Standards Board (FASB)International Accounting Standards Board (IASB).

Module III: International Financial Reporting Standards (Ifrss) (15 Hours)

Role of International Accounting Standards Board (IASB); Arguments for Global Convergence; Required Disclosure as per International Financial Reporting Standards; Achievements of International Accounting Standards Board(IASB)and Obstacles in Convergence;Difference between International Financial Reporting Standards(IFRSs) and Indian Accounting Standards; US GAAP.

Module IV: Issues in Corporate Financial Reporting (10 Hours)

Accounting for Changing Prices; Segment Reporting; Interim Reporting; Foreign Currency Translation

Suggested Readings

1. Porwal, L.S, Accounting Theory, McGraw Hill Education (India) Ltd. New Delhi
2. Lal,Jawahar,Accounting Theory and Practice, Himalaya Publishing House, New Delhi.
3. Das, Arjun &Saxena, Vishal, Accounting Theory & Practice, Navyug Publications; 2nd edition, Uttar Pradesh.
4. Evans, Thomas G., Accounting Theory, South-Western, New Delhi.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M			L
CO 2	M	H		M	
CO 3			H		
CO 4				H	
CO 5					H

SPECIALISATION: FINANCE AND INVESTMENT

CMCR0056: ADVANCED CORPORATE FINANCE (4 CREDITS – 60 HOURS)

Objectives*: The objective of this course is to equip students with the background to act as finance managers in organizations. This course develops a theoretical framework for understanding and Analysing major financial problems of modern firms in the market environment.*

COURSE/LEARNING OUTCOMES

After learning this course, the students will be able to:

CO1: Apply the concept of Time Value of Money for valuation of cash flows. (Applying)
CO2: Explain the determinants of interest rates. (Understanding)
CO3: Illustrate the features of debt securities. (Understanding)
CO4: Build a valuation model for bonds. (Applying)
CO5: Explain Capital structure choices and its impact on the firm. (Understanding)
CO6: Explain the rationale and process of a Mergers and Acquisition deal. (Understanding)

Module I: Interest Rates and Valuation of Cash Flows (15 hours)

Introduction to Time Value of Money; Converting cash across time; Timelines; Finding the present value of a stream of cash flows; Finding the future value of a stream of cash flows; Perpetuity; Annuities – Present Value and Future Value; Growing Cash flows – Growing perpetuity and growing annuity; Determinants of Interest rates; Yield curves.

Module II: Bonds (20 hours)

Features of debt securities – Indenture and covenants, Maturity, Par Value; Coupon rates; Embedded options bonds; Risk associated with bonds – Interest rate risk, Yield Curve risk, Call and prepayment risk, Credit risk, Liquidity risk, Sovereign risk; Yield spreads; Valuation of Bonds; Measurement of Interest rate risk.

Module III: Capital Structure and Payout Policy (15 hours)

Capital Structure choices – Across industries and within industries; Leverage and firm value; Effect of leverage on risk and return; Homemade leverage; Leverage and cost of capital; Costs of Bankruptcy and financial distress – Direct and Indirect costs; Tradeoff theory of Optimal Capital Structure; Dividend versus share repurchase in perfect capital markets; Payout versus retention of cash; Signaling with payout policy; Dividends, splits and spin offs.

Module IV: Mergers and Acquisitions (10 hours)

Background and trends; Rationale of a mergers and acquisition (M&A) deal; Steps in M&A deal; Takeover defences – Poison pills, Staggered Boards, White Knight, Golden Parachutes; Value added in a takeover.

Suggested Readings

1. Berk and DeMarzo: Corporate Finance, Pearson.
2. Brealey, Richard/ Myers, Stewart C. / Allen, Franklin: Principles of Corporate Finance, McGraw Hill.
3. AswathDamodaran: Investment Valuation, John Wiley.
4. Ross, Westerfield, Jordan: Fundamentals of Corporate Finance, McGraw Hill.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		H
CO 3		M	M	
CO 4			H	

CMBK0057: INVESTMENT BANKING (4 CREDITS – 60 HOURS)

Objectives*: The objective of this course is to acquaint students with the various models of equity valuation. Students are expected to be proficient in the use of Microsoft excel for conducting a comparable company analysis and discounted cash flow valuation of a publicly traded company.*

COURSE/LEARNING OUTCOMES

After learning this course, the students will be able to:

CO1: Explain different valuation models. (Understanding)
CO2: Distinguish between Comparable companies analysis model and Discounted cash flow model. (Analysing)
CO3: Apply the technique of comparable company analysis for valuation of companies. (Applying)
CO4: Build a Discounted Cash Flow model to value a subject company. (Applying)
CO5: Make use of Microsoft Excel for building valuation models. (Applying)

CO6: Explain the steps involved in the Leveraged Buyout process. (Understanding)

Module I: Comparable Companies Analysis (15 hours)
Comparable companies analysis steps; Selecting the universe of comparable companies; Identifying key characteristics of target; Spread key statistics, ratios and trading multiples; Benchmarking comparable companies; Valuation implied by EV/EBITDA; Valuation implied by P/E; Pros and cons of comparable analysis.

Case study I: Valuation of a publicly listed company using comparable company analysis.

Module II: Discounted Cash Flow Analysis I (15 hours)
Summary of Discounted Cash Flow (DCF) analysis steps; Studying the target, Determination of key performance drivers; Financial statement analysis for valuation; Estimation of growth; Models for estimation of Cost of Equity – Capital Asset Pricing Model and Fama-French model.

Case study II: Valuation of a publicly traded company using Discounted Cash Flow model.

Module III: Discounted Cash Flow Analysis II(15 hours)
Estimation of cost of debt; Determination of Weighted Average Cost of Capital; Projection of Free Cash Flow; Determining Terminal Value- Exit Multiple method and Perpetuity growth method; Calculation of present value; Determination of Valuation; Pros and cons of DCF analysis.

Case study II (contd.): Valuation of a publicly traded company using Discounted Cash Flow model.

Module IV: Leveraged Buyouts(15 hours)
Meaning and objective of Leveraged Buyout (LBO); Rationale of LBOs in modern finance; Key participants; Characteristics of a strong LBO candidate; Economics of LBO; Exit and Monetizing strategies; LBO financing.

Suggested Readings
1. Rosenbaum and Pearl: Investment Banking, Wiley Finance.
2. E. Soubeiga: Mastering Financial Models, McGraw Hill.
3. J. Tija: Building Financial Models, McGraw Hill.
4. PratapGiri S: Investment Banking, McGraw Hill.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	L	M	H	
CO 2	M	M	M	L
CO 3		H	M	M
CO 4		M	H	H

SPECIALIZATION: MANAGEMENT

CMIG0058: INTERNATIONAL MARKETING (4 CREDITS – 60 HOURS)

Objective: *To familiarize the students with the concept and issues of international marketing and enable them to be able to analyse the foreign market environment and develop international marketing strategies for a business firm.*

COURSE/ LEARNING OUTCOMES
After learning this course, the students will be able to:
CO1: Define international marketing (Remembering)
CO2: Explain International Product Planning and Pricing decisions (Understanding)
CO3: Identify the traditional to modern channel structures, Intermediaries (Applying)
CO4: Analyse the international distribution decisions in terms of issues and planning (Analysing)
CO5: Evaluate the different aspects of international promotional strategies (Evaluating)
CO6: Elaborate the trends associated with international marketing in the present context (Creating)

Module I: Introduction: Introduction to International Business (14 hours)
An overview; International marketing management process, International marketing information system. International Marketing Environment: Influence of physical, economic, socio - cultural, political and legal environments on international marketing decisions; International marketing information system. International Market Segmentation, Selection and Positioning; International market entry strategies – Exporting, licensing, contract manufacturing, joint venture, setting -up of wholly owned subsidiaries abroad.

Module II: International Product Planning and Pricing decisions (14 hours)
Major Product decisions-product design, labeling, packaging, branding and product support services; Product standardization vs. adaptation; Managing product line; International trade product life cycle; New product development. Pricing decisions for International Markets: Factors affecting international price determination; International pricing process and policies; Delivery terms and currency for export price quotations; Transfer pricing; Counter trade as a pricing tool- types and problems of counter trading.

Module III: International Distribution Decisions (12 hours)
Distribution channel- from traditional to modern channel structures, Intermediaries for international markets-their roles and functions; Alternative middlemen choices, Factors affecting choice of channels; Locating, selecting and motivating channel members; International distribution logistics- Issues and Planning.

Module IV: International Promotion Strategies (12 hours)
Communications across countries-complexities and issues; Country -of-origin effect; Sales promotions in international markets, trade fairs and exhibitions, International public relations, International Advertising decisions, Personal selling and sales management; Developing international promotion campaign.

Module V: Emerging trends in International Marketing (8 hours)
International Marketing through Internet; Ecological concerns and international marketing ethics.

Suggested Readings

1. Cateora, Philip R, Grahm John L and Prashant Salwan, International Marketing, Tata Mc Graw Hill
2. Czinkota, Michael R. and Illka A. Ronkainon, International Marketing, Cengage Learning
3. International Marketing, P K Vasudeva, 4th edition, 2010, Excel Books , New Delhi.
4. Jain, Subash C., International Marketing, South-Western.
5. Keegan, Warran J and Mark C Green, Global Marketing, Pearson
6. Kotabe, Masaaki and Kristiaan Helsen, Global Marketing Management, John Wiley and Sons.
7. Onkvist, Sak and John J.Shaw, International Marketing; Analysis and Strategy, Psychology Press.
8. Rajagopal, International Marketing, Vikas Publishing House.
9. Terpstra, Vern; Foley, James and Ravi Sarathy, International Marketing, Naper Press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	L			
CO 2		M	L	L
CO 3		M	M	
CO 4	M		H	M
CO 5				H

CMBC0059: BUSINESS ETHICS AND CORPORATE GOVERNANCE (4 CREDITS-60 HOURS)

***Objective**: This paper aims at providing the students the understanding of ethical issues related to business and good governance necessary for long term survival of business.*

COURSE/LEARNING OUTCOMES

After learning the course the students will be able to:

CO1: Define business ethics. (Remembering)
CO2: Distinguish between ethical and unethical behavior at workplace. (Understanding)
CO3: Elaborate the various theories on ethics in practice. (Applying)
CO4: Evaluate legal and economic aspects of ethics in business. (Analysing)
CO5: Interpret the accountability hierarchy from a corporate governance perspective. (Understanding)
CO6: Design issues involved in addressing litigation risks in corporate governance and regulatory contexts. (Creating)
CO7: Examine ethical theories and frameworks to Analyse ethical dilemmas in business and resolve practical problems. (Analysing)
CO8: Identify different stakeholders and understand why they may hold differing perspectives on ethical issues. (Applying)

Module I: Introduction (9 hours)
Definition & nature of business ethics, characteristics, ethical theories; causes of unethical behavior;ethical abuses; work ethics; code of conduct; public good.

Module II: Ethics Theory and Beyond (13 hours)
Management of ethics - ethics analysis [Hosmer-model]; ethical dilemma; ethics in practice, ethics for managers; role and function of ethical managers- comparative ethical behavior of managers; code of ethics; competitiveness, organizational size, profitability and ethics; cost of ethics in corporate ethics evaluation; business and ecological / environmental issues in the Indian context and case studies.

Module III: Legal Aspects of Ethics (10 hours)
Political – legal environment; provisions of the Indian constitution pertaining to business; political setup – major characteristics and their implications for business; prominent features of MRTP &FERA; social – cultural environment and their impact on business operations, salient features fIndian culture and values.

Module IV: Environmental Ethics (10 hours)
Economic environment; philosophy of economic growth and its implications for business, main features of economic planning with respect to business; industrial policy and framework of government contract over business; role of chamber of commerce and confederation of Indian industries.

Module V: Corporate Social Responsibility and Governance (15 hours)
Definition, evolution and need for CSR; theoretical perspectives; corporate citizenship; business practices; strategies for CSR; challenges and implementation; evolution of corporate governance; governance practices and regulation; structure and development of boards; role of capital market and government; governance ratings; future of governance- innovative practices; case studies with lessons learnt

Suggested Readings
1. Sherlekar S.A. , Ethics in Management, Himalaya Publishing House.
2. William B. Werther and David B. Chandler, Strategic corporate social responsibility, Sage Publications Inc.
3. Robert A.G. Monks and Nell Minow, Corporate governance, John Wiley and Sons.
4. Shaw W.H., Business Ethics, Cengage Learning.
5. Beeslory, Michel and Evens, Corporate Social Responsibility, Taylor and Francis.
6. Kotler Philip and Lee Nancy, Corporate social responsibility: doing the most good for company and your cause, Wiley.
7. Banerjee Subhabrata Bobby , Corporate social responsibility: the good, the bad and the ugly,
8. Edward Elgar Publishing.
9. Kumar Satheesh , Corporate governance, Oxford University, Press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	L			
CO 2		M	L	L
CO 3			M	M
CO 4		M		H
CO 5	M		H	

CMEM0060: ENTREPRENEURSHIP MANAGEMENT AND E-COMMERCE (4 CREDITS- 60 HOURS)
***Objective**: The students develop and can systematically apply an entrepreneurial way of thinking that will allow them to identify and create business opportunities that may be commercialized successfully.*

COURSE/LEARNING OUTCOMES
CO1: Define entrepreneurship, its features and ability to discern distinct entrepreneurial traits (Remembering)
CO2: Illustrate the parameters to assess opportunities and constraints for new business ideas (Understanding)
CO3: Demonstrate the systematic process to select and screen a business idea(Understanding)
CO4: Choose the entrepreneurship as a career objective (Applying)
CO5: Analysing the legal framework to set up new ventures (Analysing)
CO6: Find the meaning and Concept of E-Commerce; Business Model for E Commerce (Remembering)
CO7: Discuss the entrepreneurial prospects in e-commerce (Creative)

Module I (15 Hours)
a) Entrepreneurship: Definition, Concept, Growth and role. The Entrepreneur : Types, characteristics, theories of entrepreneurial class, Urges and importance of Entrepreneurship Stimulates; Seed Beds of Entrepreneurship, Influencing Factors; Problems(Operational and Non Operational) and Obstacles. Entrepreneurial Management. Role of socio economic environment.
b) Skills for a New Class of Entrepreneurs; The Ideal Entrepreneurs; The Entrepreneurship Audit; Identification of opportunities by an Entrepreneur; The steps to identify the project/ ventures; Process of converting business opportunities into reality; Feasibility Report and analysis; Process of setting up a small scale industry/unit.

Module II (15 Hours)

Promotion of a venture, External Environment Analysis; Economic, Social, Technological and competition; Legal Framework for establishing and fund raising Venture Capital: Sources and Documents required

Module III (15 Hours)

E-Commerce and Entrepreneurs; Exports and entrepreneurs. Balanced Regional Development and Entrepreneurs, relevant Acts for Entrepreneurs (An overview only); Foreign Exchange and Entrepreneurs; Micro and small enterprises; Recent Initiatives taken by the government to revitalize the Entrepreneurship.

Module IV (15 Hours)

a) Introduction to E-commerce: Meaning and Concept of E-Commerce; Business Model for E Commerce; Sales and Marketing Cycle; Features of E Commerce; Element of E-Commerce; Benefits and Limitations of E-Commerce; Types of E-Commerce System; B2B, B2C, C2C, C2B, B2G andG2C.
b) Electronic Payment systems : Features of an ideal electronic payment system; Types of an Electronic Payment System, Credit Cards, Debit Cards, Smart Cards, E-Money, E Check and Electronic fund transfer (EFT). Need of security in E Commerce; Essential security requirements for safe electronic payments; Security Schemes for an Electronic Payment Systems, Encryption, Digital Signature, Security Certificates; internet security Protocol, SSL, HTTP,SET.

Suggested Readings

1. Entrepreneurship Development Institute of India, "Handbook for New Entrepreneurs", Oxford University Press.
2. Patel V. G., "When the Going Gets Tough – Strategic responses to Business Crisis", Tata McGraw Hill Publishing Company Limited.
3. Desai Vasant, "Small scale industries and entrepreneurship", Himalayan Publishing House.
4. Desai Vasant, "Management of small scale industries", Himalayan Publishing House.
5. Bolton William, "The University Handbook on Enterprise Development", Columbus.
6. Desai Vasant, "Management of small scale industries", Himalayan Publishing House.
7. Gupta Sarika, E-Commerce, Publisher: Khanna Books
8. Joseph P. T., E-Commerce, An Indian Perspective, Prentice Hall India Pvt., Limited

Mapping of Course Outcomes

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	L	M		
CO 2		M	H	
CO 3			M	H
CO 4		L	M	H

SPECIALISATION: ACCOUNTING AND TAXATION

CMMD0061: MODERN ACCOUNTING (4 CREDITS-60 HOURS)

Objectives:

- *To provide knowledge about the various concepts of accounting.*
- *To learn the application of various accounting concepts.*
- *To categorize the key areas of modern accounting.*

COURSE/LEARNING OUTCOMES

At the end of the course the students will be able to:

CO1: Define the concept of modern accounting. (Remembering)
CO2: Compare various systems of modern accounting. (Understanding)
CO3: Apply the knowledge of environmental accounting. (Applying)
CO4: Analyse behavioural accounting. (Analysing)
CO5: Assess the challenges in social accounting. (Evaluating)
CO6: Adapt the thought of forensic accounting. (Creating)

Module I: Introduction to Modern Accounting (10 Hours)

Various concepts of modern accounting: inflation accounting, environmental accounting, social accounting, forensic accounting and behavioural accounting; its application, process and its scope.

Module II: Inflation Accounting (10 Hours)

Meaning; techniques of inflation accounting; determination of value of assets and liabilities under inflation accounting; accounts preparation under inflation accounting.

Module III: Environmental Accounting (10 Hours)
Meaning; functions of environmental accounting;valuation process under environmental accounting, methods of evaluation under environmental accounting; accounts preparation under environmental accounting.

Module IV: Forensic Accounting (10 Hours)
Meaning;branches of forensic accounting; activities under forensic accounting; procedure of forensic accounting; stages of forensic accounting; application and consequences of forensic accounting.

Module V: Behavioural Accounting (10 Hours)
Meaning; process of behavioural accounting; application of behavioural accounting; techniques of behavioural accounting; influence of accounting information on behaviour.

Module VI: Social Accounting (10 Hours)
Meaning; purpose of social accounting; scope & objectives of social accounting; benefits & challenges of social accounting; accounting under social accounting.

Suggested Readings
1. Lal, Jawahar, Accounting Theory and Practice, Himalaya Publishing House, New Delhi
2. Pedneault, Stephen, Forensic Accounting and Fraud Investigation for Non–Experts, John Wiley & Sons; 3rd edition , New Delhi.
3. Pahuja, Shuchi, Environmental Accounting & Reporting: Theory, Law & Empirical Evidence, New Century Publications, New Delhi.
4. Hellmann, Andreas, Behavioural Accounting, Routledge; 1 edition, New Delhi.
5. Rao, P.M., Corporate Social Accounting and Reporting, Deep & Deep Publications Pvt.ltd , Delhi.

Mapping of Course Outcomes

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M		M	
CO 2	M	H	H		
CO 3		M			H

CMAV0062: ADVANCED ACCOUNTING (4 Credits- 60 hours)
***Objective**: The objective of this course is to provide advanced knowledge in the field of accounting. It stresses on specialised accounting processes followed in specific organisations. This course also gives insight into various modern concepts of Accounting.*

COURSE/LEARNING OUTCOMES
At the end of the course students will be able to:
CO1: Define the recent concepts of accounting (Remembering)
CO2: Explain the conceptual framework in the preparation and presentation of financial statements (Understanding)
CO3: Identify the various modes of liquidation of companies (Applying)
CO4: Compare the accounting techniques followed under general and special processes. (Analysing)
CO5: Determine insurance claims from loss of profit and stock (Evaluating)
CO6: Compile financial statements of insurance and banking companies (Creating)

Module I: Conceptual Framework (10 credits)
Conceptual Framework in the preparation and presentation of Financial Statements: Objectives, Purpose, Constituents of Financial Statements, Underlying assumptions in the preparation of Financial Statements, Qualitative Characteristics and Elements of Financial Statements, Capital Maintenance Adjustments, Recognition of the elements of Financial Statements, Concept of Capital and Capital Maintenance, GAAP and Accounting Standards in India, Compliance Requirements of Accounting Standards in India, Applicability of Accounting Standards

Module II: Accounts of Banking Companies (15 credits)
Accounting of Banking Companies: Nature, Features of Banking Companies, Banking Regulation Act, 1949, Rebate on Bills Discounted, Income recognition, Statutory books to be maintained, special features of Bank bookkeeping, Preparation and presentation of Financial Statements of Banks, Advances and its classification, provisions to be made against advances.

Module III: Accounts of Insurance Companies and Insurance Claims (15 credits)
Accounting of Insurance Companies: Meaning of Insurance Business, Accounts of Life insurance company – Revenue Account, Profit and Loss Account and Balance Sheet, Ascertainment of profit under Life insurance business, Accounts of general

insurance business – Revenue Account, Profit and Loss Account and Balance Sheet.
Insurance Claims: Average clause, indemnity period, procedure of ascertaining loss of stock and loss of profit, Ascertainment of claims against loss of stock and loss of profit.

Module IV: Investment Accounts and Liquidation of a company (15 credits)
Investment Account: Meaning, features, concept of cum-interest, ex-interest, cum-dividend, ex- dividend, Accounting for fixed interest learning securities and variable earning securities, bonus shares and right shares, Intercompany investment.
Winding up of a company: Meaning, winding up by National Company law Tribunal, Modes of Winding up, preferential payments, Preparation of Statement of Affairs, Liquidator's Final statement of Account.

Module V: Inflation and Government Accounting (5 credits)
Inflation Accounting: Meaning, Need, Objectives, Current Purchasing Power Method, Current Cost Accounting; Government Accounting: Meaning, features and Objectives of Government Accounting; difference between commercial accounting and Government Accounting; General Principles of Government Accounting; System of financial administration and financial control in India; Accounts keeping of the government; Classification of Accounts in Government Accounting; Accounting for Human Resources in an Organisation.

Suggested Readings
1. JawaharLal, Financial Accounting, S Chand
2. Hanif & Mukherjee Advanced Accounting, McGraw Hill Education.
3. Dam B. B., Advanced Accounting, Capital Publishing Company
4. Khan M. Y., Advanced AccountingM.C. Shukla, Advanced Accounting, S Chand & Co.
5. Maheshwari S. N. Advanced Accounting, Vikas Publishing.

Mapping of Course Outcomes

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M			
CO 2	M	H			
CO 3			M	M	
CO 4			H		
CO 5				H	H

SPECIALISATION: FINANCE AND INVESTMENT

CMFI0063: FINANCIAL INSTITUTIONS MANAGEMENT (4 CREDITS – 60 HOURS)

***Objectives**: The objective of this course is to impart the knowledge of the banking, finance and insurance industry to the students. The student will be able to articulate the operations of each of this industry; understand the various potential conflicts of interests and analyse the regulatory structure of the industry.*

COURSE/LEARNING OUTCOMES
After learning this course, the students will be able to:
CO1: Explain the operations of the banking industry. (Understanding)
CO2: Analyse the potential conflicts of interest in the banking industry. (Analysing)
CO3: Explain the operations of the Insurance industry. (Understanding)
CO4: Explain the operations of the financial services industry. (Understanding)
CO5: Outline the risks in the financial industry. (Understanding)
CO6: Analyse the regulatory framework in the banking and financial industry. (Analysing)

Module I: Banking (15 hours)
Commercial Banking; Capital requirements of Banks; Merchant Banking; Investment Banking; Securities trading; Potential conflicts of Interests in Banking; Large Banks and their implications; Risks in Banking. Case study: 2008 financial crisis

Module II: Insurance companies (15 hours)
Life insurance companies: size, structure, composition of industry, recent trends and regulations; Property-casualty insurance: size, structure, composition of industry, recent trends and regulation; Health insurance; Moral hazard and adverse selection; risks in insurance industry.

Module III: Financial services industry (15 hours)
Mutual funds: size, structure, composition of industry, types, objectives, costs, recent trends and regulations; Hedge funds: types of hedge funds, fees in hedge funds industry, offshore hedge funds, and regulation of hedge funds.

Module IV: Risk and regulation (15 hours)
Interest rate risk; Market risk; Credit risk; Off balance sheet risk; Foreign exchange risk; Sovereign risk; Technology and Operational risk; Liquidity risk; Insolvency risk; Liability and liquidity management; Deposit insurance; Basel norms: rationale, Basel I, Basel II, Basel III; Dodd-Frank Act.

Suggested Readings
1. John C Hull: Risk Management and Financial Institutions, Wiley Finance Series.
2. Saunders: Financial Institutions Management, McGraw Hill.
3. Kohn: Financial Institutions and Markets, Oxford University Press.
4. Frank J Fabozzi, Franco Modigliami: Capital Markets – Institutions and Instruments, PHI Learning.

Mapping of Course Outcomes

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	M	M	L	
CO 2		H		
CO 3	H			M
CO 4				H
CO 5			H	

CMPN0064: PORTFOLIO MANAGEMENT (4 CREDITS – 60 HOURS)

***Objective**: The objective of this course is to acquaint students with the portfolio perspective of investing. The student will be able to illustrate various risk and return objectives of investors and understand the justification of diversification in a portfolio.*

COURSE/LEARNING OUTCOMES
After learning this course, the students will be able to:
CO1: Explain the Portfolio Perspective to Investing. (Understanding)
CO2: Analyse major return measures of an investment. (Analysing)
CO3: Explain the characteristics of the major asset classes that an investor should consider (Understanding)
CO4: Analyse the risk and return objectives and how they may be developed for a client. (Analysing)
CO5: Illustrate the steps in the Investment Management process. (Understanding)

Module I: Introduction to Portfolio Management (15 hours)
Meaning and objectives; Portfolio Perspective on Investing: Diversification, Risk Aversion, Composition, Downside Protection, Modern Portfolio Theory; Investment Clients; Steps in Investment Management Process; Pooled Investments: Mutual Funds, Types of Mutual Funds, Other Investment Products.

Module II: Portfolio Risk and Return I (20 hours)
Investment Characteristics of Assets: Return, Return measures and their applications, Variance and Covariance of Returns, Historical Risk and Returns, Other Investment Characteristics; Risk Aversion and Portfolio Selection; Portfolio Risk; Efficient frontier; Investor's Optimal Portfolio; Capital Market Theory; Pricing of Risk: Systematic Nonsystematic Risk.

Module III: Capital Market expectations and Asset allocation (15 hours)
Economic Analysis: Business Cycle Analysis, Economic Growth Trends, International Interactions; Asset Allocation: Strategic Asset Allocation in relation to Systematic Risk, Strategic vs Tactical Asset Allocation; Asset Allocation and Investor's Risk and Return objectives; Selection of Asset Classes; Optimization Approaches; Implementing Strategic Asset Allocation.

Module IV: Investment Planning (10 hours)
Investment Policy Statement (IPS): Components, Gathering Client Information; Capital Market Expectations; Strategic Asset Allocation; Investment Instruments: Equity, Fixed Income, Mutual Funds, Real Estate, Insurance Investments.

Suggested Readings
1. ZviBodie: Essentials of Investment, McGraw Hill.
2. Reilly and Brown: Analysis of Investments and Management of Portfolios, Cengage.
3. Chandra Prasanna : Investment Analysis and Portfolio Management, McGraw Hill.
4. Ranganatham: Security Analysis and Portfolio Management, Pearson.

Mapping of Course Outcomes

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M		M	
CO 2	M	H	H		
CO 3		M			H

CO 4			H		

SPECIALIZATION: MANAGEMENT

CMIL0065: MANAGEMENT OF INDUSTRIAL LAWS (4 CREDITS- 60HOURS)

Objective*: The objective of this course is to make the students aware of the legal aspects of management. Every industrial concern is set to follow certain terms and guidelines and the management has to take due care about it. This course will give a detailed idea about the various industrial laws and its provisions.*

COURSE/LEARNING OUTCOMES

At the end of the course students will be able to:

CO1: Define the terms commonly used in industrial laws (Remembering)
CO2: Explain the various provisions of labour laws (Understanding)
CO3: Identify the factors essential for management of labour unions (Applying)
CO4: Analyse the different theories of Trade Unionism.(Analysing)
CO5: Assess the impact of economic changes upon labour management (Evaluating)
CO6: Develop a model of business management abiding by all industrial laws (Creating)

Module I: Introduction to Labour Laws (15 credits)

Origin and Development, Objectives and Principles of Labour Laws, Development of Labour Laws in India, Concept of Industrial Relations- Importance, Scope & Aspects of Industrial Relations, Factor Affecting Industrial Relations, Different approaches/perspectives of Industrial Relations, Industrial conflict, unfair labour practices, concept of Labour welfare & activities of labour welfare officer, Political influence on trade unions, Workers Education, Role of trade union in the changed economic scenario.

Module II: Regulatory framework for management of industries (15 credits)

Trade Union Act, 1926, The Industrial Employment (Standing Orders) Act, 1946, Factories Act, 1948, Payment of Bonus Act, 1956, Payment of Wages Act, 1936: scope, objectives and important provisions

Module III: Dispute and settlement (15 credits)

Industrial Disputes Act, 1947: Industrial Disputes, Development of Industrial Disputes Legislations in India, Mechanisms for settlement of Industrial Disputes, Constitutional and Statutory Framework in India, unions and technological changes, Industrial relation system, Instruments of economic coercion, discipline, domestic enquiry grievance procedure and disciplinary action, Principle of natural justice.

Modu:le IV Prevention and legal regulations regarding labour management (15 credits)

Machinery for prevention of industrial disputes, Welfare Officer works committees, Joint Management Council, Ethical Codes, Methods of setting Industrial Disputes, Arbitration Adjudication, Tripartite and Bipartite Machinery, Collective Bargaining, workers' participation in management, Labour management and cooperation, Industrial relations and related legislations with special reference to industrial disputes Act, 1947, labour welfare and social security, Lok Adalat as a body to conduct mediation. Case studies

Suggested Readings

1. Goswami G V , Labour Industrial Laws, Central Law Agency.
2. Pillai K M , Labour and Industrial Law, Allahabad Law Agency
3. Mishra S N , Labour and Industrial Laws, Central Law PublicationsS
4. Singh BD , Labour Law for Managers, Excel Books, New Delhi,
5. Pai GB , Labour Law in India, Butterworth's India, New Delhi
6. Srivastava SC, Industrial Relations and Labour Laws, Vikas Publishing House.

Mapping of Course Outcomes

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	L	M	H	H
CO 2	M	M	H	
CO 3		H	M	H
CO 4		L	M	H

CMSM0066: SUPPLY CHAIN MANAGEMENT AND LOGISTICS (4 CREDITS – 60 HOURS)

Objective*: The objective of this paper is to acquaint the students with the concepts and tools of supply chain management and logistics as relevant for an international firm.*

COURSE/LEARNING OUTCOMES

After learning the course, the students will be able to:

CO1: Define the process of supply chain management. (Remembering)
CO2: Demonstrate operational purchasing methods and techniques on supplier management and supply in specific business contexts. (Understanding)
CO3: Explain the strategic importance of logistics elements and describe how they affect supply chain management. (Understanding)
CO4: Apply sales and operations planning, MRP and lean manufacturing concepts. (Applying)
CO5: Analyse the creation of new value in the supply chain for customers, society and the environment. (Analysing)

Module I: Basic Framework (9 hours)

Concept of supply chain management (SCM); SCM and trade Logistics; Business view of SCM; Push and pull of SCM; Decision phases; Impellers and drivers in SCM Process views of SCM, planning and operations; Supply chain modeling; Role of Relationship marketing in SCM; managing relationships with suppliers and customers; Designing strategic distribution network; Factors influencing distribution network.

Module II: Supply Chain and Information Management Systems (13 hours)

Purchasing Process- Strategic role of purchasing in the supply chain and total customer satisfaction; Types of purchases; Purchasing cycle;Supplier selection and evaluation; Vendor development; Importance of information management; Distribution and sharing of information; Information Technology as a platform for effective and efficient supply chain management.

Module III: Logistic System (10 hours)

Concept, objectives and scope of logistics; System elements; Inbound and Outbound logistics. Reverse inventory, Value added role of logistics, Logistics interface with manufacturer and marketing, Packing, Marking, Just in time concept; Third party logistic outsourcing–challenges and future directions.

Module IV: Transportation (16 hours)

Importance of effective transportation system; Service choices and their characteristics; inter- modal services; Transport cost characteristics and rate fixation; Carrier selection determinants and decision; Structure of Shipping: World seaborne trade; international shipping - characteristics and structure;Liner and tramp operations; Liner freighting; Chartering-Types, principles and practices; Charter, party agreement; Development in sea transportation-Unitization, containerisation, inter and multimodal transport; CFC and ICD; Indian shipping – growth, policy and problems; Ports and port trust; International Air transport: International set up for air transport: Freight rates; India's exports and imports by air – Problems and prospects;Carriage of Goods by sea, sea and combined transport.

Module V: Warehousing and Inventory Management (12 hours)

Warehousing And Marketing Strategy;Objectives and functions of warehousing; Warehouse Strategies; Material handling equipment and material mobility Warehousing evaluation and requirements.

Inventory management-inventory categories, EOQ, LT, ICC; Inventory levels; Material planning and sourcing of procurement; Methods of cost reduction.

Suggested Readings

1. Ballau, R.H., Business Logistics Management, Prentice Hall,Englewood Cliffs.
2. Bes, J., Chartering Practices.
3. Bes, J., Dictionary of Shipping and chartering Practices.
4. Christopher, M., Logistics and Supply Chain Management, Prentice Hall.
5. ICAO Journal, New York., various issues.
6. Indian Shipping and Transport, Mumbai, Various issues.
7. Murphy, Paul R. and Donald F. Wood, Contemporary Logistics, Prentice Hall.
8. Marks, Daniel, Shipping Cartels.
9. Shapiro, R., Logistics Strategy: Cases and Concepts, West Publishing, St. Paul.
10. Coughlan, A.,Anderson, E. and Louis W. Stern, Marketing Channels, Prentice Hall.
11. The Marine Times, Mumbai, various issues.
12. John J Coyle, C. John and Langley,Brian J Gibs, Logistics approach to Supply Chain Management, Cengage Learning.
13. Burt, Dobler and Starling, World Class Supply Management, Tata McGraw Hill.
14. Bowersor, Donald J and David J Closs, Logistics management and Integrated Supply Chain Management, Tata McGraw Hill

Mapping of Course Outcomes

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	L			
CO 2		M	L	L
CO 3			M	M
CO 4		M		H
CO 5	M		H	

CMDS6006: DISSERTATION-I (RESEARCH SOFTWARE) (4 CREDITS- 60 HOURS)

***Objective**: The objective of the course would be to educate the students about the various dimensions of a research based project work. The students will also be taught about the application of statistical tools through SPSS.*

This phase of the Dissertation will comprise of the following:

1. **Synopsis**: Submission of a write up on a specific area/topic of study (10hours)
2. **Review of Literature**: Submission of a specified number of reviews to respective guide (15 hours)
3. **Research Methodology**: Lecture based on the topic of study. (10 hours)
4. **Referencing Style**: Lecture on referencing style to be followed while submitting report (5 hours)
5. Training on application of Statistical software used in research (20hours)
6. **Submission of Progress Report after completion of Phase I**: Report should comprise of Introduction, Review of Literature, Research Methodology and References.

EVALUATION:

A diary will be maintained by every student to keep a record of meeting with his/her guide. A format of the diary will be circulated at the beginning with the semester. Evaluation at Phase I will be done by the respective guide based on timely submission of part-work and quality of work as follows:

Synopsis (30marks)
Review of Literature (30marks)
Research Methodology (30marks)
Referencing (10marks)

CMDS6007: DISSERTATION-II (6 credits - 75 hours)

***Objective**: The objective of the course would be to develop analytical skills among the students for solving any research queries. The students will also be taught about the preparation of a project report.*

This phase of the Dissertation will comprise of the following:

1. **Field Work**: Collection of data and validation with the respective guide (30 hours)
2. **Analysis of Data**: Analysis and presentation of the data collected though application of various statistical tools though SPSS and other statistical software packages. (10 hours)
3. Test of Plagiarism.
4. **Submission of Project Report**: Submission of the complete report in continuation from Phase I.
5. Presentation of work using PPT and Viva Voce Examination.

EVALUATION:

Evaluation at Phase II will be done by a panel comprising of an external and internal expert along with the respective guide based on quality of work as follows:

Report (50marks)
Presentation (30marks)
Viva-Voce (10marks)

Suggested Reading

1. Singh, J.K.Venture Capital Financing in India. Dhanpat Rai and Company,NewDelhi.
2. Annual Reports of Major Financial Institutions in India.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H			
CO 3			H		
CO 4				H	
CO 5					H

SCHOOL OF FUNDAMENTAL AND APPLIED SCIENCES

SCHOOL OF FUNDAMENTAL AND APPLIED SCIENCES
DEPARTMENT OF CHEMISTRY
MASTER OF SCIENCE IN CHEMISTRY – MSc Chemistry

SEMESTER I				
Type of Course/ Category	**Course Code**	**Course Name**	**Credits L-T-P**	**Page**
Theory/DC	CHIC0003	Fundamentals of Inorganic Chemistry	4-0-0	600
Theory/DC	CHOC0004	Fundamentals of Organic Chemistry	4-0-0	601
Theory/DC	CHPC0005	Fundamentals of Physical Chemistry	4-0-0	602
Theory/DC	CHQT0029	Introduction to Quantum Chemistry and Group Theory	4-0-0	620
Lab/DC	CHIQ6002	Inorganic Qualitative and Quantitative Analyses and Preparations - Lab	0-0-3	624
Audit Course	CHSL0200	Elements of Service Learning	NC	622
Value Added Course	CHPC6137	Petroleum Chemistry	NC	626
Total Credits			**19**	
SEMESTER II				
Theory/DC	CHIR0007	Advanced Inorganic Chemistry I	4-0-0	603
Theory/DC	CHOG0008	Advanced Organic Chemistry I	4-0-0	604
Theory/DC	CHAP0009	Advanced Physical Chemistry I	4-0-0	605
Theory/DC	CHFY0030	Fundamentals of Spectroscopy	4-0-0	621
Theory/DC	CHGC0011	Introduction to Green and Environmental Chemistry	3-0-0	606
Lab/DC	CHEQ6003	Experimental Physical Chemistry - Lab	0-0-3	624
Value Added Course	CHPA6138	Pharmaceutical Chemistry and its applications	NC	626
Total Credits			**22**	
SEMESTER III				
Theory/DC	CHAI0012	Advanced Inorganic Chemistry II	4-0-0	606
Theory/DC	CHAO0013	Advanced Organic Chemistry II	4-0-0	608
Theory/DC	CHAP0014	Advanced Physical Chemistry II	4-0-0	608
Theory/DC	CHSP0015	Special Topics in Biochemistry	3-0-0	609
Theory/DC	CHAP0031	Applied Spectroscopy	3-0-0	622
Theory/DC	CHRM0017	Research Methodology for Chemistry	3-0-0	610
Lab/DC	CHQA6004	Organic Qualitative Analysis and Synthesis Lab	3-0-0	625
Value Added Course	CHPC6137	Petroleum Chemistry	NC	626
Total Credits			**24**	
SEMESTER IV				
Theory/ DE	CHMC0018	Materials Chemistry	3-0-0	611
Theory/ DE	CHCC0019	Computational Chemistry	3-0-0	612
Theory/ DE	CHFC0020	Food Chemistry	3-0-0	613
Theory/ DE	CHIC0021	Industrial Chemistry	3-0-0	614
Theory/ DE	CHMD0022	Medicinal Chemistry	3-0-0	615
Specialization I: Inorganic Chemistry				
Theory/ DE	CHOC0027	Organometallic Chemistry	3-0-0	618
Theory/ DE	CHIP0028	Inorganic Rings, Clusters and Polymers	3-0-0	619
Specialization II: Physical Chemistry				
Theory/ DE	CHRC0023	Recent Advances in Catalysis	3-0-0	615
Theory/ DE	CHBC0024	Biophysical Chemistry	3-0-0	616
Specialization III: Organic Chemistry				

Theory/ DE	CHHC0025	Heterocyclic Chemistry	3-0-0	617
Theory/ DE	CHNP0026	Natural Products Chemistry	3-0-0	618
Project/DC	CHRP6005	Research Project	12	625
Value Added Course	CHPA6138	Pharmaceutical Chemistry and its applications	NC	626
Audit Course	EDCI0200	Constitution of India	NC	
Total Credits			**21**	
Total Programme Credits			**86**	

Note: Mandatory Course EDPC0201: Indian Polity and Constitution

DEPARTMENT OF MATHEMATICS
MASTER OF SCIENCE IN MATHEMATICS – MSc Mathematics

Type of course/ Category	Course Code	Course Name	Credits L-T-P	Page
SEMESTER I				
DC	MARA0014	Real Analysis	4-0-0	631
DC	MALA0015	Linear Algebra	4-0-0	631
DC	MAAB0016	Abstract Algebra	4-0-0	632
DC	MADE0017	Differential Equations	4-0-0	633
DC	MAMT0018	Mathematical Methods I	4-0-0	633
Mandatory Course	MASL0200	Community Engagement and Service Learning	NC	
Value Added Course	MAFG0154	Fractal Geometry and Applications	NC	659
Value Added Course	MACM6004	Computational Skill Development: MATHEMATICA		664
Total Credits			20	
SEMESTER II				
DC	MATF0019	Topology and Functional Analysis	4-0-0	634
DC	MACA0020	Complex Analysis	4-0-0	635
DC	MAMP0021	Measure Theory and Probability Theory	4-0-0	635
DC	MAMD0022	Mathematical Methods II	4-0-0	636
DC	MACL0023	Classical Mechanics	4-0-0	637
Mandatory	EDCI0200	Constitution of India	NC	
Value Added Course	MAML0152	Essential Mathematics for Machine Learning	NC	661
Value Added Course	MACS6005	Computational Mathematics with SAGEMATH		665
Total Credits			20	
SEMESTER III				
DC	MADS0030	Discrete Mathematics	4-0-0	638
DC	MACP0031	Computer Programming in C	2-0-0	638
DC	MACP6002	Computer Programming in C Lab	0-0-1	638
DC	MARM0032	Research Methodology for Mathematical Sciences	3-0-0	639
DC	MARS6001	Research Seminar	2-0-0	
	Specialization I: Theoretical			
DE	MAFA0033	Field theory & commutative Algebra	4-0-0	640
DE	MANT0034	Number Theory		641
DE	MAML0035	Mathematical Logic		641
DE	MAFS0036	Fuzzy sets and Applications		642
	Specialization II: Applicable			
DE	MAFD0037	Fluid Dynamics I	4-0-0	643
DE	MARC0038	Riemannian Geometry & Tensor Calculus		643
DE	MADS0059	Dynamical Systems and Chaos		654
DE	MACO0060	Convex Optimization		655
DE	MANS0039	Numerical solution of PDE	4-0-0	644
	Specialization III: Computational			

DE	MACN0040	Computational Number Theory	4-0-0	645
DE	MASC0041	Scientific Computing		645
DE	MASF0042	Special Functions		646
DE	MAGT0061	Introduction to Game Theory		655
Value Added Course	MACM6004	Computational Skill Development: MATHEMATICA		664
Total Credits			20	
SEMESTER IV				
Specialization I: Theoretical				
DE	MAAS0046	Advanced Analysis	4-0-0	647
DE	MAGY0047	Graph Theory	4-0-0	647
DE	MACA0048	Multivariable calculus	4-0-0	648
DE	MAAY0049	Algebraic Number Theory	4-0-0	649
	MAAN0062	Algebraic Geometry	4-0-0	656
Specialization II: Applicable				
DE	MAFL0050	Fluid Dynamics II	4-0-0	649
DE	MACM0051	Continuum Mechanics	4-0-0	650
DE	MATR0052	Theory of Relativity	4-0-0	651
DE	MANO0063	Numerical Optimization	4-0-0	657
DE	MAPD0065	Plasma Dynamics	4-0-0	658
Specialization III: Computational				
DE	MADN0054	Design and Algorithms Analysis	4-0-0	652
DE	MAML0064	Machine Learning	4-0-0	657
DE	MAFE0053	Finite Elements Methods	4-0-0	652
DE	MAIC0055	Introduction to Cryptography	4-0-0	653
Project DC	MARP6003	Research Project	8	664
Value Added Course	MAMR0153	Statistical Methods & Software in Research	3-0-0	660
Value Added Course	MACS6005	Computational Mathematics with SAGEMATH		665
Total Credits			20	
Total Programme Credits			80	

Note: Mandatory Course EDPC0201: Indian Polity and Constitution

DEPARTMENT OF PHYSICS
MASTER OF SCIENCE IN PHYSICS - MSc Physics

Type of Course/ Category	Course Code	Course Name	Credits	Page
Semester I				
Theory/DC	PSCM0020	Classical Mechanics	4	669
Theory/DC	PSQM0021	Quantum Mechanics I	4	669
Theory/DC	PSMP0055	Mathematical Physics-I	4	687
Theory/DC	PSEL0049	Electronics I	4	682
Theory/DC	PSPL6009	Physics Laboratory I	4	690
Mandatory	PSPS0200	Physics and Service Learning		688
Value Added Course	PSCP6120	Computational Physics using PYTHON	2-0-0	695
Total Credits			**20**	
Semester II				
Theory/DC	PSQM0024	Quantum Mechanics II	4	670
Theory/DC	PSMP0056	Mathematical Physics -II	4	688
Theory/DC	PSED0026	Electrodynamics	4	672
Theory/DC	PSNP0050	Nanophysics I	4	683
Theory/DC	PSPL6003	Physics Laboratory II	4	690
Total Credits			**20**	
Semester III				
Theory/DC	PSCP0025	Condensed Matter Physics	4	671
Theory/DC	PSNP0054	Nuclear and Particle Physics	4	686
Theory/DC	PSRM0051	Research Methodology	2	684
Theory/DC	PSCN0030	Computer Oriented Numerical Methods	2	673
Theory/DC	PSCN6010	Computer Oriented Numerical Methods Laboratory	4	691
Theory/DC	PSPP6017	Project Phase I	2	695
	Specialisation: High Energy Physics			
Theory/DE	PSHP0052	High Energy Physics I	4	685
	Specialisation: Astrophysics			
Theory/DE	PSPL0036	Plasma Physics I	4	679
	Specialisation: Plasma Physics			
Theory/DE	PSPL0036	Plasma Physics I	4	675
	Specialisation: Electronics			
Theory/DE	PSEC0037	Electronics II	4	676
	Specialisation: Nanophysics			
Theory/DE	PSNS0041	Nanophysics II	4	677
Mandatory	EDCI0200	Constitution of India		
Total Credits			**23**	
Semester IV				
Theory/DC	PSSM0034	Statistical Mechanics	4	674
Theory/DC	PSAM0028	Atomic and Molecular Physics	4	673
Theory/DC	PSPR6018	Project Phase II	3	695
Theory/DC	PSST6016	Study Tour	P/NP	
	Specialisation: High Energy Physics			
Theory/DE	PSEP0053	High Energy Physics II	4	685

Theory/DE	PSGR0044	General Theory of Relativity and Cosmology	4	678
	Specialisation: Astrophysics			
Theory/DE	PSAR0045	Astrophysics	4	679
Theory/DE	PSGR0044	General Theory of Relativity and Cosmology	4	678
	Specialisation: Plasma Physics			
Theory/DE	PSPM0046	Plasma Physics II	4	679
Theory/DE	PSPM6013	Plasma Physics Laboratory	4	693
	Specialisation: Electronics			
Theory/DE	PSER0047	Electronics III	4	680
Theory/DE	PSEL6014	Electronics Laboratory	4	693
	Specialisation: Nanophysics			
Theory/DE	PSNY0048	Nanophysics III	4	681
Theory/DE	PSNY6015	Nanophysics Laboratory	4	694
Total Credits			19	
Total Programme Credits			81	

Note: Mandatory Course EDPC0201: Indian Polity and Constitution

SCHOOL OF FUNDAMENTAL AND APPLIED SCIENCES
DETAILED SYLLABUS
DEPARTMENT OF CHEMISTRY

VISION:

To produce competent chemistry graduates through dedicated teaching in classrooms, through labs and research, who can contribute meaningfully to society while fulfilling their ambitions in academia, research or industry.

MISSION:

The objective of the department is to provide dedicated guidance and support to students to equip them with a sound understanding of the fundamentals of chemistry

- to enable them to explore the diverse and hitherto unexplored resources of the north-eastern region
- to make significant contributions to fundamental and socially relevant research in the frontiers ofchemistry
- to help them generate their ideas and provide them the knowhow to convert them into reality

PROGRAM OUTCOMES – MSC PROGRAMME

PO 1: **Critical Thinking**: Inculcate critical thinking to carry out scientific investigation objectively. Formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. Critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.

PO 2: **Knowledge Skil**l: Equip the student with skills to analyse problems, formulate an hypothesis, evaluate and validate results, and draw reasonable conclusions thereof. Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems , rather than replicate curriculum content knowledge .

PO 3: **Scientific Communication Skills**: Imbibe effective scientific and / or technical communication in both oral and writing. Ability to show the importance of the subject as precursor to various scientific developments since the beginning of the civilization.

PO 4: **Ethics**: Continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in the subject concerned .Ability to identify unethical behavior such as fabrication, falsification or misrepresentation of data and adoptive objective , unbiased and truthful actions in all aspects .

PO 5: **Enlightened Citizenship**: Create awareness to become an enlightened citizen with commitment to deliver one's responsibilities within the scope of bestowed rights and privileges

PO 6: **Analytical Reasoning**: Ability to evaluate the reliability and relevance of evidence;identify logical flaws and holes in the arguments of others; analyse and synthesise data from a variety of sources; draw valid conclusions andsupport them with evidence and examples, and addressing opposing viewpoints.

PO 7: **Multicultural Competence**: Development of a set of competencies in order to enhance and promote the growth of multicultural sensitivity within universities. Integrating multicultural awareness such as race, gender, physical ability, age, income and other social variables, and by creating an environment that is , "welcoming for allstudents" .

PO 8: **Lifelong Learning**: Ability to think, acquire knowledge and skills through logical reasoning and to inculcatethe habit of self-learning throughout life, through self- paced and self- directed learning aimed at personal development, and adapting to changing academic demands of work place through knowledge/ skill development/reskilling .

PO 9: **Leadership Qualities**: Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination in a smooth and efficient way.

PO 10: **Research Skills**: Prepare students for pursuing research or careers in industry in concerned subject and allied fields. Capability to use appropriate software to solve various problems and to apply programming concepts of C++ and Mathematica/Matlab to various scientific investigations , problem solving and interpretation

PROGRAMME SPECIFIC OUTCOMES FOR MSC CHEMISTRY

PSO 1: **Scientific Problem solving skills:** Deep knowledge of the topic which can develop the problem solving skills using chemical principles.

PSO 2: **Analytical skills:** Develop analytical skills such as synthesizing, separating, characterizing chemical compounds and chemical reaction with the help of sophisticated instruments.

PSO 3: **Research skil**ls: Develop research skills through dissertation/Project work in different fields of chemistrysuch as organic, nanoscience, analytical, physical etc.

PSO 4: **Learning skills on life processes:** Acquire advanced level of knowledge in natural products as well asbiological system from the chemistry point of view.

COURSES OFFERED IN MSC CHEMISTRY

Sl. No.	Course Name
1.1	Fundamentals of Inorganic Chemistry
1.2	Fundamentals of Organic Chemistry
1.3	Fundamentals of Physical Chemistry
1.4	Introduction to Quantum Chemistry and Group Theory
1.5	Inorganic Qualitative and Quantitative Analyses and Preparations - Lab
1.6	Value Added Course
2.1	Advanced Inorganic Chemistry I
2.2	Advanced Organic Chemistry I
2.3	Advanced Physical Chemistry I
2.4	Fundamentals of Spectroscopy
2.5	Introduction to Green and Environmental Chemistry
2.6	Experimental Physical Chemistry - Lab
2.7	Service learning
2.8	Value Added Course
3.1	Advanced Inorganic Chemistry II
3.3	Advanced Organic Chemistry II
3.3	Advanced Physical Chemistry II
3.4	Special Topics in Biochemistry
3.5	Applied Spectroscopy
3.6	Research Methodology for Chemistry
3.7	Organic Qualitative Analysis and Synthesis Lab
3.8	Value Added Course
4.1.1	Materials Chemistry
4.1.2	Computational Chemistry
4.1.3	Food Chemistry
4.1.4	Industrial Chemistry
4.1.5	Medicinal Chemistry
4.2.1	Organometallic Chemistry
4.2.2	Inorganic Rings, Clusters and Polymers
4.3.1	Recent Advances in Catalysis
4.3.2	Biophysical Chemistry
4.4.1	Heterocyclic Chemistry
4.4.2	Natural Products Chemistry
4.5	Research Project
4.6	Value Added Course

MSC Chemistry- Mapping of Courses to PO/PSO

Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO1	PSO2	PSO3	PSO4
1.1	H	H	H	M		H		H			H		L	
1.2	H	H	H			H		H			H		L	
1.3	H	H	H			H		H			H		L	
1.4	H	H	H			H		H			H		L	
1.5	H	M	H	H		H		M		M	H	H	H	
1.6		L				M		M	M	H	M	H	M	
2.1	H	H	H	M		H		H			H		L	
2.2	H	H	H	M		H		H			H		L	
2.3	H	H	H	M		H		H			H		L	
2.4	H	H	H	M		H		H		L	H	L	M	
2.5	H	M	H	M	M	M		H			M	L	L	
2.6	H	M	H	H		H		M		M	H	H	H	
2.7	M	M	H	L	H		H	H	H		L		L	
2.8		L				M		M	M	H	M	H	M	
3.1	H	H	H	M		H		H			H		L	M
3.2	H	H	H	M		H		H			H		L	M
3.3	H	H	H	M		H		H			H		L	L
3.4	H	H	H	M		H		H			H		L	H
3.5	H	H	H	H		H		H		M	H	L	H	L
3.6	H	H	H	H	L	H		H		H	M		H	
3.7	H	M	H	M		H		M		M	H	H	M	
3.8		L				M		M	M	H	M	H	M	
4.1.1	H	H	H	M		H		H			M		M	
4.1.2	H	H	H	M		H		H			M	M	M	
4.1.3	H	H	H	M		H		H			M		M	L
4.1.4	H	H	H	M		H		H			M		M	
4.1.5	H	H	H	M		H		H			M		M	L
4.2.1	H	H	H	M		H		H		M	M		H	
4.2.2	H	H	H	M		H		H		M	M		H	
4.3.1	H	H	H	M		H		H		M	M		H	

4.3.2	H	H	H	M		H		H		M	M		H	H
4.4.1	H	H	H	M		H		H		M	M		H	H
4.4.2	H	H	H	M		H		H		M	M		H	H
4. 5	H	H	H	H	M	H		H		H	M	H	H	M
4.6		L				M		M	M	H	M	H	M	

THEORY COURSES

CHIC0003: Fundamentals of Inorganic Chemistry

(4-0-0)

Course Outcomes

CO 1: Recall the fundamental concepts associated with hard and soft acids and bases. (Remembering)
CO 2: Explain the general characteristics and applications of coordination compounds. (Understanding)
CO 3: Make use of the electronic spectra to understand the electronic transition in coordination complexes. (Applying)
CO 4: Analyse the Metal-ligand bonding in transition metal complexes. (Analysing)
CO 5: Explain the Magnetic properties of transition metal complexes. (Evaluating)
CO 6: Design complexes of transition metal and predict their electronic and magnetic properties. (Creating)

Module I: Concepts of Acids and bases (10 lectures)

Hard and soft acid-base concept, non-aqueous solvents, redox chemistry.

Module II: Transition Metal Chemistry (8 lectures)

Descriptive chemistry of transition metals including lanthanides and actinides, coordination chemistry - coordination number and geometry, isomerism, thermodynamic stability - successive and overall stability constants, Irving-William series, chelate and macrocyclic effects.

Module III: Bonding in Inorganic and Coordination Compounds (20 lectures)

VBT (hybridization), CFT and their limitations, ligand field theory, d-orbital wave functions, d-orbital splitting in octahedral, square planar, square pyramidal, trigonal bipyramidal, and tetrahedral complexes; Jahn-Teller distortion, CFSE for d1 to d10 systems, pairing energy, low-spin and high-spin complexes and molecular orbital (MO) theory of selected octahedral, tetrahedral complexes and other geometries, Walsh Diagram.

Module IV: Electronic Spectra of Transition Metal Complexes (12 lectures)

d-d transition, charge transfer transition, color, intensity and origin of spectra, interpretation, term symbols and splitting of terms different geometries, selection rules for electronic transitions, correlation, Tanabe-Sugano and Orgel diagrams, calculation of Dq, B and C, nephelauxetic ratio.

Module V: Magnetic Properties of Transition Metal Complexes (10 lectures)

Magnetic properties of free ions, types of magnetic behavior: dia-, para-, ferro- and antiferro-magnetism, temperature independent paramagnetism, magnetic susceptibility - Van Vleck equation, experimental measurement, magnetic moment - orbital contribution, quenching of contribution, effect of spin orbit coupling, spin crossover, temperature dependence of magnetic susceptibility, exchange coupling effects, magnetic properties of second and third transition series and lanthanides.

Suggested Readings

1. Inorganic Chemistry: Principles of Structure and Reactivity, J. E. Huheey, E. A. Keiter and R. L. Keiter, Pearson Education.
2. Ligand Field theory and its Applications, B. N. Figgis and M. A. Hitchman, Wiley India.
3. Inorganic Chemistry, G. L. Miessler and D. Tarr, Pearson Education.
4. Inorganic Chemistry, P.W. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, Oxford UniversityPress.
5. Fundamental Concepts of Inorganic Chemistry, Vols. 1-7, A. K. Das and M. Das, CBS Publishers and Distributors.
6. Essentials of Nuclear Chemistry, H. J. Arnikar, Wiley Eastern, New Delhi.
7. Advanced Inorganic Chemistry, F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, Wiley.
8. Inorganic Chemistry, C. E. Housecroft and A. G. Sharpe, Prentice Hall.
9. Chemical Applications of Group Theory, F. A. Cotton, Wiley.
10. Lanthanide and Actinide Chemistry, S. A. Cotton, John Wiley.
11. Nuclear and Radiochemistry, G. Fridlander, J.W. Kennedy, E. S. Macias and J. M. Miller, John Wiley, New York.
12. Inorganic Chemistry, M. Weller, F. Armstrong, J. Rourke and T. Overton, Oxford University Press.
13. Elements of Magnetochemistry, R. L. Dutta and A. Syamal, Affiliated East-West Press Pvt. Ltd.-New Delhi.
14. Magnetism and Transition Metal Complexes, F. E. Mabbs and D. J. Machin, Dover Pub. Inc.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H	M	L	
CO 3				H	
CO 4			H		
CO 5		L			H

CO 6				H	M

CHOC0004: Fundamentals of Organic Chemistry

(4-0-0)

Course Outcomes

CO 1: Recall various concepts associated with the kinetics of organic reaction mechanisms. (Remembering)

CO 2: Explain the generation and application of different reaction intermediates in organic synthesis. (Understanding)

CO 3: Analyse Point group of organic molecules and their connection with optical activity. (Analysing)

CO 4: Determine the absolute or relative configuration of chiral organic molecules and design asymmetric synthesis. (Evaluating)

CO 5: Predict the stereochemistry of the product of different reactions. (Creating)

Module I: Kinetics and Energetics of Reaction Mechanism (15 lectures)

Transition state theory of reaction rates - kinetics and thermodynamics of activation, reaction profiles for multistep reactions, Hammond postulate, Curtin-Hammett Principle, kinetic and thermodynamic control, Linear free energy relationships (LFER), Hammett equation - substituent and reaction constants, the Taft treatment of polar and steric effects in aliphatic compounds, kinetic isotope effects in organic reactions, effects of conformation on reactivity, stereoelectronic effects, neighbouring group participation, anomeric effect.

Module II: Reaction Mechanisms and Intermediates (Structure and Reactivity) - I (15 lectures)

a. Carbanions: enolates and enamines, kinetic and thermodynamic enolates, lithium and boron enolates in Aldol and Michael reactions, alkylation and acylation of enolates, name reactions under carbanion chemistry - Claisen, Dieckmann, Knoevenegal, Stobbe, Darzen, Acyloin condensations, Shapiro reaction, Julia olefination, Brook rearrangement, Sakurai reaction, Henry reaction, Kulinkovich reaction, Nef reaction, Baylis-Hillman reaction.

b. Ylids: Chemistry of phosphorous and sulfur ylids - Wittig and related reactions, Peterson olefination.

c. Carbocations: structure and stability of carbocations, classical and non-classical carbocations, neighbouring group participation and rearrangements including Wagner-Meerwein, pinacol-pinacolone, semi-pinacol rearrangement, C-C bond formation involving carbocations, oxymercuration, halolactonisation, Tishchenko reaction, Ritter reaction, Prins reaction.

Module III: Reaction Mechanisms and Intermediates (Structure and Reactivity) – II (15 lectures)

a. Carbenes and Nitrenes: Structure of carbenes, generation of carbenes, addition and insertion reactions, rearrangement reactions of carbenes such as Wolff rearrangement, generation and reactions of ylids by carbenoid decomposition (existence of O and N based ylids), Structure of nitrene, generation and reactions of nitrene and related electron deficient nitrogen intermediates, Curtius, Hoffmann, Schmidt, Beckmann rearrangement, structure and reactivity of benzynes.

b. Radicals: Generation of radical intermediates and its addition to alkenes, alkynes (inter &intramolecular) for C-C bond formation and Baldwin’s rules, name reactions involving radical intermediates such as Barton deoxygenation and decarboxylation, Mc Murry coupling.

Module IV: Stereochemistry (15 lectures)

a. Classification of organic molecules into different Point Groups, R and S, E and Z nomenclature in C, N, S, P containing compounds, concept of absolute and relative configuration, chirality in molecules devoid of chiral centres - allenes, spiranes and biphenyls.

b. Concepts of stereogenic centres – chirotopic and achirotopic centres, homotopic and heterotopic ligands and faces, optical purity and enantiomeric excess, conformation of acyclic organic molecules, cyclohexane and decalins.

c. Dynamic stereochemistry, stereoselective synthesis, classification of stereoselective synthesis, diastereoselective, enantioselective and double stereo-differentiating reactions, nucleophilic addition to aldehyde and acyclic ketones, Prelog’s rule, nucleophilic addition to cyclic ketones.

d. Enantioselective synthesis, use of chiral reagent, chiral catalyst and chiral auxiliary, stereospecific and stereoselective reactions.

Suggested Readings

1. Advanced Organic Chemistry, Part A and B, F. A. Cary and R. I. Sundberg, Springer.
2. Stereoelectronic Effects, A. J. Kirby, OUP.
3. Modern methods of Organic Synthesis, W. Carruthers and I. Coldham, Cambridge University Press.
4. Mechanism and Theory in Organic Chemistry, T. H. Lowry and K. S. Richardson.
5. Organic Chemistry, J. Clayden, N. Greeves and S. Warren.
6. Modern Physical Organic Chemistry, E. V. Anslyn and D. A. Dougherty, University Science Books.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H	H	
CO 3				H
CO 4				H
CO 5		H	H	L

CHPC0005: Fundamentals of Physical Chemistry

(4-0-0)

Course Outcomes

CO 1: Explain the laws of thermodynamics. (Understanding)
CO 2: Explain the methods to determine the properties of polymers. (Understanding)
CO 3: Explain the various terms involved in data analysis. (Understanding)
CO 4: Apply the laws of thermodynamics and kinetics of polymerization to solve problems. (Applying)
CO 5: Distinguish between different types of systems, polymers and various statistical parameters. (Analysing).
CO 6: Calculate the sizes of polymer molecules and analyses the results of different chemical experiments from thestatistical point of view. (Evaluating)

Module I: Equilibrium and Non-Equilibrium Thermodynamics (22 lectures)

a. Laws of thermodynamics, state and path functions and their applications, Maxwell ‘s relations, spontaneity and equilibria, Le Chatelier principle.
b. Non-ideal system - thermodynamics of real gases and gas mixtures, fugacity and its determination, non-ideal solutions, activity and activity coefficient, different scales of activity coefficient, electronic activity coefficients.
c. Phase equilibrium - thermodynamic criteria of phase equilibrium, Gibbs phase rule and its application to three component systems- triangular plots - water-acetic acid-chloroform system and ammonium chloride-ammonium sulphate-water system.
d. Non-equilibrium thermodynamics - forced flows and entropy of production, coupled flows and phenomenological relations, Onsager reciprocal relations, thermodynamic effects-Seebeck, Peltier and Thomson effects.

Module II: Statistical Thermodynamics (22 lectures)

a. Statistical mechanics of systems independent particles - Maxwell Boltzmann distribution, entropy and probability, calculation of thermodynamic properties for independent particles, molecular partition functions, evaluation of translational, rotational and vibrational and nuclear partition functions.
b. Thermodynamic properties of monatomic and diatomic gases (Suckur Tetrode equation), calculation of partition functions, thermodynamic function, principles of equipartition, heat capacities (Einstein model and Debye modification), residual entropy, equilibrium constant.

Module III: Polymer Chemistry (8 lectures)

Molecular weight of polymers, determination of molecular weight, kinetics of polymerization reaction, copolymerization, average dimension of polymer molecules, size exclusion chromatography.

Module IV: Sampling and Data Analysis (8 lectures)

Sampling of solid, liquid and gaseous samples, mean and standard deviation, absolute and relative errors, linear regression, covariance and correlation coefficient.

Suggested Readings

1. Physical Chemistry, P. Atkins and J. Paula, Oxford University Press.
2. Physical chemistry, I. R. Levine, Mcgraw Hill Education.
3. Physical Chemistry: A Molecular Approach, D. A. McQuarrie and J. D. Simon, Viva Student Edition.
4. Physical Chemistry, R. S. Berry, S. A. Rice and J. Ross, Oxford University Press.
5. Statistical Mechanics, D. A. McQuarrie, University Science Books, California.
6. Vogel’s Textbook of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas and B. Sivasankar, Pearson.
7. Polymer Science, V. R. Gowarikar, N. V. Viwanathan and J. Sreedhar, New age International Publishers.
8. Principles of Polymerization, G. Odian, Willy Student Edition.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	M			

CO 2	M		M	
CO 3				H
CO 4	M	H	M	
CO 5		H	M	
CO 6			H	

CHIR0007: Advanced Inorganic Chemistry I

(4-0-0)

Course Outcomes

CO 1: Recall the concepts of organometallic chemistry. (Remembering)
CO 2: Illustrate the photochemistry of different inorganic compounds. (Understanding)
CO 3: Select the inorganic compounds for their suitable analytical and industrial use. (Applying)
CO 4: Analyse the structure, bonding and synthesis of some inorganic compounds. (Analysing)
CO 5: Explain the bonding in solid-state chemistry. (Evaluating)
CO 6: Discuss the mechanism of Inorganic reactions. (Creating)

Module I: Descriptive Inorganic Chemistry (20 lectures)

a. Structure and bonding in polyhedral boranes and carboranes, styx notation, Wade's rules, electron count in polyhedral boranes, synthesis of polyhedral boranes, isolobal analogy, boron halides, phosphine-boranes, boron heterocycles, borazine.
b. Silanes, silicon halides, silicates, silicones, silanols, zeolites, germanium, tin and lead organyls, silenes, germenes, stannenes, phosphorous halides, phosphazenes, sulphur halides, structural features and reactivity of S-N heterocycles.
c. Synthesis and reactivity of organo-lithium, beryllium and magnesium compounds, calixarines, cryptands and crown ethers in complexation chemistry.
d. Preparation and reactivity of aluminium organyls, carbalumination, hydro alumination, chemistry of Ga (I) and In (I), reduction of Al, Ga and In organyls, Metal organic framework structures (MOFs).

Module II: Introduction to Solid State Chemistry (10 lectures)

Structure of simple solids – metals, alloys and compounds; common structure types; synthesis of solid state compounds - ceramic method, microwave synthesis, sol-gel, precursor method, hydrothermal synthesis, CVD and intercalation; characterization of solids, bonding in solids – free-electron and molecular orbital theory; bands in solid state compounds, properties of solids – optical, magnetic and electrical properties of solids.

Module III: Organometallic Chemistry (15 lectures)

a. Valence electron count (16/18 electron rules), synthesis, structure, bonding and reactivity of mono and polynuclear
b. metal carbonyls, substituted metal carbonyls, vibrational spectra of metal carbonyls, metal-metal bonding.
c. Types of M-C bonds, synthesis and reactivity of metal alkyls, carbenes, alkenes, alkynes, and arene complexes, metallocenes and bent metallocenes, isolobal analogy.
d. Reactions of organometallic complexes: Substitution, oxidative addition, reductive elimination, insertion and de insertion, catalysis, hydrogenation, hydroformylation, Monsanto process, Wacker process, alkene polymerization.

Module IV: Mechanism of Inorganic Reactions (10 lectures)

Substitution in octahedral and square planar complexes, lability, trans-effect, conjugate base mechanism, racemisation, electron transfer reactions - inertness and lability, inner sphere and outer sphere mechanism, Marcus theory, solid state reactions – topotactic and epitactic mechanisms.

Module V: Inorganic Photochemistry (5 lectures)

Photosubstitution and photoredox reactions of chromium, cobalt and ruthenium compounds, Ligand field and charge transfer state (Thexi and DOSENCO states), cis-trans isomerization, photocatalysis and solar energy conservation by ruthenium complexes.

Suggested Readings

1. Advanced Inorganic Chemistry, F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, Wiley.
2. Chemistry of elements, N. N. Greenwood and E. A. Earnshaw, Butterworth-Heinemann.
3. Inorganic Chemistry: Principles of Structure and Reactivity, J. E. Huheey, E. A. Keiter and R. L. Keiter, PearsonEducation.
4. Inorganic.Chemistry, G. L. Miessler and D. Tarr, Pearson Education.
5. Inorganic Chemistry, P.W. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, Oxford UniversityPress.
6. Concepts and Models of Inorganic Chemistry, B. E. Douglas, D. H. McDaniel and J. J. Alexander, John Wiley.
7. Inorganic Chemistry, G. Wulfsberg, University Science Books.
8. Solid State Chemistry: An Introduction, L. Smart, E. Moore, Nelson Thorns Ltd.

9. Fundamental Concepts of Inorganic Chemistry, A. K. Das and M. Das, CBS Publishers and Distributors.
10. Organometallic Chemistry of the Transition Metals, R. H. Crabtree, John Wiley.
11. Mechanisms of Inorganic Reactions, F. Basalo and R. G. Pearson, John Wiley

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1			H		
CO 2					H
CO 3	L	L	M		
CO 4	H			L	
CO 5		H			
CO 6				H	

CHOG0008: Advanced Organic Chemistry-I

Course Outcomes

CO 1: Recall nucleophilic and electrophilic substitution reactions and the factors related to the rate of these reactions. (Remembering)
CO 2: Explain the stereo chemical aspects and mechanism of elimination reactions. (Understanding)
CO 3: Apply the practical utility of metal and metal-free oxidising agents in organic synthesis. (Applying)
CO 4: Compare various kinds of reducing agents in chemo selective and stereo selective synthesis. (Analysing)
CO 5: Select name reactions for constructing compounds having industrial and academic importance. (Evaluating)

Module I (15 lectures)

a. **Nucleophilic Substitution**: S_N1, S_N2 and related mechanisms; Factors influencing reaction rates; Neighboring group participation by π- and σ-bond; Anchimeric assistance; Aromatic Nucleophilic Substitution: The SNAr, S_N1, benzyne and SR_N1 mechanisms. Reactivity; effect of substrate structure, leaving group and attacking nucleophile; The S_Ni mechanism. Nucleophilic substitution at an allylic, aliphatic trigonal and a vinyl carbon. Aromaticity, antiaromaticity and homoaromaticity.

b. **Electrophilic Substitution**: Aliphatic: Bimolecular mechanisms: SE1, SE2 and SEi. The SE1mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity. Aromatic: The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems.

Module II (15 lectures)

a. **Elimination reactions**: Mechanism and stereochemistry of different types of elimination reactions; Effects of substrate structure, attacking base, leaving group and medium; Formation of other double bonds (C=N, C=O) and triple bonds by elimination reactions; Mechanism and orientation in pyrolytic elimination.

b. **Miscellaneous Reactions:** Biginelli reaction, Passerini reaction, Nazarov cyclisation, Pd-catalyzed reactions, Vilsmeier Hack reaction, Ugi reaction, Robbinson annulations, Mitsonobu reaction, Appel reaction, Favoriskii rearrangement.

Module III: Oxidation Reactions (15 lectures)

Metal and non-metal based oxidations (Cr, Mn, Al, Ag, Os, Ru, Se, DMSO, hypervalent iodine), reagents (Fremy's salt, silver carbonate, peroxides/per-acids), Sharpless asymmetric epoxidation, Jacobsen epoxidation, Shi epoxidation, Sharpless asymmetric dihydroxylation, Baeyer-Villiger oxidation, Wacker oxidation, hydroboration-oxidation, Prevost reaction and Woodward modification.

Module IV: Reduction Reactions (15 lectures)

Catalytic hydrogenation (Pd/Pt/Rh/Ni), Wilkinson catalyst, Noyori asymmetric hydrogenation, metal based reductions using Li/Na/Ca in liquid ammonia, Sodium, Magnesium, Zinc, Titanium and Samarium (Birch, Pinacol formation, McMurry, Acyloin formation, dehalogenation and deoxygenations), Hydride transfer reagents from Group III and Group IV in reductions ($NaBH_4$triacetoxyborohydride, L-selectride, K-selectride, Luche reduction, $LiAlH_4$, DIBAL-H, and Red-Al, Trialkylsilanes and Trialkylstannane, Meerwein-Pondorff-Verley reduction), stereo/enantioselective reductions (Chiral Boranes, Corey-Bakshi-Shibata).

Suggested Readings

1. Advanced Organic Chemistry, Part A and B, F. A. Cary and R. I. Sundberg, Springer.
2. Organic Synthesis, M. B. Smith, Academic Press.
3. Modern Methods of Organic Synthesis, W. Carruthers and I. Coldham, Cambridge University Press.
4. Organic Chemistry, J. Clayden, N. Greeves and S. Warren. Oxford University Press.
5. Organic Chemistry, S. H. Pine, McGraw-Hill Bool.

6. Advanced Organic Chemistry: Reactions, Mechanisms and Structure (4th edn.), J. March, Wiley Student Edition, John Wiley & Sons Asia Pte. Ltd.
7. Modern Synthetic Reaction, H. O. House, W. A. Benjamin Inc.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		
CO 3			H	
CO 4				H
CO 5	L	H	H	H

CHAP0009: Advanced Physical Chemistry I

(4-0-0)

Course Outcomes

CO 1: Recall the kinetics of different types of chemical reactions. (Remembering)
CO 2: Explain the interactions of ionic species with solvent molecules. (Understanding)
CO 3: Apply the knowledge of chemical kinetics to some important types of reactions. (Applying)
CO 4: Analyse the application of electrochemistry in different fields. (Analysing)
CO 5: Calculate the rate of different types of chemical reactions. (Evaluating)

Module I: Chemical Kinetics (15 lectures)

Theories of unimolecular reactions: Lindemann theory, drawbacks of Lindemann theory- Hinshelwood modification, RRK theory, Slaters treatment, RRKM theory. Steady state approximation and its applications, oscillating reactions, chemical chaos, Belousov-Zhabotinski reaction, straight chain reactions - hydrogen-halogen reactions, alkane pyrolysis, Branching- chain reactions - the hydrogen-oxygen reaction, explosion limits, Enzyme catalyzed reactions, Michaelis-Menten mechanism-Lineweaver-Burk and Eadie plots, enzyme inhibiton.

Module II: Study of Fast Reactions (5 lectures)

Stopped flow technique, temperature and pressure jump methods, NMR studies in fast reactions, shock tube kinetics, relaxation kinetics, Linearized rate equation, relaxation time in single step fast reactions, determination of relaxation time.

Module III: Molecular Reaction Dynamics (15 lectures)

Collisions of real molecules- trajectory calculations, Laser techniques, reactions in molecular beam, reaction dynamics, estimation of activation energy and calculation of potential energy surface- the transition state theory (TST) of bimolecular gaseous reactions, statistical and thermodynamic formulations. Comparison between TST and hard sphere collision theory, theory of unimolecular reactions- Lindemann theory and its limitations, kinetics of reactions in solution-diffusion controlled and chemically controlled reactions, TST of reactions in solution- Bronsted and Bjerrum equation, effect of ionic strength, kinetic salt effect.

Module IV: Electrochemistry - I (10 lectures)

a. Ion-solvent interaction- the Born model, Thermodynamic parameters of ion solvent interactions- structural treatment, the ion-dipole model-its modifications, ion-quadrupole and ion-induced dipole interactions.
b. Primary solution- determination of hydration number, compressibility method and viscosity-mobility method, Debye-Huckel theory of ion-ion interactions, derivation, validity and limitations, extended Debye-Huckel-Onsager equation, random walk model of ionic Diffusion-Einstein Smoluchowski reaction.

Module V: Electrochemistry – II (15 lectures)

a. **Theories of Electrical Interface:** Electrocapillary phenomena - Lippmann equation, electron transfer at interfaces, polarizable, non-polarizable and non-polarisable interfaces, Butler-Volmer equation, Tafel plot.
b. **Electro-analytical Techniques:** Potential step methods, potential sweep methods, Polarography and Pulse voltammetry, controlled current techniques, techniques based on impedance.
c. **Systems for Electro-Chemical Energy Storage and Conversion**: Types of Batteries, Lead- acid batteries, Nickel-cadmium batteries and Li-ion batteries, electrical double layer capacitor, pseudo-capacitor, fuel cells.

Suggested Readings

1. Physical Chemistry, P. Atkins and J. Paula, Oxford University Press, Oxford.
2. Physical chemistry, I. R. Levine, Mcgraw Hill Education.
3. Chemical Kinetics, K. J. Laidler, Pearson.
4. Modern Electrochemistry Part 1, 2A and 2B, J. O. Bockris and A. K. N. Reddy, Springer.
5. Electrochemical Methods Fundamentals and Applications, J. Bard and L. R. Faulkner, Willy India.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M			
CO 2				H	M
CO 3	H	M	M		
CO 4				L	H
CO 5	M	M			

CHGC0011: An Introduction to Environmental and Green Chemistry

Course Outcomes

CO 1: Recall the basic concepts of green chemistry. (Remembering)
CO 2: Explain the principles of green chemistry, green reaction conditions, renewable sources of energy etc.(Understanding)
CO 3: Apply the concept of green chemistry in the applied research field. (Applying)
CO 4: Analyse and solve the problems related to the environment. (Analysing)
CO 5: Identify the causes of environmental degradation and find solutions for its protection. (Applying)

Module I: Environmental pollution (15 lectures)
Chemistry and environmental pollution: Chemical hazards, chemical disasters, Water pollution, air pollution and soil pollution; agricultural pollution, pollution by plastics; environmental biochemistry, toxicological chemistry, e-pollution and nuclear hazard.Environmental analysis: Analysis of water and wastewater, solid-wastes and air pollution.

Module II: Environmental protection (10 lectures)
Environmental protection: pollution prevention, green chemistry, biodegradation, water and wastewater purification – removal of arsenic, iron, fluoride, etc.; air purification, waste minimization, industrial and municipal waste treatment and soil remediation.

Module III: Principles and concepts of Green Chemistry (10 lectures)
Green chemistry: Principles of green chemistry, development of green chemistry; atom economy reactions – rearrangement reactions, addition reactions; atom uneconomic reactions–sublimation, elimination; toxicity measures, need of green chemistry in day-to-day life.

Module IV: Emerging Green Technology and alternative energy sources (10 lectures)
Design for energy efficiency, photochemical reactions – advantages, disadvantages; microwave technology in chemistry - microwave heating, microwave assisted reactions, ultrasound assisted reactions, reactions in organic liquids, reactions in aqueous media, electrochemical synthesis- examples. Supercritical solvents, ionic liquids, green catalyst, auto-exhaust catalyst and clean technology. Real world examples.

Suggested Readings

1. Environmental Chemistry, S. E. Manahan, CRC Press, Boca Raton.
2. Green Chemistry: Theory and Practice, P. T. Anastas and J. C. Warner, Oxford University Press.
3. Environmental Chemistry, J. W. Moore and E. A. Moore, Academic Press, London.
4. Green Chemistry: An Introductory Text, M. Lancaster, RSC.
5. Handbook of Environmental Chemistry, O. Hutzinger, Springer-Verlag.
6. M. C. Cann and M. E. Connelly, Real World Cases in Green Chemistry, ACS.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1			H	M
CO 2			H	H
CO 3			M	H
CO 4	H	H		
CO 5	H	H		

CHAI0012: Advanced Inorganic Chemistry II

(4-0-0)

Course Outcomes

1. Recall the concepts of analytical techniques used in inorganic analysis. (Remembering)
2. Illustrate the role of metal ions in the function of biological macromolecules. (Understanding)
3. Apply the special Analytical Techniques for the characterization of inorganic compounds. (Applying)

4. Analyse the principles and application of Nuclear and Radiochemistry. (Analysing)
5. Explain the nature of supramolecular interactions. (Evaluating)
6. Develop a fundamental knowledge of nanomaterials. (Creating)

Module I: Special Analytical Techniques (25 lectures)

a. Principles and applications of Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Spectroscopy (EDS/EDX), Transmission Electron Microscopy (TEM), Selected Area (Electron) Diffraction (SAED), Thermal methods of analysis – thermogravimetric analysis (TGA), Differential Thermal Analysis (DTA), Differential Thermogravimetry (DTG), Differential Scanning Calorimetry (DSC), Powder X-ray Diffraction, Single crystal X-ray diffraction.
b. Principles and applications of atomic absorption spectroscopy, atomic emission spectroscopy, Infrared and Raman Spectroscopy, Magnetic Resonance Spectroscopy- Electron Spin Resonance (ESR) of d^1 and d^9 transition metal ions in cubic and tetragonal ligand fields, applications of ^{31}P, ^{19}F, ^{119}Sn and ^{195}Pt nuclear magnetic resonance (NMR) spectroscopy.

Module II: Bioinorganic Chemistry (15 lectures)

Role of metal ions in biology and their toxic effects; Iron management in biological systems– siderophores, ferritin and transferrin; Dioxygen storage and transport – structure of myoglobin and haemoglobin, cooperativity of O_2 binding in haemoglobin, Bohr effect and Hill coefficients; Electron transfer proteins (structure and function) - Fe-S proteins, cytochromes and plastocyanines; Structure of nitrogenase and its role in di-nitrogen fixation; Structure and function of vitamin B_{12} and mechanism of 1,2-shift reaction; Inorganic therapeutics - chelate therapy, metal based drugs.

Module III: Introduction to Supramolecular Chemistry (5 lectures)

Supramolecular chemistry: Definition, supramolecular host-guest compounds, macrocyclic effect, nature of supramolecular interactions.

Module IV: Introduction to Nanomaterials (5 lectures)

Fabrication of nanomaterials – top-down and bottom-up approaches; solution-based synthesis of nanoparticles; other methods of nanomaterial synthesis – brief overview. Carbon fullerenes and nanotubes. Applications of nanoparticles.

Module V: Nuclear and Radiochemistry (10 lectures)

Radioactive decay and equilibrium. Mass defect and binding energy, packing fraction, stability of nucleus, neutron-proton ratio, Artificial radioactivity. Nuclear reactions; Q value, cross sections, types of reactions, Chemical effects of nuclear transformations; fission and fusion, fission products and fission yields. Radioactive techniques; nuclear reactors, separation of isotopes; tracer technique, neutron activation analysis, counting techniques such as G.M. ionization and proportional counter. Application of radio-isotopes in agriculture, medicine and industry. Radiocarbon dating**.**

Suggested Readings

1. Fundamentals of Light Microscopy and Electronic Imaging, D. B. Murphy and M. W. Davidson, Wiley.
2. Transmission Electron Microscopy a Textbook for Materials Science, D. B. Williams, C. B. Carter, Springer.
3. Principles of Biochemistry, D. Nelson, A. L. Lehninger and M. M. Cox, W. H. Freeman & Co.
4. Biochemistry, R. H. Abeles, P. A. Frey and W. P. Jencks, Jones and Bartlett Publishers, Boston
5. Fundamentals of Biochemistry: Life at the Molecular Level, D. Voet, J. G. Voet and C. W. Pratt.
6. Bioinorganic Chemistry, I. Bertini, H. B. Gray, S. J. Lippard and J. S. Valentine, Viva books Pvt. Ltd.
7. Inorganic Biochemistry: An introduction, J. A. Cowan, Wiley.
8. Supramolecular chemistry, J. W. Steed and J. L. Atwood, John Wiley
9. Supramolecular Chemistry: Concepts and Perspectives, J. M. Lehn, Wiley-VCH.
10. Nanostructures and Nanomaterials: Synthesis, Properties and Applications, C. G. Zhong, Imperial College Press.
11. Nuclear and Radiochemistry, G. Friedlander, J.W. Kennedy, E. S. Macias and J. M. Miller, John Wiley, New York.
12. Perspectives in Supramolecular Chemistry and Molecular Recognition, G. R. Desiraju, Wiley.
13. Nanotechnology: A Gentle Introduction to the Next Big Idea, M. Ratner and D. Ratner, Pearson Education.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	M				
CO 2		H			
CO 3	H				
CO 4					H
CO 5			H		
CO 6				H	

CHAO0013: Advanced Organic Chemistry-II

(4-0-0)

Course Outcomes

CO 1: Recall the principles of organic photochemistry, pericyclic reactions. (Remembering)
CO 2: Explain the theories related to pericyclic reactions. (Understanding)
CO 3: Apply the knowledge of different reactions in research and industrial field. (Applying)
CO 4: Analyse the problems related to photochemistry and synthetic strategy. (Analysing)
CO 5: Demonstrate different theories in pericyclic reaction and photochemistry to check the feasibility of chemicalreactions. (Understanding)

Module I: Organic Photochemistry (15 lectures)

a. Introduction to organic photochemical-photophysical processes, chemiluminescence, photosensitization.
b. Photochemistry of carbonyl compounds - α-cleavage, β-cleavage, intramolecular H-abstraction, addition to π-systems-Paterno-Buchi reaction, electron transfer reactions, Photochemistry of olefins – photo stereomutation of cis-trans isomers, optical pumping, cycloaddition, photochemistry of conjugated polyenes. Photochemistry of enones, photo-rearrangement reactions- di-π-methane rearrangement, Photo-rearrangement of cyclohexadienones, Barton rearrangement, singlet oxygen photochemistry.

Module II: Pericyclic Reactions (15 lectures)

Main features of pericyclic reactions; Woodward-Hoffman rules, correlation diagram and FMO approaches; Electrocyclic reactions – conrotatory and disrotatory motions for 4n and 4n+2systems; Cycloadditions – antarafacial and suprafacial additions, [2+2] and [4+2] reactions (hν and Δ), 1,3-dipolar cycloadditions and chelotropic reactions; Sigmatropic[i,j] shifts of C-H and C-C bonds; Sommelet-Hauser, Claisen, thio-Claisen, Cope and aza-Cope rearrangements.

Module III: Introduction to Heterocyclic chemistry (15 lectures)

Nomenclature of heterocyclic compounds. Structure, reactivity, synthesis and reactions Pyridine, quinoline, Isoquinoline, Indole, Benzofuran, Benzothiophene, pyrazole, Imidazole, oxazole, Isoxazole, Thiazole, Isothiazole, pyridazine, pyrimidine and pyrazine.

Module IV: Synthetic Strategies (15 lectures)

Synthons and synthetic equivalents, disconnection approach, functional group inter-conversions, importance of order of events in organic synthesis, one group and two group C-X disconnections, chemo selectivity, reversal of polarity, cyclisation reactions, amine synthesis.
One group C-C disconnections – alcohols and carbonyl compounds, regioselectiviity, alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis.
Two group C-C disconnections – Diels-Alder reaction, 1,3-difunctionalised compounds, α, β-unsaturated carbonyl compounds, control in carbonyl condensations, 1,5-difunctionalised compounds, Michael addition and Robinsonannelation. Principle of protection of alcohol, amine, carbonyl and carboxyl groups; Common protecting groups.

Suggested Readings

1. Organic Chemistry, J. Clayden, N. Greeves and S. Warren, Oxford University Press.
2. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic and Professional.
3. Strategies and Tactics in Organic Synthesis 4 & 5, M. Harmata, Academic Press.
4. Modern Heterocyclic Chemistry, L. A. Paquette, John Wiley.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	H		
CO 2		H		
CO 3	M	H	H	L
CO 4	H			H
CO 5	H	H		

CHAP0014: Advanced Physical Chemistry II

(4-0-0)

Course Outcomes

CO 1: Recall the basic structure and properties of solids. (Remembering)
CO 2: Explain the electrical properties in terms of semiconductor, superconductor etc. (Understanding)
CO 3: Interpret the results of problems related to adsorption processes and electro kinetic phenomena of surfaces.(Applying)

CO 4: Analyse the process of surface adsorption and types of different catalysed reactions. (Analysing)
CO 5: Apply the properties of solids to interpret the conducting behaviour of different types of materials. (Applying)

Module I: Solid state (18 lectures)
Structures of solids - crystal planes and Miller indices, Bragg's law and applications, Debye-Scherrer powder method, nanoparticles and nanotechnology, defects in solids, thermodynamics of Schottky and Frenkel defect formation, thin films, Langmuir-Blodget film. Electrical properties of solids, intrinsic and extrinsic semiconductors, doping of semiconductors, p-n junction, super conductors, conducting polymers, organic conductors, molecular electronic devices, nonlinear optical materials, optical reflectance, photoconduction, ionic conductors, Meissner effect, BCS theory.

Module II: Surface Chemistry (22 lectures)
a. Electrical aspects of surface chemistry, Electro kinetic phenomena, the structure of electrical double layer, Zeta potential and colloidal stability, Measurement of zeta potential. Surfactants – definition and classification, micelle formation and determination of critical micelle concentration.
b. Reverse micelle and its application, solubilization, microemulsion.
c. Adsorption of gases on solid surfaces – Langmuir's theory and its limitations. Derivation of BET equation – determination of surface area of an adsorbent, thermodynamics of adsorption processes. Capillary condensation – adsorption in micro pores, Kinetics of heterogeneous catalysis – Langmuir-Hinshelwood model and Eley-Riedel mechanism.

Module III: Catalysis and Photochemistry (20 lectures)
a. Catalysts, classification of catalysts. Characterization of catalysts: Methods of surface analysis, surface area, pore size, void fraction, particle size, mechanical strength, surface chemical composition, surface acidity and reactivity. Rates of homogeneously catalysed reactions, turnover number and frequency.
b. Photochemistry - kinetics of photophysical and photochemical processes, complex photochemical processes.

Suggested Readings
1. Solid State Chemistry and its Applications, A. R. West, John Wiley.
2. Solid State Chemistry, D.K. Chakrabarty, New Age Publishers.
3. New Directions in Solid State Chemistry, C.N. R. Rao and J. Gopala Krishnan.
4. Catalytic Chemistry, B. C. Gates, John Wiley & Sons.
5. Fundamentals of Industrial Catalytic Processes, C. H. Bartholomew and R. J. Furrauto , Wiley Interscience.
6. Surfactants and Interfacial Phenomena, M. J. Rosen, John Wiley.
7. Physical Chemistry, J. P. Atkins, Oxford University Press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H		
CO 2	H		
CO 3		H	
CO 4		H	M
CO 5	H		

CHSP0015: Special Topics in Biochemistry
(3-0-0)

Course Outcomes
CO 1: Recall the characteristic, properties of carbohydrates. (Remembering)
CO 2: Explain the synthesis and biosynthesis of different biomolecules. (Understanding)
CO 3: Distinguish between the physical, chemical and biochemical properties of amino acids, proteins, peptides, enzymes etc. (Analysing)
CO 4: Explain the chemistry of nucleic acids. (Understanding)
CO 5: Explain the importance of vitamins for a living being. (understanding)

Module I: Carbohydrates (9 lectures)
Characteristics and properties of carbohydrates – nomenclature and stereochemistry of monosaccharides, typical carbohydrates, sweetening agents; chemistry of monosaccharides – cyclic structures, Haworth and conformational representations, oxidation, determination of ring size, structure of correlations, synthesis, glycosides; Oligosaccharides and Polysaccharides – sucrose and other oligosaccharides, starch, cellulose and other polysaccharides.

Module II: Lipids (9 lectures)
a. Glycerol derivatives- fats and oils, fatty acid biosynthesis, phospholipids, glycolipids, properties of lipid aggregates, micelles, bilayers, liposomes and biological membranes.

b. Steroids – structural characteristics, synthesis and biosynthesis, steroid hormones; prostaglandins – structural characteristics, synthesis and biosynthesis.
c. Pheromones – structure and origin, synthesis.

Module III: Nucleosides, Nucleotides and Nucleic acids (9 lectures)
a. Nucleosides and Nucleotides: The structure of nucleosides, chemistry of nucleosides, nucleotides; sunlight, carbohydrates and energy – photosynthesis, glycolysis and metabolic energy.
b. Nucleic acids: Structure and function of DNA, RNA (m-RNA, t-RNA, r-RNA), an overview of gene expression (replication, transcription and translation), genetic code (origin, Wobble hypothesis and other features), genetic errors, carcinogenesis and recombinant DNA technology.

Module IV: Amino acids, Peptides and Proteins (9 lectures)
a. Amino Acids – structural characteristics, acid-base properties, synthesis.
b. Peptides – amino acid analysis, terminal group analysis, the amino acid sequence, synthesis; I Proteins, enzymes and biosynthesis – the alpha-helix, other secondary and tertiary structural characteristics, enzymes; protein synthesis.

Module V: Vitamins (9 lectures)
Vitamins: Classification; occurrence; chemistry of Vitamins – structure elucidation and synthesis; biochemical functions; deficiency syndromes.

Suggested Readings
1. Organic Chemistry, S. H. Pine, J. B. Hendrickson, D. J. Cram and G. S. Hammond, McGraw Hill.
2. Organic Chemistry, J. Clayden, N. Greeves, S. Warren and P. Wothers, Oxford University Press.
3. Biochemistry, J. M. Berg, J. L. Tymoczco, G. J. Gatto and L. Stryer, W. H. Freeman & Co.
4. Biochemistry, D. Voet and J. G. Voet, John Wiley and Sons Berg.
5. Principles of Biochemistry, D. Nelson, A. L. Lehninger, M. M. Cox, W. H. Freeman & Co.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H		M	M
CO 3				H	
CO 4			H		
CO 5					H

CHRM0017: Research Methodology for Chemistry
(3-0-0)

Course Outcomes
CO 1: Explain the different methods of scientific Research. (Understanding)
CO 2: Explain how to use e-resources for research. (Understanding)
CO 3: Explain the analysis and presentation of data. (Understanding)
CO 4: Apply the knowledge of chemical safety and handle chemicals safely in the lab. (Applying)
CO 5: Construct a proposal for project funding. (Creating)

Mode of Assessment:
Modules I-II will be assessed based on a written examination (2 credits) while Module III will be assessed on the basis of a seminar (1-credit).

Module I: Methods of Scientific Research and Chemical Safety (15 lectures)
a. Print resources, digital resources, information technology and library resources, reporting practical and project work, writing literature surveys and reviews, organizing a poster display, giving an oral presentation, writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publication of scientific work; writing ethics – avoiding plagiarism.
b. Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals, overview of chemical regulations in India.

Module II: Data Analysis (15 lectures)
The Investigative Approach: Making and Recording Measurements. SI Units and their use. Scientific method and design of experiments.
Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests. Chemometrics, Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, r and its abuse. Basic aspects of multiple linear regression analysis.

Module III: Project Proposal Writing (Seminar Module) (15 lectures)
In this module, students will be reviewing scientific articles, writing reports on the papers they have read and finally prepare a research proposal.

Suggested Readings
1. Practical skills in chemistry, J. R. Dean, A. M. Jones, D. Holmes, R. Reed, J. Weyers and A. Jones, Prentice-Hall, Harlow.
2. Data analysis for chemistry, D. B. Hibbert and J. J. Gooding, Oxford University Press.
3. Errors of observation and their treatment, Fourth Ed., J. Topping, Chapman Hall, London.
4. Quantitative chemical analysis, D. C. Harris, Freeman.
5. How to use Excel in analytical chemistry and in general scientific data analysis, R. de Levie, Cambridge Univ. Press.
6. Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.
7. OSU safety manual 1.01.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H	M	M
CO 2	H		L
CO 3		H	
CO 4	H		
CO 5			H

CHMC0018: Materials Chemistry
(3-0-0)

Course Outcomes
CO 1: Recall the knowledge of the basic structure of materials. (Remembering).
CO 2: Explain how molecular structure affects the properties of materials. (Understanding)
CO 3: Explain the properties of different materials based on their structures. (Applying)
CO 4: Analyse the application of different types of materials in a different field. (Analysing).
CO 5: Predict and control material properties. (Creating)

Module I: Solid state ionic conductors (11 lectures)
Structure, physico-chemical principles, applications of Ferrous alloys, Fe-C phase transformations in ferrous alloys, non- ferrous alloys, properties and applications of ferrous and non-ferrous alloys, magnetic alloy, metallic glass, ceramics, nano- materials and optical materials.

Module II: Polymeric materials and inorganic Polymers (12 lectures)
a. Molecular shape, structure and configuration, crystallinity, stress-strain behaviour, thermal behaviour, polymer typesand their applications, conducting and ferro-electric properties.
b. Polysiloxanes, polysilanes, polyphosphazenes, polymeric sulphur - synthesis, structure, properties and applications,co-ordination polymers and organometallic polymers.

Module III: Liquid crystals and high-temperature superconductors (High-Tc or HTS) materials (12 lectures)
Nomatic, smectic, cholesteric - properties and applications, high Tc materials, defect perovskites, high Tc superconductivity in cuprates, 1-2-3 and 2-1-4 materials, anisotropy, temperature dependence of electrical resistance, optical phonon modes, superconducting state, heat capacity, coherence length, elastic constants, position lifetimes, micro-wave absorption pairing and multi gap structure in high Tc materials, applications of high Tc materials.

Module IV: Organic solids and molecular devices (10 lectures)
a. Conducting organics, organic superconductors, magnetism in organic materials, fullerenes, doped fullerenes as superconductors.
b. Molecular rectifiers and transistors, artificial photosynthetic devices, sensors, clay -polymer and carbon composites, phosphor and laser materials.

Suggested Readings

1. Principles of the Solid State, H. V. Keer, Wiley Eastern.
2. Material Science and Engineering- An Introduction, W. D. Callister, Wiley, New York.
3. Materials Science, K. D. Lever, J. M. Alexender and R. D. Rawlings, J.C. Senderson, ELBS.
4. Inorganic Polymers, J. E. Marck, H. R. Allcock and R. West, Prentice Hall.
5. Solid State Physics, N. W. Ashcroft and N. D. Mermin, Saunders College.
6. Thermotropic Liquid Crystals, G.W. Gray, John Wiley.
7. Handbook oi Liquid Crystals, K. V. Chemie Verlag.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	M	H	M	H
CO 2	H		H	
CO 3	M	M		
CO 4	M			H
CO 5		M	M	M

CHCC0019: Computational Chemistry

(3-0-0)

Course Outcomes

CO 1: Recall the programming and some numerical methods in Chemistry. (Remembering)
CO 2: Explain the molecular mechanics methods. (Understanding)
CO 3: Apply QM/MM methods in organic, inorganic and organometallic systems. (Applying)
CO 4: Explain the quantum mechanical methods. (understanding)

Module I: Programming and some numerical methods in chemistry (10 lectures)

Introduction to Linux/UNIX and shell scripts; programming in C /python; Least squares fit; root finding; numerical differentiation; integration and solution of ODE; matrix multiplication, inversion and diagonalization; interpolation; pattern recognition techniques and molecular graphics.

Module II: Molecular Mechanics (MM) Methods (10 lectures)

Basic geometrical description of molecules; force field energy, force field parameterization, differences between force fields, computational considerations, validation of force fields, advantages and limitations of force field methods, transition structure modelling, hybrid force field – electronic structure methods.

Module III: Electronic structure (or Quantum Mechanical, QM) Methods (15 lectures)

Many electron systems, Hartree-Fock method, basis sets, electron correlation and its treatment, basics of density functional theory, DFT based reactivity descriptors. Introduction to popular softwares (like Gaussian, DMol, GAMESS). Applications to simple molecular systems. Monte Carlo and molecular dynamics simulations.

Module IV: Combined QM/MM methods (10 lectures)

Implications of the choice of QM and MM methods; Application of QM/MM methods in organic, inorganic and organometallic systems including bio-organic and bio-inorganic molecules.

Quantitative structure activity relation (QSAR): Early approaches, topological indices, fragmental models; quantum mechanical descriptors.

Suggested Readings

1. Modelling Molecular Structure, A. Hinchcliffe, John Wiley and Sons.
2. Molecular Modeling Basic Principles and Applications, H. D. Holtje, W. Sippl, D. Rognan and G. Folkers , Wiley-VCH.
3. Molecular Modeling: Principles and Applications, A. R. Leach, Pearson Education.
4. Introduction to computational chemistry, F. Jensen, John Wiley and Sons Press.
5. Numerical Recipes in Fortran/C, S. A. Tenkolsky, W. T. Vetterling and P. Flannery, Cambridge University Press.
6. Python programming for the absolute beginner, Course Technology, M. Dawson, CENGAGE learning.
7. C Programing for the absolute beginner, M. Vine, Thomson Course Technology.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M	M	M
CO 2		H		
CO 3		M	M	H

CO 4			H	

CHFC0020: Food Chemistry
(3-0-0)

Course Outcomes
CO 1: Recall the relationship between food, nutrition and health. (Remembering)
CO 2: Explain the nutritional needs during the life cycle and nutritional deficiency and their prevention. (Understanding)
CO 3: Apply the knowledge of food chemistry for entrepreneurial development. (Applying)
CO 4: Explain the sources, functions of major nutritional constituents. (Analysing).
CO 5: Outline the changes in nutrition during cooking, ripening, storage of different categories of food. (understanding)
CO 6: Explain nutritional perspectives of diets. (understanding)

Module I: Basic idea of food and nutrients (2 lectures)
Relationship between food, nutrition and health; functions of food: physiological and social.

Module II: Major nutritional constituents (12 lectures)
Functions, sources, deficiency/excess diseases of the following major nutrients:(a) Carbohydrates; (b) Amino acids and proteins; (c) Lipids, sterols, metabolite; (d) Mineral; (e) Vitamins: A, D, E, K.

Module III: Different categories of food (7 lectures)
Selection, nutritional contribution and changes during Cooking/Ripening/storage of the following categories of food: (a) Cereals; (b) Pulses; (c) Fruits and vegetables; (d) Milk and milk products; (e) Egg, meat, poultry and fish; (f) Fats and oils.

Module IV: Nutritional needs during life cycle (6 lectures)
Body composition, Influence of Nutrition, Physical Activity, Growth and Aging; Maternal Nutrition, Nutritional Requirement during Infancy, Childhood; Diet, Nutrition and Adolescence; Nutrition in the Elderly.

Module V: Prevention and management of deficiencies (6 lectures)
Causes, symptoms, treatments and preventions of the following: Protein-Energy malnutrition among children; Vitamin A deficiency; Iron deficiency; Fluorosis: Over nutrition, obesity, coronary heart diseases, Diabetes (Type I & II); Diet, Nutritionand cancer.

Module VI: Dietary goals & guidelines (10 lectures)
National Perspectives; nutritional perspectives of vegetarian diets; Social Health Issues – Smoking, Alcoholism, DrugAddiction, AIDS and AIDS Control Programs; Food Preservation & Food Additives & Colorants.

Module VII: Entrepreneurship Development (2 lectures)
Scope of Food based items for Entrepreneur Development in North East India & Identification of Resources; Developmentof a Project Plan.

Suggested Readings
1. Fundamentals of Foods, Nutrition and Diet Therapy, S. R. Mudambi and M. V. Rajagopal, New Age International.
2. Nutrition Science, B. Srilakshmi, New Age International.
3. Handbook of Food and Nutrition, M. Swaminathan,BAPPCO.
4. Perspectives of Nutrition, G. M. Wardlaw and J. S. Hanpl, McGraw Hill.
5. Food Science, Nutrition and Food Safety, S. Sari, A. Malhotra, Pearson India Ltd.
6. Nutritive Value of Indian Foods, NIN, ICMR, C. Gopalan, B.V. Rama Sastri and S. C. Balasubramanian.
7. Textbook of Human Nutrition, M. S. Bamji, Oxford & IBH Pub Co Pvt Ltd.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI	Module VII
CO 1	H	M	M	M	M		
CO 2				H	H		
CO 3							H
CO 4		H	L				
CO 5				H			
CO 6						H	

CHIC0021: Industrial Chemistry
(3-0-0)

Course Outcomes
CO 1: Recall the origin, importance of elastomers. (Remembering)
CO 2: Recall the classification, limitations of synthetic fibers. (Remembering)
CO 3: Illustrate the classification and utility of fertilizers and pesticides. (Understanding)
CO 4: Compare and Analyse different chemical reactions and procedures adopted in different industries. (Analysing)
CO 5: Evaluate the challenges existing in the tea and sugar industries and suggest ways to overcome them. (Evaluating)
CO 6: Explain the classes, manufacturing of different paints. (Understanding)

Module I: Elastomers (7.5 lectures)
Rubbers: origin, importance, types of rubber, natural rubber, gutta-percha, guayle rubber, balata. Refining of crude rubber, drawbacks of natural rubber, vulcanization, technique of vulcanization. Synthetic rubber, poly butadiene, buna –S or SBR rubber, neoprene, nitrile rubber, butyl rubber, silicone rubber, & poly urethane.

Module II: Synthetic Fibres (5 lectures)
Introduction, natural and artificial fibres characteristics and limitations. Study of following synthetic fibres- Rayon (nitro cellulose) cupra ammonium rayon, acetate rayon, nylon 66, nylon-6, terylene (Dacron) Teflon & Saran.

Module III: Fertilizers and Pesticides (10 lectures)
a. Fertilizers: Plants nutrients, need for fertilizers, qualities of fertilizers, NPK ratio, classification of fertilizers, straight and mixed fertilizers. Nitrogenous fertilizers, manufacture of ammonium nitrate, urea, ammonium sulphate, phosphate fertilizers manufacture of triple phosphate and super phosphate, potassium fertilizers.
b. Pesticides: Introduction, classification, Study of the following types: - Organo chlorine pesticides like DDT, BHC and Aldrin. Organo phosphorous pesticides, malathion& parathion. Rodenticides, fungicides, herbicides, fumigants and repellants (one example each).

Module IV: Sugar and Fermentation Industries (10 lectures)
a. Sugar: Importance of sugar industry, manufacture of raw and refined sugar with flow sheet, estimation of sugar (physical and chemical methods).
b. Fermentation: Definition of fermentation, importance of various fermentation industries, basic requirements for fermentation, steps in fermentation process. Manufacture of alcohol from molasses, distillation, coffee still, preparation of absolute alcohol, various useful fractions and their uses, proof sprit, denatured spirit.

Module V: Tea Industry (7.5 lectures)
Chemical composition - an overview, Polyphenols in tea- Mechanism of theaflavin formation, biochemistry of tea - Biosynthesis of caffeine, Cinnamate, flavonoids, Chemical properties of tea- Polyphenols as Antioxidants.

Module VI: Paints (5 lectures)
Introduction, classification of paints, constituents of paints in brief. Manufacture of paints, qualities of good paint, emulsion paints, paint removers, varnishes enamels, lacquers, thinners in brief.

Suggested Readings

1. Industrial Chemistry, B. K. Sharma, Goel Publishing House Meerut, India.
2. Shreeve's Chemical Process Industries, G. T. Austin, Mc Graw Hill.
3. Organic Chemistry Vol I, I. L. Finar.
4. Organic Chemistry Vol II, I. L. Finar.
5. Introduction to Paint Chemistry and Principles of Technology, J. Bentley and G. P. A. Turner, Springer Science.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H					
CO 2		H				
CO 3			H			
CO 4			L	H	H	M
CO 5				H	H	
CO 6						H

CHMD0022: Medicinal Chemistry

(3-0-0)

Course Outcomes

CO 1: Recall the definition of drugs and pro drugs and history of drug development. (Remembering)
CO 2: Explain the mechanisms and theoretical aspects of drug action. (Understanding)
CO 3: Explain the properties and synthetic methods of antibiotics, antiviral, antimalarials etc. (Understanding)
CO 4: Explain the classes of neurotransmitters, drugs affecting cholinergic and adrenergic pathways. (Understanding)
CO 5: Recall about antihistamines, anti-inflammatory drugs, analgesics, anticancer gene therapy etc. (Remembering)

Module I: Introduction and History of Drug Development (5 lectures)

Definition of drug and prodrugs; need of drugs; germ theory of diseases; history of sulpha drugs and their mode of action; antibacterial agents.

Module II: Mechanisms and Theoretical aspects of drug action, drug discovery, design and delivery (10 lectures)

Receptors – two-state model of receptor theory, drug-receptor interaction and Clark's Occupancy Theory; physiological response; drug agonist and antagonist – classification; Need of quantification of drug action; definition of chemotherapeutic index and therapeutic index; factors affecting bioactivity of drugs; pharmacokinetics and pharmacodynamics; QSAR; Lead compounds in drug discovery; importance of SAR and molecular modification; importance of combinatorial library and molecular modelling in drug discovery; drug delivery – controlled drug delivery methods.

Module III: Antibiotics, Antivirals and Antimalarials (15 lectures)

a. General introduction to antibiotics – their sources and classification; causes and concerns of bacterial resistance to antibiotics; definition and need of broad Spectrum Antibiotics. Mechanism of action of lactam antibiotics, non-lactam antibiotics and quinolones.
b. Antivirals – difficulty in developing clinical solutions to viral diseases, introduction to antiviral agents, AIDS –its cause and prevention.
c. Antimalarials – classification of human malaria and plasmodia responsible for human malaria; discovery of quinine and its structure-activity-relationship (SAR), importance of quinine as a lead to the discovery of low cost antimalarials,artemisinin and its derivatives – their SAR and importance in dealing with chloroquine resistant malaria, mode of action.

Module IV: Neurotransmitters (5 lectures)

Classes of neurotransmitters, drugs affecting cholinergic and adrenergic pathways.

Module V: Miscellaneous topics (10 lectures)

Antihistamines, anti-inflammatory drugs, analgesics, anticancer and antihypertensive drugs, gene therapy, anti-sense and anti-gene strategies and drug resistance.

Suggested Readings

1. Medicinal Chemistry: An Introduction, G. Thomas, John Wiley & Sons.
2. An Introduction to Medicinal Chemistry, G. L. Patrick, Oxford University Press.
3. Introduction to Medicinal Chemistry, A. Gringauz, Wiley India Pvt Ltd.
4. Medicinal Chemistry, D. Sriram and P. Yogeeswari, Pearson Education. (Dorling Kindersley India).

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H	M	M	M
CO 3			H		
CO 4				H	
CO 5					H

CHRC0023: Recent Advances in Catalysis

Course Outcomes

CO 1: Recall the kinetics of heterogeneous catalysis. (Remembering)
CO 2: Explain the preparation and characterization of industrial catalysts. (Understanding)
CO 3: Explain the synthesis and properties of Zeolite and clays. (Understanding).
CO 4: Explain the environmental catalyst and role of catalyst in the petroleum industry. (Understanding)

Module I: Kinetics of heterogeneous catalysis (10 lectures)

Adsorption and catalysis, mechanism of heterogeneous catalysis, kinetics of heterogeneous catalytic reactions, volcano principle, shape and size selectivity of catalysts, characterization of catalysts and their surfaces, methods of surface analysis, surface area, pore size, void fraction, particle size, mechanical strength, surface chemical composition, surface acidity and reactivity.

Module II: Preparation and characterization of industrial catalysts (8 lectures)
Catalyst design methods, catalyst support and preparation of industrial catalyst, supported and unsupported metal catalysts, bimetallic catalysts, Electron microscopy, XPS and PES, ESCA, IR and magnetic resonance spectroscopy, temperature programmed desorption (TDP), and DTA and TGA.

Module III: Zeolite and clays (15 lectures)
a. Synthesis of some selected important zeolites, modification of zeolites, ion exchange, metals supported on zeolites, dealumination and desilication of zeolites, shape selective catalysis in zeolites.
b. Properties of pillared clays, use of coordination and organometallic compounds as pillaring, pillaring of acid activated clays, mesoporous materials, ordered mesoporous materials, synthesis of silica molecular sieve materials,characterization of mesoporous molecular sieves, catalytic properties of mesoporous materials, catalytic applications of zeolite, clays and mesoporous materials.

Module IV: Catalysis in petroleum industry and environmental catalysts (12 lectures)
Design of catalytic reactors, promotion and promoters, catalytic processes in petroleum industry, reforming, cracking and hydrotreating, hydrogenation, hydrodesulphurization, Fischer-Tropsch process, Catalytic deactivation and reactivation, control of pollution from automobile exhaust, catalytic converters, abatement of nitrogen oxides and odours, cleaning of industrial effluents.

Suggested Readings
1. Fundamentals of Industrial Catalytic Processes, C. H. Bartholomew and R. J. Furrauto, Wiley Interscience.
2. Heterogeneous Catalysis, D. K. Chakrabarty and B. Viswanathan, New Age Int.
3. Catalytic Chemistry, B. C. Gates, John Wiley & Sons.
4. Heterogeneous Catalysts for Synthetic Chemists, R.L. Augustine, Marcel-Dekker.
5. Catalysis and zeolites – fundamentals and applications, J. Weitkamp and L. Puppe, Springer-Verlag.
6. Handbook of Heterogeneous Catalysis, Vol 4 and 5, G. Ertl, H. Knozinger and J. Weitkamp, Wiley-VCH.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2		H		
CO 3			H	
CO 4				H

CHBC0024: Biophysical Chemistry
(3-0-0)

Course Outcomes
CO 1: Recall the fundamentals of biological macromolecules. (Remembering)
CO 2: Explain the molecular modelling and conformational analysis of biological macromolecules. (Understanding)
CO 3: Explain different methods for analysis and separation of biomolecules. (Understanding)
CO 4: Explain different techniques for the structural determination of biomolecules. (Understanding)
CO 5: Explain different optical methods in biological systems. (Understanding)

Module I: Fundamentals of biological macromolecules (5 lectures)
Chemical bonds in biological systems; properties of water; thermodynamic principles in biological systems; properties and classification of amino acids; protein structure and function; properties of nucleosides and nucleotides; composition of nucleic acids; structure of nucleic acids.

Module II: Molecular modelling and conformational analysis (10 lectures)
Complexities in modelling macromolecular structure; polypeptide chain geometries and internal rotation angles; Ramachandran plots; Molecular mechanics; stabilizing interactions in biomolecules; simulating macromolecular structure; energy minimization; molecular dynamics.

Module III: Methods for analysis and separation of biomolecules (10 lectures)
General principles, chromatography; analytical centrifugation – basic principles, sedimentation velocity, sedimentation equilibrium, density gradient sedimentation – isopycnic and rate- zonal centrifugation; electrophoresis, isoelectric focussing; capillary electrophoresis, MALDI-TOF, calorimetry – introduction, isothermal titration calorimetry, differential scanning calorimetry.

Module IV: Structural determinations: Physical Methods (10 lectures)
Ultracentrifugation and other hydrodynamic techniques; light scattering – fundamental concepts, scattering from a number of small particles, Rayleigh scattering, scattering from particles that are not small compared to the wavelength of radiation, dynamic light scattering, low angle X-ray scattering, neutron scattering, Raman scattering.

Module V: Optical Methods and Applications (10 lectures)
Optical techniques in biological systems – refraction, evanescent waves and plasmons-surface plasmon resonance; absorption spectroscopy, fluorescence spectroscopy, linear and circular dichroism, single and multidimensional NMRspectroscopy.

Suggested Readings
1. Biophysical Chemistry Parts I-III, C. R. Cantor and P. R. Schimmel, Macmillan.
2. Principles of Biochemistry,A. L. Lehninger, D. L. Nelson, L. Lehninger and M. M. Cox, W. H. Freeman.
3. Biophysical Chemistry the Royal Society of Chemistry, A. Cooper, UK.
4. Biophysical Chemistry, J. P. Allen, Blackwell Publishing.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H		L	M	
CO 2		H			
CO 3			H		
CO 4		L		H	
CO 5					H

CHHC0025: Heterocyclic Chemistry
(3-0-0)

Course Outcomes
CO 1: Recall the systematic nomenclature of heterocyclic compounds. (Remembering)
CO 2: Explain the synthesis and properties of azoles and condensed five-membered rings. (Understanding)
CO 3: Explain the synthesis and properties of three and four-membered heterocyclic compounds. (Understanding)
CO 4: Explain the importance and chemistry of natural heterocyclic compounds. (Understanding)
CO 5: Explain synthesis and properties of Diazines, bicyclic heterocycles & seven-membered heterocycles. (Understanding)

Module I: Introduction & Small Ring Heterocycles (10 lectures)
Hantzsch-Widman nomenclature for monocyclic, fused and bridged heterocycles; General approaches to heterocyclic synthesis; Aliphatic and aromatic heterocycles; Basicity and aromaticity of heterocycles.
Syntheses of aziranes, oxiranes &thiiranes; Ring openings and heteroatom extrusion; Synthesis & reactions of azetidines, oxetanes & thietanes; Strain.

Module II: Azoles and condensed five membered Rings (15 lectures)
Physical and chemical properties; Synthesis of pyrazole, isothiazole and isoxazole; Synthesis of imidazoles, thiazoles & oxazoles; Nucleophilic and electrophilic substitutions; Ring cleavages; Benzofused analogues.
Synthesis of indole, benzofuran and benzo-thiophene; Nucleophilic, electrophilic and radical substitutions; Additionreactions; Indole rings in biology.

Module III: Diazines, bicyclic heterocycles & seven membered heterocycles (10 lectures)
Physical & chemical properties and synthesis of pyridazines, pyrimidines, pyrazines; Nucleophilic and electrophilic substitutions.
Synthesis of quinolines, isoquinolines, benzofused diazines, acridines, phenothiazines, carbazoles and pteridines; Substitution reactions.
Synthesis & reactions of azepines, oxepines, thiepines & diazepines.

Module IV: Natural heterocycles (10 lectures)
a. **Porphyrins:** Classification and synthesis of porphin rings.
b. **Nucleic Acids:** Primary, secondary and tertiary structure of DNA; DNA replication and heredity; Structure and functionof mRNA, tRNA and rRNA.
c. **Proteins:** Acid-base properties of amino acids; polypeptides; primary, secondary, tertiary and quaternary protein structures; classification of proteins on basis of structure and biological function; Merrifield peptide synthesis.

Suggested Readings
1. Modern Heterocyclic Chemistry, L. A. Paquette, W. A. Benjamin.
2. Organic Chemistry, Vol. II, I. L. Finar, ELBS.

3. Heterocyclic Chemistry, T. L. Gilchrist, Longman.
4. Biochemistry, A. L. Lehninger, Kalyani Publishers.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		
CO 3	H			
CO 4				H
CO 5			H	

CHNP0026: Natural Products Chemistry

Course Outcomes

CO 1: Recall the chemistry of medicinal compounds of natural origin. (Remembering)
CO 2: Explain the role of co-enzyme during Bio-synthesis of natural products. (Understanding)
CO 3: Illustrate the biosynthesis and total synthesis of terpenoids and alkaloids. (understanding)
CO 4: Analyse the presence of isoprene units in the natural product. (Analysing)
CO 5: Analyse the practical utility of steroid chemistry. (Analysing)

Module I: Natural Products and their Biosynthetic Pathways (15 lectures)

General classification of natural products, sources and their isolation, characterisation and biosynthesis of common plant products; Extraction and Separation of Natural Products Biosynthesis pathways for natural products using co-enzymes and enzymes, general biogenesis and synthesis of cis-jasmone, methyl jasmonate, prostaglandins, exaltone and muscone.

Module II: Terpenoids and Alkaloids (15 lectures)

Terpenes and the Isoprene Rule; General biosyntheses of mono- and sesquiterpenes, trans-chrysanthemic acid, cyclo- pentato monoterpene lactones; Synthesis of α-vetinone and total synthesis of β-eudesmol; Synthesis of hirsutene, abietic acid, cis juvenile hormone, trans annular cyclisation of caryophyllene; Synthesis of caryophyllene and isocaryophyllene; Rearrangements of santonic acid and thujospene; Synthesis and rearrangement of longifolene; Structure, synthesis and biosynthesis of common alkaloids: reticuline, yohimbine and tylophorine.

Module III: Steroids (15 lectures)

Nomenclature of steroids and synthesis of squalene; Lanosterol and caretonoids; Synthesis of equlenins; Estrogens and total synthesis of non-aromatic steroids (progesterones); Corticosteroids; Degradation of diosgenin to progesterone and itssynthesis; Miscellaneous transformations of steroid molecules.

Suggested Readings

1. Natural Products Chemistry, Vols. I and II, K. Nakanashi, Academic Press, New York and London.
2. Natural Products Chemistry, sources, separations and structures, R. Cooper and G. Nicola, CRC Press, Taylor & Francis Group.
3. Chemistry of Natural Products, S. V. Bhat, B. A. Nagasampagi and M. Sivakumar, Springer Science & Business Media.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H	M	M
CO 2	H	L	L
CO 3		H	
CO 4		H	
CO 5			H

CHOC0027: Organometallic Chemistry

(3-0-0)

Course Outcomes

CO 1: Recall the fundamentals of organometallic compounds and their reactions. (Remembering)
CO 2: Explain the physical techniques required for the characterization of Organometallic compounds. (Understanding)
CO 3: Explain the synthesis and application of the main group organometallic compounds. (Understanding)
CO 4: Analyse the function of transition metal-based organometallic compounds. (Analysing)
CO 5: Evaluate potential applications of Organometallic chemistry in organic synthesis. (Evaluating)
CO 6: Design one-pot synthesis of complex molecules using organometallic chemistry. (Creating)

Module I: Introduction to organometallic compounds and reaction mechanisms (7 lectures)
History of Organometallic Chemistry, 18 electron rule, Electronic structure, Ligand substitution, oxidative addition, reductive elimination, migratory insertion, hydride elimination, trans-metallation, nucleophile and electrophilic attack on the ligands coordinated to metals.

Module II: Physical methods in organometallic chemistry (8 lectures)
Characterization of organometallic compounds using NMR, EPR, Mossbauer, IR, Mass spectroscopy and X-ray crystallography; Isotope effect; Fluxionality of organometallic complexes.

Module III: Main group organometallic compounds (8 lectures)
Synthesis and reactions of main group organometallic compounds including organo lithium, organo magnesium, organo boron, organo aluminium, organosilicon and organotin compounds.

Module IV: d-block organometallic compounds (8 lectures)
Structure, Preparation, and Chemistry of Transition metal carbene and –carbyne complexes. N-Heterocyclic Carbenecomplexes; Transition metal compounds with M-H bonds (classical and non-classical metal-hydrides), Agostic interaction.

Module V: Organometallic catalysis and application of organometallic chemistry to organic synthesis (14 lectures)
Synthetic applications of metathesis reactions, ring opening, ring closing metathesis in organic synthesis, macrocycle synthesis. Asymmetric hydrogenation, Hydrosilylation, Hydrocyanation, Palladium in Homogenous catalysis- Heck coupling, Stille coupling, Suzuki coupling, Negishi coupling, Sonogashira coupling and Buchwald-Hartwig coupling reactions. Synthetic utility of organotitanium, organochromium, organonickel, organocopper, organ rhodium compounds.

Suggested Readings
1. Organometallics, C. Elschenbroich, Wiley.
2. The Organometallic Chemistry of the Transition Metals, R. H. Crabtree, Wiley-Blackwell.
3. Organometallics and Catalysis: An Introduction, M. Bochmann, Oxford University Press.
4. Organometallic Chemistry, G. O. Spessard and G. L. Miessler, Oxford University Press, New York.
5. Transition Metal Organometallic Chemistry, F. Mathey, Springer.
6. Organic Synthesis, M. B. Smith, McGraw Hill Higher Education.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H		L	L	M
CO 2		H			
CO 3			H		
CO 4				H	
CO 5					H
CO 6					M

CHIP0028: Inorganic Rings, Clusters and Polymers
(3-0-0)

Course Outcomes
CO 1: Recall the knowledge of inorganic rings, clusters and inorganic polymers with respect to their structural diversity. (Remembering)
CO 2: Illustrate different theories to predict the structure of metal clusters. (Understanding)
CO 3: Make use of isolobal analogy in the understanding of structure and bonding of heteroboranes. (Applying)
CO 4: Analyse the concept of electron deficiency and sufficiency of Polyhedral boranes. (Analysing)
CO 5: Compare inorganic polymers with organic polymers. (Evaluating).
CO 6: Discuss the synthesis, structure, bonding and applications of inorganic polymers. (Creating)

Module I: Boranes and Heteroboranes (13 lectures)
Polyhedral boranes, concept of electron deficiency and sufficiency, types and IUPAC nomenclature of polyhedral boranes. Polyhedral skeleton electron pair theory (PSEPT). W. N. Equivalent and resonance structures. Wade’s vs Lipscomb’smethods of studying higher boranes.
Heteroboranes: types and IUPAC nomenclature, structure and bonding of heteroboranes with special reference to carboranes, Metallaboranes, Metallacarboranes, metal σ and μ bonded borane/carborane clusters. Resemblance of Metallaboranes/Metallacarboranes with ferrocene and related compounds. Applications of Metallaboranes/Metallacarboranes as drug delivery system. Applications of PSEPT over heteroboranes.

Module II: Isolobility (6 lectures)
Concept of isolobility and isolobal groups with examples. Its application in the understanding of structure and bonding of heteroboranes.

Module III: Metal Clusters (11 lectures)
Metal-metal bonding, quadrupolar bond and its comparison with a C-C bond; Types of metal clusters and multiplicity of M- M bonds. Simple and condensed metal carbonyl clusters. Applications of PSEPT and Wade's-Mingo's and Lauhr's rule over metal carbonyl clusters. Metal halide and metal chalcogenide clusters, polyatomic Zintl ions, Bloomington shuffle.

Module IV: Inorganic Polymers (15 lectures)
Inorganic polymers, classification of inorganic polymers, comparison with organic polymers, Boron-oxygen and boron- nitrogen polymers, silicones, polysilanes, polyphosphazenes, coordination polymers, sulphur-nitrogen, sulphur-nitrogen- fluorine compounds, preceramic inorganic polymers.

Suggested Readings
1. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson, John Wiley & Sons, New York.
2. Inorganic Chemistry, J. E. Huheey, Addison Wesley Pub. Co., New York.
3. Chemistry of the Elements, N. N. Greenwood and A. Earnshaw, Butterworth Heinemann, London.
4. Inorganic polymers, J. E. Mark, H. R. Allcock and R. West, Oxford University Press, New York.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	M	L	H	H
CO 2			H	
CO 3		H		
CO 4	H			
CO 5				H
CO 6				H

CHQT0029: Introduction to Quantum Chemistry and Group Theory

Course Outcomes
CO 1: Recall the postulates and principles of quantum chemistry. (Remembering)
CO 2: Explain the Schrodinger equation. (Understanding)
CO 3: Solve the problems related to wave functions. (Applying)
CO 4: Distinguish one approximation method from another, one molecular point group from another. (Analysing)

Module I: Quantum Chemistry I (20 lectures)
Planck's theory, wave-particle duality, uncertainty principle, operators, eigen functions and eigen values in quantum mechanics, postulates of quantum mechanics, Schrodinger equation, free particle, particle in a box, degeneracy, harmonic oscillator, rigid rotator, the hydrogen atom, angular momentum, electron spin, spin-orbit coupling.

Module II: Quantum Chemistry II (20 lectures)
Approximate methods in quantum mechanics - the variation theorem, linear variation principle and perturbation theory (first order and non-degenerate), application of variation method and perturbation theory to the Helium atom, anti- symmetry, Slater determinant, term symbols and spectroscopic states, Huckel approximation for small pi-conjugated molecules.

Module III: Chemical Applications of Group Theory (20 lectures)
Symmetry elements and operations, equivalent symmetry elements and equivalent atoms, identification of symmetry point groups with examples, groups of very high symmetry, molecular dissymmetry and optical activity, systematic procedure for symmetry classification of molecules and illustrative examples, brief review of matrix representation of groups, reducible and irreducible representations, rules about irreducible representations as derived from great orthogonality theorem, relationship between reducible and irreducible groups, character tables.

Suggested Readings
1. Molecular quantum Mechanics, P. Atkins and R. Friedman, Oxford University Press.
2. Quantum Chemistry, I. N. Levine, PHI Learning Pvt. Ltd.
3. Introduction to Quantum mechanics, D. J. Griffiths, Pearson Education Ltd.
4. Chemical Applications of Group Theory, F. A. Cotton, Willey India Pvt. Ltd.
5. Molecular Symmetry and Group Theory, R. L. Carter, John Wiley & Sons.
6. Molecular Symmetry and Group Theory, A. Vincent, Wiley.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H	L	
CO 2	H		
CO 3	H	L	
CO 4	M	H	H

CHFY0030: Fundamentals of Spectroscopy

(4-0-0)

Course Outcomes

CO 1: Recall the fundamental aspects of absorption and emission spectroscopy. (Remembering)
CO 2: Explain the basic concepts of rotational and vibrational spectroscopy. (Understanding)
CO 3: Illustrate basics and applications of electronic spectra. (Understanding)
CO 4: Explain theories and applications of NMR, ESR and Mossbauer spectroscopy. (Understanding)
CO 5: Identify unknown molecules with the help of different spectroscopic techniques. (Applying)

Module I: Interaction of light with matter (5 lectures)

Fundamental aspects of absorption and emission spectroscopy, probability of transition, oscillator strength, dipole strength, Spontaneous and stimulated emission, origin of selection rules.

Module II: Rotational and Vibrational Spectroscopy (15 lectures)

Degrees of freedom of molecules, rigid rotor model, rotational spectra of diatomics and polyatomics, effect of isotopic substitution and non-rigidity, selection rules and intensity distribution, Vibrational spectra of diatomics, effect of anharmonicity, Morse potential, Vibrational-rotational spectra of diatomics, P, Q, R branches, normal modes of vibration, overtones, hot bands, Raman spectroscopy – Origin, rotational and vibrational Raman spectra of diatomics.

Module III: Electronic Spectroscopy (15 lectures)

Electronic spectra of diatomic molecules, Frank-Condon principle, vibronic transitions, Spectra of organic compounds, $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ transition, Photoelectron Spectroscopy – basic principle, photoelectron spectra of simple molecules, X-ray photoelectron spectroscopy (ESCA), Auger electron spectroscopy, Lasers – Laser action, population inversion, properties oflaser radiation, examples of simple laser systems.

Module IV: Magnetic Resonance Spectroscopy (15 lectures)

a. **Nuclear Magnetic Resonance:** Nuclear spin and nuclear spin states in magnetic field, resonance phenomenon, relaxation process, NMR line shapes and saturation, shielding and de-shielding of magnetic nuclei, chemical shift, spin-spin interactions, spectra of two-spin system (A_2, AB and AX cases), ^{13}C, ^{19}F and ^{31}P NMR spectroscopy.
b. **Electron Spin Resonance:** Basic principles, factors affecting g values, hyperfine coupling, spin densities and McConnell relationship, Zero field splitting.

Module V: Mass spectrometry and Mossbauer spectroscopy (10 lectures)

a. **Mass spectrometry**: Basic principles, ionization techniques, isotope abundance, molecular ion, fragmentationprocesses of organic molecules, deduction of structure through mass spectral fragmentation
b. **Mossbauer spectroscopy**: Principles, instrumentation and applications.

Suggested Readings

1. Fundamentals of Molecular Spectroscopy, C.N. Banwell and E. M. McCash, Tata McGraw Hill.
2. Introduction to Spectroscopy, D.L. Pavia, G. M. Lampman and G. S. Kriz, Brooks/Cole Cengage Learning.
3. Physical Methods in Chemistry, R.S. Drago, Saunders, Thomson Learning.
4. Spectrometric Identifications of Organic Compounds, R.M. Silverstein, F. X. Webster, D. J. Kiemle and D. L. Bryce, Wiley India Pvt. Ltd.
5. Organic Spectroscopy, W. Kemp, Palgrave Macmillan.
6. Organic Structures from Spectra, L. D. Field, S. Sternhell and J. R. Kalman, John Wiley and Sons.
7. Structural Methods in Molecular Inorganic Chemistry, D. W. H. Rankin, N. Mitzel and C. Morrison, Wiley.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H			
CO 3			H		

CO 4				H	H
CO 5	L	L	M	H	H

CHAP0031: Applied Spectroscopy

(3-0-0)

Course Outcomes

CO 1: Recall various principles involved in UV-Visible spectroscopy. (Remembering)
CO 2: Explain the theories and applications of IR and mass Spectrometry. (Understanding)
CO 3: Apply the NMR spectroscopy for structural elucidation of simple and complex molecules. (Applying)
CO 4: Explain the role of various spectroscopic tools required for analysing the structure of unknown molecules. (Analysing)
CO 5: Interpret the progress of organic reactions by FT-IR spectroscopy. (Evaluating)

Module I: Ultraviolet and visible spectroscopy (10 Lectures)

Electronic transitions, chromophores, auxochromes, red and blue shift, applications of UV spectroscopy, spectrum shifts with solvents, isolated and conjugated double bonds, woodward Fieser rules, Analytical uses of UV spectroscopy in polyenes, carbonyl compounds and aromatic systems.

Module II: IR and Mass Spectrometry (15 lectures)

a. **Infrared Spectroscopy**: Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, amines; Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acid anydrides, lactones, lactams, conjugated carbonyl compounds); Effects of H- bonding and solvent effect on vibrational frequency, extension to various organic molecules for structuralassignment.
b. **Mass Spectrometry**: Mass spectral fragmentation of organic compounds, common functional groups; molecular peak, McLafferty rearrangements, examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

Module III: NMR spectroscopy (20 lectures)

a. **Nuclear Magnetic Resonance Spectroscopy**: Approximate chemical shift values of various chemically non- equivalent protons and correlation to protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic); Protons bonded to other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides, SH); Chemical exchange, effect of deuteration; complex spin-spin interaction between two, three, four and interacting nuclei (first order spectra); Complex interaction, virtual coupling, stereochemically hindered rotation, Karplus curve, variation of coupling constant with dihedral angle, nuclear magnetic double resonance, simplification of complex spectra using shift reagents, Fourier transform technique and nuclear Overhauser effect (NOE).
b. **C-13 NMR Spectroscopy**: Chemical shift (aliphatic, olefinic, alkynes, aromatic, hetero-aromatic, carbonyl carbon);Coupling constants, two-dimensional NMR spectroscopy, NOESY, DEPT and INEPT terminologies.
c. **Applications:** IR, NMR and Mass spectroscopy for structure elucidation of organic compounds.

Suggested Readings

1. Spectroscopic Identification of Organic Compounds, R. M. Silverstein, G. C. Basseler and T. Morill, C.John Wiley.
2. Organic Spectroscopy, W. Kemp, McMillan Press Ltd.
3. Spectroscopic Methods in Organic Chemistry, W. Williams, I. Fleming, McGraw Hill.
4. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash, Tata McGraw- Hill, New Delhi.
5. Introduction to Spectroscopy, D.L. Pavia, G. M. Lampman and G. S. Kriz, Harcourt College Publisher NY.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H		
CO 2		H	
CO 3			H
CO 4	L	H	H
CO 5		H	

CHSL0200: Elements of Service

(2-0-0)

Course Outcomes

1. Understanding social responsibility of higher educational institutes. (Understanding)
2. Identifying problems in the community and where students originated. (Applying)

3. Influence to get involved in the local community to gain insight into local issues. (Evaluating)
4. Adopt strong leadership skills which allow students to work well in a team. (Creating)

Module I (6 lectures)
Understanding social responsibility of higher educational institutes; community university engagement (CUE) and its importance, engaged teaching, engaged research. Community Based Participatory Research (CBPR). Statutory bodies of higher educational institutions and social responsibility.

Module II (9 lectures)
Service learning and active learning.; principles of service learning; classification of service learning models; servicelearning vis a vis other community experiences; historical context of university community partnership; chemistry and service learning; service Learning for a postgraduate chemistry student and its scope in research.

Module III (15 lectures)
Conceptualisation of the idea of service learning through their practical implementations (any two): (i) demonstrating experiments to inoculate scientific temper for nearby communities, (ii) organising awareness programmes for school children to eradicate the fear of pursuing higher studies in science, (iii) engaging with communities to find out various possibilities of providing the solutions to societal problems from chemistry point of view, (iv) providing consultancy to school students for various inter school science competitions.

Suggested Readings
1. Service-Learning Essentials: Questions, Answers, and Lessons Learned, B. Jacoby, Jossey-bass.
2. Where's the Learning in Service-Learning? J. Eyler, and D. E. Giles Jr., Jossey-bass.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H		
CO 2		M	H
CO 3			M
CO 4	M		

LABORATORY COURSES

CHIQ6002: Inorganic Qualitative and Quantitative Analysis – Lab

(0-0-3)

Course Outcomes

CO 1: Recall the procedures followed to carry out the qualitative and quantitative analysis. (Remembering)
CO 2: Explain the reason behind each step for Analysing mixtures and preparing compounds and metal nanoparticles. (Understanding)
CO 3: Apply different spectroscopic methods to characterize coordination compounds. (Applying)
CO 4: Design protocols for Analysing inorganic mixtures and synthesizing nanoparticles. (Creating)

Experiments:

a. Qualitative analysis (tertiary mixtures, alloys, ores).
b. Quantitative analysis (binary mixtures, alloys, ores).
c. Inorganic preparation (crystallization, precipitation, calcination).
d. Coordination compounds through ligand synthesis and spectroscopic characterization, magnetic properties.
e. Metal Nanoparticle synthesis and characterization.

Suggested Readings

1. Vogel’s Textbook of Quantitative Chemical Analysis,J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, and B. Sivasankar, Pearson.
2. Vogel's Qualitative Inorganic Analysis, G. Svehla and S. Mittal, Pearson Education.

Mapping of COs to Syllabus

Course Outcomes	Exp a	Exp b	Exp c	Exp d	Exp e
CO 1	H	H			
CO 2	H	H	H	L	H
CO 3				H	
CO 4	M	M			M

CHEQ6003: Experimental Physical Chemistry – Lab

(0-0-3)

Course Outcomes

CO 1: Recall the theoretical concepts of experiments related to chemical kinetics and electrochemistry etc. (Remembering)
CO 2: Explain the principles and the procedures for spectrophotometry based experiments. (Understanding)
CO 3: Apply the theoretical knowledge for determination of rate constant, pH, emf etc. (Applying)
CO 4: Analyse the practical utility of different theories of chemical kinetics, electrochemistry, adsorption etc. (Analysing)

Experiments:

a. Chemical Kinetics based experiments.
b. Electrochemistry based experiments.
c. Spectrophotometry based experiments.
d. pH-metric Titrations.
e. Adsorption on porous materials - equilibrium, kinetic and thermodynamic studies.

Suggested Readings

1. Advanced Practical Physical Chemistry, J. B. Yadav, Goel Publishing House.

Mapping of COs to Syllabus

Course Outcomes	Exp a	Exp b	Exp c	Exp d	Exp e
CO 1	H	H			
CO 2			H		
CO 3	H	H		H	
CO 4	M	M			M

CHQA6004: Organic Qualitative Analysis and Synthesis Lab
(0-0-3)

Course Outcomes
CO 1: Recall the procedures for qualitative analysis, separation of binary mixtures of organic compounds. (Remembering)
CO 2: Explain the chemistry behind the preparation of some important organic compounds. (Understanding)
CO 3: Apply different chromatographic techniques for the identification and purification of organic compounds. (Applying)
CO 4: Analyse practical utility of chromatographic techniques. (Analysing)
CO 5: Identify and extract different types of natural products. (Applying)

a. Qualitative analysis of binary mixtures of organic compounds
1. Separation of binary mixture into individual components.
2. Qualitative analysis of individual components by
    I. Detection of extra elements N, S, Halogens.
    II. Test for functional groups by systematic analysis.
    III. Solubility, melting point.
    IV. Preparation of a derivative and determination of its melting point.

b. Preparation of organic compounds by using single and multistep process.
1. Chromatographic techniques
2. Qualitative TLC separation and identification.
3. Column chromatographic separation of a mixture of compounds.

c. Extraction of natural products.

Suggested Readings
1. Vogel's Textbook of Practical Organic Chemistry, Including Qualitative Organic Analysis (5th Edition).
2. Practical Organic Chemistry, F. G. Mann and B. C. Saunders, Pearson Education.
3. Practical Organic Chemistry, B. S. Furniss, A. J. Hannaford, P. W. G. Smith and A. R. Tatchell, 2012, Pearson.
4. Comprehensive Practical Organic Chemistry, V. K. Ahluwali and S. Dhingra, University Press.

Mapping of COs to Syllabus

Course Outcomes	Exp a	Exp b	Exp c	Exp d
CO 1	H			
CO 2		H		
CO 3			H	
CO 4			H	
CO 5				H

CHRP6005: Research Project
(0-0-12)

Course Outcomes
This will be a research-based module, whereby, students will carry out either theoretical or wet lab experiments and present their findings in a thesis and perhaps as a paper in a conference or a journal.
CO 1: Learn to carry out experiments to fulfil their research objectives and will in the process learn a wide range of techniques both scientific and statistical, and also probably add to the existing body of scientific knowledge. (Remembering)
CO 2: Develop an understanding of the methods they use to carry out their research and why a certain set of methods is chosen. (Understanding)
CO 3: Apply their understanding to steer their research in the right direction. (Applying)
CO 4: Troubleshoot when a chosen approach does not yield the expected result. (Analysing)
CO 5: Critically analyse the results they obtain to decide whether the data obtained proves or disproves a stated hypothesis. (Evaluating)
CO 6: Learn to choose a methodology or approach to fulfil a set of objectives or prove or disprove a hypothesis. (Creating)

In this course, each student undertakes research on a topic that he/she chooses in project phase I or on a topic assigned to him/her by the concerned mentor.
To this end, the student will first review the current status of research on the selected topic, state a hypothesis or a set of objectives and then carry out experiments (either wet-lab or theoretical) to gather data, which he/she will then analyse, draw conclusions and finally present in a dissertation at the end of the semester.

The format for the final dissertation will be as prescribed by the department. There will be a viva voce examination on the dissertation by an expert committee comprising external and internal members of the department. The mode andcomponents of the evaluation and the weightages attached to them shall be published by the department at the beginning of the semester.

CHPC6137: Petroleum Chemistry

(1-0-1)

Course Outcomes

CO 1: To gain knowledge about the composition of crude petroleum and the refining process. (Remembering)
CO 2: To correlate the quality of fuels with various parameters. (Understanding)
CO 3: Determination of different types of water testing parameters required in thermal power plant. (Applying)
CO 4: Analysing of chemical impurities and their separation techniques. (Analysing)
CO 5: Designing of eco-friendly and sustainable energy source in future. (Evaluating)

Module I: Oil Section (15 Lectures)

Renewable and non-renewable source of energy, Petroleum, Composition of crude petroleum, Hydrocarbon, Distillation (Upper distillation, middle ditillation, Residue distillation), crude distillation unit, Fractional distillation, petroleum refining-applications of various fractions, Cracking, Reforming, Petrol, Diesel, viation turbine fuel, Kerocene, LPG, CNG, LNG, clean fuels, Octane number, Cetane number, Flash point, calorific value, knocking and antiknocking, isomerization, smoke point, Lubricants, viscosity index, cloud point, pore point, Density, Gas chromatography, HPLC.

Module II: Water section (15 Lectures)

Thermal power plant station, concept of zero discharge refinery, Oil content, Effluent treatment plant, boiler, demineralization, uses of cationic and anionic resin during neutralization reaction, requirement of *p*H determination, BOD, COD, TDS, TSS, DO, Microbiological treatment, Scavenger, alkalinity, corrosion monitoring, permanent alkalinity, Total hardness, temporary hardness, silica and phosphate removal process, removal of sulphate, sulphite, ammonia, cyanide, water testing.

Suggested Readings

1. Engineering Chemistry, P. C. Jain and M. Jain, Dhanpat Rai & Sons, Delhi.
2. Industrial Chemistry, B. K. Sharma, Goel Publishing House, Meerut
3. Fundamentals of Petroleum and Petrochemical Engineering, U.R. Chaudhuri, CRC Press, Taylor & Francis group.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II
CO 1	H	
CO 2	H	
CO 3		H
CO 4		H
CO 5	H	

CHPA6138: Pharmaceutical Chemistry and its applications

(1-0-1)

Course Outcomes

CO 1: Explanation of the preliminary concept of drug and their classification. (Remembering)
CO 2: To understand the mode of action of different kinds of drugs. (Understanding)
CO 3: Synthesis of simple drug molecules and their purification techniques. (Applying)
CO 4: Extraction of the medicinally active component from a plant source and their characterization techniques. (Analysing)
CO 5: To provide knowledge of computational chemistry in designing drug molecules. (Evaluating)

Module I: Introduction and importance of drug Chemistry (15 Lectures)

Definition of drug, pro-drug, host-receptors interactions in connection to biological response, pharmacokinetics andmechanism of drug action-absorption, distribution, metabolism, and excretion (ADME), Structure activity relationship (SARand QSAR), drug classification based on mode of action, analgesics and anti-inflammatory drug, COX-2 inhibitors, mode of action of NSAID and SAID, anti-histamine drugs, antidepressant drugs, narcotics, sedative-hypnotics and their mechanism of action, antibiotics, antiviral drugs, anti-bacterial drugs, anti-neoplastic drug, drugs derived from natural origin including plants and bacteria, chemotherapy, nano-drug delivery systems, toxicology, positive and negative aspect of drug chemistry, future scope of drug chemistry.

Module II: Hands on experience on drug chemistry (15 Lectures)

Experimental aspect of drug chemistry: Synthesis of simple drug molecules, various techniques used for purification including crystallization / recrystallization, acid-base purification, column chromatography, quality control / purity determination of drugs using GC-MS, HPLC etc., extraction of active ingredient from various plants in North-eastern region having medicinal importance, procedure for bioactivity test.

Theoretical feature of drug chemistry: Application of computational chemistry in designing of drug molecule, computer simulation to assist in solving chemical problems, drug-DNA interaction study, drug-delivery study.

Suggested Readings

1. An Introduction to Medicinal Chemistry, G. L. Patrick, Oxford University Press.
2. Introduction to Medicinal Chemistry, A. Gringauz, Wiley India Pvt Ltd.
3. Medicinal Chemistry, A. Kar, New Age International Publishers.
4. Medicinal Chemistry: An Introduction, G. Thomas, John Wiley & Sons
5. Computational Chemistry: A Practical Guide for Applying Techniques to Real World Problems, D. C. Young, John Wiley& Sons, Inc.
6. Computational Materials Science: An Introduction, J. G. Lee, CRC press, Taylor & Francis Group.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II
CO 1	H	
CO 2	H	
CO 3		H
CO 4		H
CO 5		H

DEPARTMENT OF MATHEMATICS

VISION:

To elucidate the philosophy of Mathematical principles coupled with the exhibition of Mathematical laws in fundamental and frontier areas of science whereupon fostering an intuitive mathematical mind.

MISSION:

- To provide adequate understanding of Mathematical laws by means of both conventional techniques and skilful approaches.
- To familiarize students as well as faculty members with the state-of –the –art by means of talks,workshops, symposia.
- To invoke interest tinged with anxiety to facilitate further pursuit in terms of research pertaining to advanced knowledge.

PROGRAM OUTCOMES – MSC PROGRAMME

PO 1: **Critical Thinking**: Inculcate critical thinking to carry out scientific investigation objectively. Formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. Critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.

PO 2: **Knowledge Skil**l: Equip the student with skills to analyse problems, formulate a hypothesis, evaluate and validate results, and draw reasonable conclusions thereof. Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculumcontent knowledge.

PO 3: **Scientific Communication Skill**s: Imbibe effective scientific and / or technical communication in both oral and writing. Ability to show the importance of the subject as precursor to various scientific developments since thebeginning of the civilization.

PO 4: **Ethics**: Continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in the subject concerned. Ability to identify unethical behaviour such as fabrication, falsification or misrepresentation of data and adoptive objective, unbiased and truthful actionsin all aspects.

PO 5: **Enlightened Citizenship**: Create awareness to become an enlightened citizen with commitment to deliver one's responsibilities within the scope of bestowed rights and privileges

PO 6: **Analytical Reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyse and synthesise data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.

PO 7: **Multicultural Competence**: Development of a set of competencies in order to enhance and promote the growth of multicultural sensitivity within universities. Integrating multicultural awareness such as race, gender, physical ability, age, income and other social variables, and by creating an environment that is, "welcoming for all students".

PO 8: **Lifelong Learning**: Ability to think, acquire knowledge and skills through logical reasoning and to inculcate the habit of self-learning throughout life, through self- paced and self- directed learning aimed at personal development, and adapting to changing academic demands of work place through knowledge/ skill development/ reskilling.

PO 9: **Leadership Qualities**: Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiringteam members to engage with that vision, and using management skills to guide people to the right destination in a smooth and efficient way.

PO 10: **Research Skills**: Prepare students for pursuing research or careers in industry in concerned subject and allied fields. Capability to use appropriate software to solve various problems and to apply programming concepts of C++ and Mathematica/ Matlab to various scientific investigations, problem solving and interpretation.

PROGRAMME SPECIFIC OUTCOMES FOR MSC MATHEMATICS

PSO 1: **Strong Foundation in Knowledge:** Have strong foundation in core areas of Mathematics, and able to communicate Mathematics effectively.

PSO 2: **Abstract Skills:** Evaluate hypotheses, theories, methods and evidence within their proper contexts

PSO 3: **Problem Solving**: Solve complex problems by critical understanding, analysis and synthesis

PSO 4: **Proficiency in Interdisciplinary Skills:** Select, interpret and critically evaluate information from a range of sources that include books, scientific reports, journals, case studies and internet.

PSO 5: **Application and Research Efficiency:** Provide a systematic understanding of the concepts and theories of mathematics and their application in the real world- to an advanced level, and enhance career prospects in a huge array of fields, viz. in industry, commerce, education, finance and research.

PSO 6: **Lifelong Practical Knowledge**: Recognise the need to engage in lifelong learning through continuous education, and research leading to higher degrees like PhD, DSc etc.

COURSES OFFERED IN MSC MATHEMATICS

Sl. No.	**Course Name**
1.1	Real Analysis
1.2	Linear Algebra
1.3	Abstract Algebra
1.4	Differential equations
1.5	Mathematical Methods I
1.6	Community engagement and Service Learning
1.7	Fractal geometry and Applications
2.1	Topology and Functional Analysis
2.2	Complex Analysis
2.3	Measure Theory and Probability Theory
2.4	Mathematical methods II
2.5	Classical Mechanics
2.6	Essential Mathematics for Machine Learning
3.1	Discrete Mathematics
3.2	Computer Programming In C
3.3	Computer Programming In C Lab
3.4	Research Methodology for Mathematical Sciences
3.5	Research Seminar
3.6.1	Field theory & commutative Algebra
3.6.2	Number Theory
3.6.3	Mathematical Logic
3.6.4	Fuzzy sets and Applications
3.7.1	Fluid Dynamics I
3.7.2	Riemannian Geometry & Tensor Calculus
3.7.3	Dynamical Systems and Chaos
3.7.4	Convex Optimization
3.7.5	Numerical solution of PDE
3.8.1	Computational Number Theory
3.8.2	Scientific Computing
3.8.3	Special Functions
3.8.4	Introduction to Game Theory
4.1.1	Advance Analysis
4.1.2	Graph Theory
4.1.3	Multivariable calculus
4.1.4	Algebraic Number Theory
4.1.5	Algebraic Geometry
4.2.1	Fluid Dynamics II
4.2.2	Continuum Mechanics
4.2.3	Theory of Relativity
4.2.4	Numerical Optimization
4.3.1	Design and Algorithms Analysis
4.3.2	Machine Learning
4.3.3	Finite Elements Methods
4.3.4	Introduction to Cryptography
4.4	Research Project
4.5	Statistical Methods & Software in Research

MSC MATHEMATICS- MAPPING OF COURSES TO PO/PSO

Mapping	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PS01**	**PS02**	**PS03**	**PSO4**	**PSO5**	**PSO6**
1.1	M	H	M			M		M		M	H	M	M		L	M
1.2	M	M	M	L		M			L	M	M		M	L	L	M

1.3		H	M			M	M	M	L	H	M		M		M	H
1.4	M	M	M		L	M				H	M	H	H	M	M	M
1.5	M	M	M	L	L	M			M		M	H	M		L	
1.6			L	M	M				H							L
1.7		M	M	H			L							M		
2.1	H	H			L	M	L		L	M	M	H	H	M		M
2.2	M	H	M	M		M	M	M	L		H		M	M		M
2.3	H	H	M			M	M			M	H	M	H		M	M
2.4		H	M			M		M		M		M	M	M	M	M
2.5		H	M			M			L		H		M	M		
2.6		M	M	H			L							M		
3.1	M	M				M	M						L		H	M
3.2		H	H			M		M		L			M		M	
3.3			H	M	M		M	M	M	L		H		M	L	L
3.4			M	M	M		L		M	L		M		M		L
3.5	M	H		M		M	M	M		M	H	H	M			M
3.6.1		M	M	L	L	M		M		H	M	M	M		M	H
3.6.2		M	M	L	L	M		M		H	M	M	M		M	H
3.6.3		M	M	L	L	M		M		H	M	M	M		M	H
3.6.4		M	M	L	L	M		M		H	M	M	M		M	H
3.7.1		M	H	L		M	L	M		M		M	M	M	H	M
3.7.2		M	H	L		M	L	M		M		M	M	M	H	M
3.7.3		M	H	L		M	L	M		M		M	M	M	H	M
3.7.4		M	H	L		M	L	M		M		M	M	M	H	M
3.7.5		M	H	L		M	L	M		M		M	M	M	H	M
3.8.1	M	M	H			M	L	M		M		M	M	M	H	M
3.8.2	M	M	H			M	L	M		M		M	M	M	H	M
3.8.3	M	M	H			M	L	M		M		M	M	M	H	M
3.8.4	M	M	H			M	L	M		M		M	M	M	H	M
3.9				H	H		M	M	M			M		M	M	
4.1.1	M	H		M		M	M	M		M	H	H	M			M
4.1.2	M	H		M		M	M	M		M	H	H	M			M
4.1.3	M	H		M		M	M	M		M	H	H	M			M
4.1.4	M	H		M		M	M	M		M	H	H	M			M
4.1.5	M	H		M		M	M	M		M	H	H	M			M
4.2.1		M	M	L	L	M		M		H	M	M	M		M	H
4.2.2		M	M	L	L	M		M		H	M	M	M		M	H
4.2.3		M	M	L	L	M		M		H	M	M	M		M	H
4.2.4		M	M	L	L	M		M		H	M	M	M		M	H
4.3.1		M	H	L		M	L	M		M		M	M	M	H	M
4.3.2		M	H	L		M	L	M		M		M	M	M	H	M
4.3.3		M	H	L		M	L	M		M		M	M	M	H	M
4.3.4		M	H	L		M	L	M		M		M	M	M	H	M
4.4			H	M	L		M		L	M		M		M		M
4.5	M	M	H			L							M		M	M

DETAILED SYLLABUS THEORY COURSES

MARA0014: REAL ANALYSIS

(4-0-0)

COURSE OUTCOMES

CO 1: Classify the convergence of sequences and series of real numbers, and study various tests. (Understanding)
CO 2: Recall the fundamental properties of continuity and uniform continuity. (Remembering)
CO 3: Test for uniform convergence of sequence and series of real valued functions. (Analysing)
CO 4: Solve problems of the Riemann integrals and improper integrals. (Evaluating)
CO 5: Develop the concepts of compact sets, connected sets and their properties. (Creating)

Module I: (14 lectures)
Review of set theory, relations and functions, finite and infinite sets, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum. Sequence of real numbers, bounded sequence, limsup, liminf, Cauchy sequences, Series, convergence of series, root and ratio tests, absolute convergence.

Module II: (8 lectures)
Limit, Continuity, types of discontinuity, Intermediate value theorem, Fixed point theorem, uniform continuity, Monotonic functions.

Module III: (14 lectures)
Sequence and series of real valued functions, Point wise and uniform convergence, uniform convergence and continuity, uniform convergence and differentiation, uniform convergence and integration. Cauchy criterion for uniform convergence. Series of functions and convergence, Weierstrass M-test.

Module IV: (12 lectures)
Riemann sums and Riemann integral, Riemann-Stieltjes Integrals, Improper Integrals Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation, inverse and implicit function theorems.

Module V: (16 lectures)
Open and closed sets, limit points, interior points, Euclidean space, compact spaces, Bolzano Weierstrass theorem, Heine Borel theorem in R only.

Suggested Readings

1. Principles of Mathematical Analysis, W. Rudin, McGraw Hill Kogakusha Ltd.
2. Mathematical Analysis, T. Apostol, Addison-Wesley; Publishing Company.
3. Introduction to Real Analysis, R. G. Bartle and D. R. Sherbert, John Wiley & Sons, Inc., New York.
4. The Elements of Real Analysis, R. G. Bartle, Wiley International Edition.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H			
CO 3	M		H		
CO 4				H	
CO 5	M				H

MALA0015: LINEAR ALGEBRA

(4-0-0)

COURSE OUTCOMES

CO 1: Find the fundamental concepts and properties associated with vector spaces. (Remembering)
CO 2: Demonstrate the algebra of matrices, eigenvalues and eigenvectors. (Understanding)
CO 3: Develop the representation between linear transformations and Matrix theory. (Applying)
CO 4: Choose various examples in Inner product spaces and study the applications to various problems. (Evaluating)
CO 5: Elaborate quadratic forms and solve related problems. (Creating)

Module I: (10 lectures)
Vector spaces, subspaces, quotient spaces, linear dependence, basis, dimension of a vector space, LinearTransformations.

Module II: (20 lectures)
Algebra of Matrices, trace of matrices, rank and determinant of matrices, system of linear equations. Eigenvalues and eigenvectors, relation between characteristic and minimal polynomial, Cayley- Hamilton theorem, Diagonalizability.

Module III: (10 lectures)
Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms.

Module IV: (15 lectures)
Inner product spaces, properties of inner products and norms, Cauchy-Schwarz inequality, Orthogonality and orthogonal complements, orthonormal basis, Gram-Schmidt process.

Module V: (5 lectures)
Quadratic forms, reduction and classification of quadratic forms.

Suggested Readings
1. Linear Algebra, K. Hoffman and R. Kunze, Prentice Hall.
2. Linear Algebra, G.E. Shilov, Prentice Hall.
3. Linear Algebra: A Geometric Approach, S. Kumaresan, Prentice-Hall of India Pvt. Ltd., New Delhi.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M	M		
CO 2		H	M		
CO 3			H		
CO 4				H	
CO 5					H

MAAB0016: ABSTRACT ALGEBRA
(4-0-0)

COURSE OUTCOMES
CO 1: Find the concepts of Group theory and the application of Sylow theorems. (Understanding)
CO 2: Categorize among unique factorization domain, Euclidean domain, Principal ideal domain and irreducible criteria. (Analysing)
CO 3: Organize the characteristics of field extensions, Algebraic extension, Galois theory. (Applying)
CO 4: Develop the concepts related to representation theory and study their application. (Creating)

Module I: (15 lectures)
Review of Groups, Cayley's theorem, class equations, Sylow theorems and its applications, Direct products of groups,Solvable groups, Jordan-Holder theorem.

Module II: (20 lectures)
Rings, ideals, prime and maximal ideals, quotient rings, Euclidean domain. principal ideal domain, unique factorization domain, Polynomial ring over a field, reducible and irreducible polynomials, irreducibility criteria.

Module III: (20 lectures)
Fields, finite fields, field extensions, Algebraic extensions, Galois Theory.

Module IV: (5 lectures)
Fundamentals of representation theory.

Suggested Readings
1. Topics in Algebra, I. N. Herstein, Wiley Eastern Limited, New Delhi.
2. University Algebra, N. S. Gopalakrishnan, Wiley Eastern.
3. Contemporary Abstract Algebra, J. A. Gallian, Narosa Publishing.
4. Algebra, Dummit & Foote, John Wiley & Sons

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		
CO 3			H	

CO 4				H

MADE0017: DIFFERENTIAL EQUATIONS

(4-0-0)

COURSE OUTCOMES

CO 1: Find the classification of differential equations with existence and uniqueness criteria. (Remembering)
CO 2: Develop appropriate methods to solve linear differential equations. (Applying)
CO 3: Examine the solvability of differential equation and partial differential equation. (Analysing)
CO 4: Determine various methods for the solution of Partial Differential Equation. (Evaluating)

Module I: (16 lectures)

Classification of Differential Equations, their origin and solution; Exact differential equation and integrating factors, special integrating factors, linear equation and Bernoulli equations. existence and uniqueness for initial Value problem: Peano and Picard theorem.

Module II: (18 lectures)

Second order Linear Differential equations, dimension of the solution space for homogeneous equations, general solution for non-homogeneous Equations.; method of undetermined coefficients, method of variation of parameters. Power series solution about an ordinary point, solution about singular points, Frobenius method BVP, Sturm-Liouville Problem, Orthogonality of Characteristic functions, Fourier series exp.

Module III: (26 lectures)

Origin of Partial Differential Equation, Linear and quasi-linear partial differential equation, method of characteristics, Lagrange's and Charpit's method to solve first order PDE, Cauchy problem for first order PDE, Classification of PDEs (second order), Method of separation of variables for Heat (one and two dimension), Wave and Laplace equation.

Suggested Readings

1. Differential Equations, S. L. Ross, Wiley-India.
2. Partial Differential Equations an introduction, W. Strauss, John Wiley and Sons Ltd.
3. Linear PDE for scientist and engineers, Tye Myint U and L. Debnath; Birkhauser, Boston.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H	M	
CO 2	M	H	
CO 3		M	H
CO 4			H

MAMT0018: MATHEMATICAL METHODS I

(4-0-0)

COURSE OUTCOMES

CO 1: Explain basic numerical methods to solve algebraic and transcendental equations. (Understanding)
CO 2: Classify interpolation formulae and solve different numerical problems. (Applying)
CO 3: Make use of Interpolation formulae to solve numerical differentiation and integration. (Evaluating)
CO 4: Compose various methods to obtain numerical solutions of ODE and PDE. (Creating)
CO 5: Determine the methods to solve linear programming problems. (Evaluating)

Module I: (10 lectures)

Numerical solution of algebraic and Transcendental equations: Bisection method, Regula-Falsi methods and Newton- Raphson method; Rate of convergence of these methods. Of systems of linear algebraic equations: Gauss elimination method, Gauss-Jordan method, Gauss-Seidel methods, Error analysis.

Module II: (6 lectures)

Interpolation: Finite differences, Newton's forward and backward difference interpolations, Central difference interpolation, Lagrange's and Newton's divided difference interpolation, Hermite and spline interpolation.

Module III: (15 lectures)

Numerical differentiation and integration: Differentiation using interpolation formulae (Newton's forward and backward difference interpolation, Central difference interpolation, Lagrange's and Newton's divided difference interpolation), Numerical integration by trapezoidal and Simpson's 1/3 and 3/8 rule, Romberg method.

Module IV: (14 lectures)
Numerical solutions of ODE and PDE: Initial value problem for ODE of first and second order, Taylor series method, Picard's method, Euler and modified Euler methods, Runge-Kutta methods, Milne's and Adam's predictor and corrector methods, Finite difference solution of second order ODE and PDE.

Module V: (15 lectures)
Mathematical formulation of LPP, Solution of a LPP by graphical method, simplex method, Revised simplex method, Duality. Transportation and Assignment problem, Two person-zero sum games. Equivalence of Rectangular game and linear programming.

Suggested Readings
1. Numerical methods, Problems and solutions, M.K. Jain, S. R. K. Iyengar, R. K. Jain, New Age International(P) Ltd.
2. Elementary Numerical Analysis – An Algorithmic Approach, S D. Conte and Carlde Boor, McGrawHill.
3. Introduction to Numerical Analysis, K. E. Atkinson, John Wiley.
4. Operations Research: An Introduction, H. A. Taha, Macmillan.
5. Operations Research, Kant Swarup, P. K. Gupta and M. M. Singh, Sultan Chand and Sons.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M			
CO 2	M	M	H		
CO 3				H	
CO4	L	M	M	H	
CO5					H

MATF0019: TOPOLOGY AND FUNCTIONAL ANALYSIS
(4-0-0)

COURSE OUTCOMES
CO 1: Demonstrate the basic characteristics and properties of metric spaces. (Understanding)
CO 2: Categorize the various properties related to Topological Spaces. (Creating)
CO 3: Examine the Connectedness and Compactness of Topological Spaces. (Analysing)
CO 4: Deduct various results from separation axioms and Metrization theorem. (Evaluation)
CO 5: Explain basic results related to Normed linear spaces, Banach spaces and Hilbert spaces. (Understanding)

Module I: (10 lectures)
Metric spaces, open and closed sets, limit points, interior points, convergence, Cauchy sequence, completeness, completion in metric spaces, separable spaces.

Module II: (10 lectures)
Topological Spaces, Basis for a topology, The order topology, The product topology, The subspace topology, Closed sets and limit points, convergent sequence, Continuous function, homeomorphism, metric topology.

Module III: (10 lectures)
Connected spaces, connected subspaces of real line, Components, local connectedness, Compact spaces, compact spacesof real line, limit point compactness, local compactness.

Module IV: (15 lectures)
The countability axioms, the separation axioms, Urysohn Lemma, Urysohn metrization theorem. Tychonoff's theorem, Stone-Cech Compactification.
Local finiteness, the Nagata Smirnov Metrization theorem, paracompactness, the Smirnov Metrization theorem, space of continuous function.

Module V: (15 lectures)
Normed linear spaces, properties of normed linear spaces, Banach space, Hahn-Banach theorem, Open mapping theorem, Closed graph theorem, Principle of uniform boundedness, Hilbert spaces, Orthogonal complements, orthonormal sets, the Reisz representation theorem, Bessel's inequality, Parseval's identity, The dual space, self –adjoint, normal and unitary operators.

Suggested Readings
1. Introduction to topology and modern analysis, G. F. Simmons, Tata-McGraw-Hill.
2. Topology, J. R. Munkres, Prentice Hall.
3. Introductory functional analysis with application, E. Kreyszig, John Willey and Sons.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M	M		
CO 2	M	H	M		
CO 3		M	H		
CO 4				H	
CO 5					H

MACA0020: COMPLEX ANALYSIS

(4-0-0)

COURSE OUTCOMES

CO 1: Define the concept analytic functions and the significance of CR-equations. (Remembering)
CO 2: Explain the basic concepts and theorems associated with complex functions. (Understanding)
CO 3: Apply Cauchy Integrals formulae and Residue theorem to evaluate real and complex integrals. (Applying)
CO 4: Analyse various theorems associated with entire functions and Complex integrals. (Analysing)

Module I: (10 lectures)

Complex numbers and their properties, Complex Plane, Polar form of complex numbers, Powers and roots, set of pointsin the complex plane. Complex function, Special power functions, Reciprocal function.

Module II: (15 lectures)

Limits and Continuity, differentiability and analyticity, Cauchy-Reimann equations, Harmonic functions, Exponential and Logarithmic functions, complex powers, Trigonometric and Hyperbolic functions.

Module III: (20 lectures)

Complex integrals, Cauchy-Goursat Theorem, Cauchy's integral formula and their consequences, Taylor and Laurent series, Zeroes and poles, Residues and residue theorem and consequences, evaluation of real improper integrals.

Module IV: (15 lectures)

Entire function, Liouville's theorem, Maximum modulus principle, Schwarz Lemma, Schwarz-Pick Lemma, OpenMapping theorem. Conformal Mapping, Linear Fractional Transformations, Cross Ratio.

Suggested Readings

1. Foundation of Complex Analysis, S. Ponnusamy, Alpha science International.
2. Functions of one Complex variable I, J. B. Conway, Springer.
3. Complex variable, Murray Spiegel, Seymour Lipschutz, John Schiller, Dennis Spellman, Schum's outlines.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2	M	H		
CO 3			H	
CO 4			M	H

MAMP0021: MEASURE THEORY AND PROBABILITY THEORY

(4-0-0)

COURSE OUTCOMES

CO 1: Explain the concept of algebra of sets, measure and Lebesgue measure. (Understanding)
CO 2: Demonstrate understanding of the statement and proofs of monotone convergence theorems and their applications. (Understanding)
CO 3: Explain the axioms and properties of probability theory. (Understanding)
CO 4: Develop probabilistic concepts within the framework of measure theory. (Applying)

Module I: (12 lectures)

Algebra of sets, Borel set, extension of measures, Lebesgue measure on: outer measure, measurable sets and Lebesgue measure. Extension of measure, Lebesgue-Stieltjes measures and distribution functions.

Module II: (18 lectures)

Measurable functions and Integration: Lebesgue integral, Monotone convergence theorem, extended monotone convergence theorem, Fatou's Lemma, dominated convergence theorem, Comparison of Riemann and Lebesgue integral. Radon-Nikodym

Theorem and related results.

Module III: (10 lectures)
Probability axioms, sample spaces, events, law of total probability, conditional probability, Bayes Theorem and independence.

Module IV: (20 lectures)
Random Variables, types of random variables, distribution functions, function of random variables, standard univariate discrete and continuous distributions and their properties; expectations, moments, moments generating functions; Chebyshev's inequality, joint, marginal and conditional distributions; covariance, correlation; Random vectors, functions of random vectors, strong and weak law of large numbers, central limit theorem.

Suggested Readings

1. Probability and Measure Theory, R.B. Ash and C. Doleans Dade, Academic press.
2. An Introduction to Probability Theory and its Applications, W. Feller, Wiley.
3. An Introduction to Probability and Statistics, V. K. Rohatgi and A. K. Md. E. Saleh, Wiley.
4. Real Analysis, Royden, H.L. and Fitzpatrick, P. M., Pearson.
5. Measure Theory, Halmos, P. R., Springer-Verlag.

Mapping of Cos to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M		
CO 2		H		
CO 3	M		H	
CO 4			M	H

MAMD0022: MATHEMATICAL METHODS II

(4-0-0)

COURSE OUTCOMES

CO 1: Gain the knowledge fundamentals concepts of calculus of variation and integral equations and their applications. (Understanding)

CO 2: Use concept of Laplace and Fourier transform in solving science and engineering problems. (Applying)

CO 3: Analyse and classify Differential Equations, Partial Differential Equations and Integral Equations and their solutions by various methods. (Analysing)

CO 4: Determine the solutions of various classes of differential equations and special functions with their properties. (Evaluating)

Module I: (10 lectures)
Linear functional, minimal functional theorem, general variation of a functional, Euler- Lagrange equation, Necessary and sufficient conditions for extrema, strong extremum and weak extremum, broken extremum; Weirstras Erdmann corner conditions.

Module II: (10 lectures)
Linear integral equation of the first and second kind of Fredholm and Volterra type Reduction of ordinary differential equations into integral equations, Solution of integral Equations with separable kernels, Characteristic numbers and eigenfunctions, resolvent kernel.

Module III: (10 lectures)
Fourier Transform. Properties of Fourier Transform, Fourier sine and cosine transform, Inverse Fourier Transform, Application of Fourier transform to ordinary and partial differential equations of initial and boundary value problems.

Module IV: (12 lectures)
Laplace Transform and its properties, Convolution theorem, Inverse Laplace Transform, Application of Laplace Transform to solution of ordinary and partial differential equations of initial boundary value problems.

Module V: (18 lectures)
General solution of Bessel equation, Recurrence relations, Orthogonal sets of Bessel functions, Modified Bessel functions, Applications. General solution of Legendre equation, Legendre polynomials, Associated Legendre polynomials, Rodrigues formula, Orthogonality of Legendre polynomial, Concept and calculation of Green's function, Approximate Green's function, Green's function method for differential equations.

Suggested Readings

1. Introduction to Theory and Application of Laplace Transforms, Doetsch G., Springer Verlag.

2. Theory and problems of Laplace transforms, Murray Spiegel, Schum's Outline Series Tata Mc Graw Hill.
3. Integral Transforms & their applications, Brian Daries, Springers.
4. Integral Transforms & their applications, L Debnath, D Bhatta, Chapman & Hall/CRC.
5. Fourier analysis and its applications, G.B. Folland sally series, American Mathematical Society.
6. Fourier and Laplace Transform, R.J. Becrends H.G., Morsche. J.C. Vande Berg and E.M. VandeVrie, Cambridge Press.
7. Introduction to Fourier analysis and wavelets, Graduate Studies in Mathematics, Mark A. Pinsky, AmericanMathematical Society.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO2		H	M	M	
CO3			H		
CO4			M	M	H

MACL0023: CLASSICAL MECHANICS

(4-0-0)

COURSE OUTCOMES

CO 1: Learn and understand the fundamental of motion and its governing equations. (Understanding)
CO 2: Extend the concept of rigid body in two dimensions. (Understanding)
CO 3: Apply concepts of Lagrangian and Hamiltonian methods to model various practical situations. (Applying)
CO 4: Analyse diverse physical motions by studying the properties of mathematical model. (Analysing)
CO 5: Evaluate different practical situations by discussing the properties of existing models. (Evaluating)

Module I: (18 lectures)

Introduction to the ideas of constrained motion, Different classifications of constraints of motion, Holonomic and nonholonomic constraints, rhenomic and scleronomic dynamical constraints, Concept of degree of freedom.
Introduction to generalized coordinates, generalized velocities, Total Kinetic energy of a system of particles in terms of generalized velocity. Introduction to generalized momenta and generalized force. D'Alemberts principle and Lagrangian form of equation motion of a dynamical system of N particles. Calculus of variations, Euler-Lagrange equation, applicationof calculus of variations in dynamical problems.

Module II: (12 lectures)

Two-dimensional motion of rigid bodies, Euler 's dynamical equations of motion for a rigid body, Motion of a rigid body about an axis, motion about revolving axis, Eulerian angles, Euler's theorem on the motion of a rigid body, infinitesimal rotations, rate of change of a vector, Coriolis force, Euler 's equations of motion, force free motion of a rigid body.

Module III: (15 lectures)

Hamilton's principle, Lagrange's equations from Hamilton's principle, extension of Hamilton's principle to non- conservative and non-holonomic systems, conservation theorems and symmetry properties. Hamilton's equations of motion, conservation theorems and physical significance of Hamiltonian, Hamilton's equations from variational principle, principle of least action.

Module IV: (15 lectures)

Hamilton Jacobi Method: Hamilton - Jacobi equation, Time independent Hamilton - Jacobi equation, canonical transformation generated by Hamilton characteristic function, application of Hamilton- Jacobi equation in solving problems of mechanics.

Suggested Readings

1. Classical Mechanics, H. Goldstein, Addison Wesley Publications, Massachusetts.
2. Lagrangian and Hamiltonian Mechanics by M.G. Calkin, World Scientific, Singapore.
3. Classical Mechanics, Takwale, R. G. & Puranik, P. S., Tata-McGraw Hill.
4. Problems and Solutions on Mechanics, Yung-Kuo, World Scientific.

Mapping of COs to Syllabus:

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2	M	H	M	
CO 3	L	M	H	M
CO 4		M	H	M
CO 5		L	M	H

MADS0030: DISCRETE MATHEMATICS

(4-0-0)

COURSE OUTCOMES

CO 1: Explain how to work with some of the discrete structures which include sets, relations, functions, graphs andrecurrence relation. (Understanding)
CO 2: Construct mathematical statements using logical connectives and quantifiers. (Creating)
CO 3: Apply basic counting techniques to solve combinatorial problems. (Applying)
CO 4: Develop the given problem as graph networks and solve with techniques of graph theory. (Understanding)

Module I: Set Theory (18 lectures)

Sets and classes, relations and functions, Equivalence Relation, Partial Ordering Relation, Cantor's diagonal argument and The Power Set theorem, Schroeder-Bernstein theorem. Principles of Mathematical Induction: The Well-Ordering Principle, Recursive definition, Cardinal and ordinal numbers, Lattice; The Division algorithm: Prime Numbers, The Greatest Common Divisor: Euclidean Algorithm, The Fundamental Theorem of Arithmetic.

Module II: Logic (15 lectures)

Propositional logic: Syntax, Semantics, Validity and Satisfiability, Basic Connectives and Truth Tables, Logical Equivalence: The Laws of Logic, Logical Implication, Rules of Inference, The use of Quantifiers. Proof Techniques: Some Terminology, Proof Methods and Strategies, Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof of Necessity and Sufficiency. Predicate Calculus.

Module III: Combinatorics (12 lectures)

Combinatorics: Mathematical induction, recursive mathematical definitions, basics of counting, permutations, combinations, inclusion-exclusion, recurrence relations (nth order recurrence relation with constant coefficients, Homogeneous recurrence relations, Inhomogeneous recurrence relation), generating function (closed form expression, properties of generating functions., solution of recurrence relation using generating functions, solution of combinatorial problem using generating functions).

Module IV: Graphs and Trees (15 lectures)

Graphs and their properties, Degree, Connectivity, Path, Cycle, Sub Graph, Isomorphism, Eulerian and Hamiltonian Walks, Graph Colouring, Colouring maps and Planar Graphs, Colouring Vertices, Colouring Edges; trees.

Suggested Readings

1. Discrete Mathematics with Applications, Susanna S. Epp, Wadsworth. Publishing Co. Inc.
2. Elements of Discrete Mathematics A Computer Oriented Approach, C L Liu and D P Mohapatra, Tata McGraw – Hill.
3. Discrete Mathematical Structure and Its Application to Computer Science, J.P. Tremblay and R. Manohar, TataMcGraw-Hill.
4. Discrete Mathematics, N. Biggs, Oxford University Press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		
CO 3			H	
CO 4	M			H

MACP0031: COMPUTER PROGRAMMING IN C

(2-0-0)

COURSE OUTCOMES

CO 1: Interpret the concepts of C language's syntax. (Understanding)
CO 2: Choose the loops and the decision-making statements to solve various problems. (Applying)
CO 3: Implement standard algorithms and translate pseudo-codes into C programs. (Applying)
CO 4: Apply their analytical skills for choosing the right data structure, function, data types and develop logic to solve various instances of problems. (Analysing)

Module I: Introduction to Algorithms and Programming Languages (8 lectures)

Introduction to structured programming and problem-solving methods: Algorithms, key features of algorithms, flowcharts, pseudocode, generation of programming languages, structured programming languages. Overview of C:Introduction to C, basic structure of a C program, compiling and executing C programs, comments, characteristics of a good program, character set, identifiers, keywords, data types, constants and variables, I/O statements, operators and expressions, precedence and associativity of operators, type conversion and type casting.

Module II: Decision Control Statements, Loops and Functions (8 lectures)
Decision Control Statements and Loops: Introduction to decision control statements, conditional branching statements, goto statements, while loop, do-while loop, for loop, nested loops, break and continue statements Functions: Need for functions, function declaration and definition, user defined and library functions, passing parameters to function, return statement, scope of variables, storage classes, recursive functions.

Module III: Arrays (7 lectures)
Arrays: One-dimensional arrays, passing array to function, multidimensional arrays and their applications, character arrays, dynamic memory allocation. Some algorithms and programs on theory of matrices and numbers like Sieve methodfor primality test, generation of twin primes, solution of congruence using complete residue system, addition, subtractionand multiplication of matrices, transpose, and determinant.

Module IV: Structures, Files (7 lectures)
Structures and Unions: Declaration of structures and simple implementation of structures, unions, enumerated data types. Files: Introduction to files, file managements-open, close, input/output operations, command line arguments.

Suggested Readings

1. Computer Fundamentals and Programming in C, Thareja R., Oxford University Press, New Delhi.
2. Computer Programming in C Rajaraman V., 2005, Prentice-Hall of India Pvt. Ltd.
3. Computer Fundamental and C Programming, Balagurusamy E., Tata McGraw Hill publishing company limited, New Delhi.
4. Programming with C (Schaum's outlines series), Gottfried Byron S., Tata McGraw Hill publishing company limited,
5. New Delhi.
6. Primes and Programming – An Introduction to Number Theory with Programming, Goblin P., 1993, Cambridge University Press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			M
CO 2		H	M	
CO 3		M	H	M
CO 4				H

MARM0032: RESEARCH METHODOLOGY FOR MATHEMATICAL SCIENCES

(3-0-0)

COURSE OUTCOMES

CO 1: Learn and understand some basic concepts of research and its methodologies. (Remembering)
CO 2: Compare different results and identify appropriate research topics with the help of literature review. (Understanding)
CO 3: Select and define appropriate research problem and parameters. (Applying)
CO 4: Organize and conduct research (advanced project) in a more appropriate manner. (Evaluating)
CO 5: Design and write a research proposal, research report and thesis. (Creating)

Module I: (12 lectures)
Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, literature survey of a research topic, Importance of knowing how Research is done, Research Process, Criteria of good Research, Problems encountered by Researchers in India.
Defining the Research problem: Selecting the Problem, Necessity of Defining the Problem, Techniques involved in defining a problem.

Module II: (15 lectures)
Report writing: Significance of Report writing, Difference steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Precautions for Writing Research Reports, Publishing a paper, Research proposal writing, Copyright issues, Ethics and plagiarism.

Module III: (18 lectures)
Research tools: MathSciNet, Scopus, ISI Web of Science, Impact factor, h-index, Google Scholar, ORCID, JStor, Online and open access journals, Virtual library of various countries. Scientific writing and presentation: LaTeX, Beamer. Software for Mathematics: MATHEMATICA, MATLAB.

Suggested Readings
1. Research Methodology; C.R. Kothari, New Age Publishers.
2. LaTeX, a Document Preparation System, L. Lamport, Addison-Wesley.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H	M	M
CO 2	M		
CO 3	M		M
CO 4		H	
CO 5		M	H

MAFA0033: FIELD THEORY AND COMMUTATIVE ALGEBRA
(4-0-0)

COURSE OUTCOMES
CO 1: Define the key notions of field theory and outline their interrelation. (Remembering)
CO 2: Demonstrate the key concepts by interpreting them under various hypotheses. (Understanding)
CO 3: Identify perfect fields using separable extensions, construct examples of automorphism group of a field. (Applying)
CO 4: Analyse the proof a theorem by imposing the rules of commutative algebra. (Analysing)
CO 5: Determination of validity of a problem such as insolvability of quantic by field theoretic techniques. (Evaluating)

Module I: (10 lectures)
Field extensions. Simple extensions, algebraic and transcendental case. Minimum polynomial. Construction of simple algebraic extension from an irreducible polynomial. Classification of simple extensions.

Module II: (15 lectures)
Degree of extension. Algebraic elements and algebraic extensions; finite extensions. Algebraic numbers. Geometric constructions with ruler and compasses. The Galois group of an extension. Examples. Splitting field for a polynomial. Existence, uniqueness up to isomorphism. Normal extensions. Relation to splitting fields. Normality of intermediate extension. Normal closure.

Module III: (15 lectures)
Separability. Example of inseparable polynomial. Separability of all polynomials in characteristic zero. Separable extensions. Separability of intermediate extensions. Degree of the extension corresponding to a group of field automorphisms.

Module IV: (12 lectures)
Integral extension, integral closure of a ring, finitely generated modules, localization of a ring, construction, localization of modules, Dedekind domain, factorization ideals, unique factorization of ideals.

Module V: (8 lectures)
Galois groups of normal separable extensions, Galois extensions, factorization of prime ideals in Galois extensions, discrete valuation.

Suggested Readings
1. A First Course in Abstract Algebra, J.B. Fraleigh, Addison-Wesley.
2. Galois Theory, I. Stewart, Chapman and Hall.
3. Abstract Algebra, Dummit D.S.; Foote R. M., John Wiley and sons.
4. Introduction to Commutative Algebra, Atiyah M.F.; Macdonald I.G., Addision-Wesley.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M	M	M	M
CO 2		H			
CO 3		M	M	M	
CO 4				H	M
CO 5					H

MANT0034: NUMBER THEORY
(4-0-0)

COURSE OUTCOMES

CO 1: Identify and analyse different types of divisibility tests, Euler's theorem, Wilson theorem etc and solve various related
CO 2: problems. (Applying)
CO 3: Apply Quadratic Reciprocity law and other methods to classify numbers as primitive roots, quadratic residues, and quadratic nonresidues. (Applying)
CO 4: Evaluate primitive roots and Pell's equation with the use of continued fraction. (Evaluating)
CO 5: Perceive classical cipher and public cryptosystem and their cryptanalysis. (Evaluating)

Module I: (15 lectures)
Divisibility, Congruences, complete residue system, reduced residue system, Chinese remainder theorem., Arithmetic modulo p, Fermat's little theorem, Wilson's theorem.
Arithmetic functions-Mobius function, Euler function.

Module II: (15 lectures)
Quadratic residues and congruences of second degree in one unknown, Legendre symbol, Jacobi symbol, congruences of second degree with prime modulus and with composite modulus.

Module III: (18 lectures)
Primitive roots and indices, order, necessary and sufficient condition for the existence of primitive roots, construction of reduced residue system.
Continued fractions, simple continued fractions, approximation of irrational numbers by continued fractions, solution of Pell's equation.
Introduction to partitions, geometric representation, generating functions, Euler's Pentagonal number theorem.

Module IV: (12 lectures)
Basic of Cryptography: History of cryptography, terminologies used in cryptography; Substitution Techniques- The Caesar Cipher, One Time Pads, The Vernam Cipher, Book Cipher; Transposition Techniques-Encipherment/Decipherment Complexity, Public Key Cryptography: Characteristics of Public Key System; RSA Technique-Encryption –Method; Diffie- Hellman Scheme.

Suggested Readings

1. Elementary Number Theory, M. Burton, Universal Book Stall, New Delhi.
2. An Introduction to the Theory of Numbers, G. H. Hardy and E. M. Wright, Oxford, Clarendon Press.
3. Number Theory, G. E. Andrews, Hindustan Publishing Corporation, New Delhi.
4. Number Theory, S. G. Telang, Tata McGraw Hill Publishing Company Limited, New Delhi.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M	M	
CO 2		H		
CO 3	M		H	
CO 4	M			H

MAML0035: MATHEMATICAL LOGIC
(4-0-0)

COURSE OUTCOMES

CO 1: Interpret any Mathematical statement into the language of logic. (Understanding)
CO 2: Analyse various methods of proofs and deduction theorems. (Analysing)
CO 3: Interpret the syntax of first-order logic and semantics of first-order languages. (Understanding)
CO 4: Analyse the validity a problem by means of completeness and consistency. (Analysing)
CO 5: Determine the valuation and validity of various logical statements. (Evaluating)

Module I: (15 lectures)
Propositions, truth table, negation, conjunction and disjunction. Adequate set of connectives, propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Arguments and validity.

Module II: (15 lectures)
Formal definition of proof, various methods of proof, theorem and deduction, theory of L of statement calculus. Valuation and tautology in L, extensions of L, adequacy theorem of L.

Module III: (15 lectures)
First order logic, truth values of well-formed formulas, first order systems with equality, first order arithmetic, formal set theory.

Module IV: (15 lectures)
Completeness and compactness, notion of consistency, Boolean algebra, incompleteness, first incompleteness theorem, undecidability.

Suggested Readings
1. Logic for Mathematicians - Hamilton A. G., Cambridge University press.
2. Introduction to Mathematical Logic - Mendelson E., CRC Press, Taylor and Francis Group.
3. Fundamentals of Mathematical Logic, Hinman P. G., A.K. Peters, 2005, Wellesley.
4. Mathematical Logic, 2nd edition, Ebbinghaus H.D., Flum J., Thomas W., Springer-Verlag

Mapping of Cos to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H	M	M	
CO2	M	H		
CO3	M	M	H	
CO4	M			H
CO5		M	M	M

MAFS0036: FUZZY SETS AND APPLICATIONS
(4-0-0)

COURSE OUTCOMES
CO 1: Classify the crisp and fuzzy set theorems. (Understanding)
CO 2: Apply fuzzy set theory in modelling and analysing uncertainty in a decision problem. (Applying)
CO 3: Analyse and examine the difference between the crisp set and fuzzy set concepts. (Analysing)
CO 4: Determine fuzzy set theory and uncertainty concepts. (Evaluating)

Module I: (17 lectures)
Fuzzy sets - Fuzzy numbers, fuzzy numbers in the set of Integers, arithmetic with fuzzy numbers. Definition of fuzzy sets, α-level sets, convex fuzzy sets. Basic operations on fuzzy sets, types of fuzzy sets, Cartesian products, algebraic products, bounded sum and difference, t-norms and t-conorms. Fuzzy sets in contrast of probability theory.

Module II: (12 lectures)
The extension principle - the Zadeh's extension principle, image and inverse image of fuzzy sets. Fuzzy relations, basic properties of fuzzy relations, fuzzy relations and approximate reasoning.

Module III: (16 lectures)
Fuzzy relations and fuzzy graphs, composition of fuzzy relations, min-max composition and its properties, fuzzy equivalence relations, fuzzy relational equations, fuzzy graphs.

Module IV: (15 lectures)
Possibility Theory: Fuzzy measures, evidence theory, necessity measure, probability measure, possibility measure,possibility distribution, possibility theory and fuzzy sets, possibility theory and probability theory.

Suggested Readings
1. Fuzzy Sets and Fuzzy Logic: Theory and Applications, Klir, G. J. and Yuan, B., Prentice Hall of India, New Delhi.
2. 2 Fuzzy set theory and its Applications, Zimmermann, H. J., Allied publishers Ltd., New Delhi.
3. Fuzzy sets, fuzzy logic applications, G. Bojadzieve and M. Bojadzieve, World Scientific.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M		H
CO 2	M	H	M	M
CO 3		M	H	
CO 4			M	H

MAFD0037: FLUID DYNAMICS I
(4-0-0)

COURSE OUTCOMES

CO 1: Develop an appreciation for the properties of Newtonian fluids. (Remembering)
CO 2: Understand the dynamics of fluid flows and the governing non-dimensional parameters. (Understanding)
CO 3: Apply concepts of mass, momentum and energy conservation to flows. (Applying)
CO 4: Formulate the problems on buoyancy and solve them. (Evaluating)

Module I: (20 lectures)
Classification of fluids, Lagrangian and Eulerian methods. Equation of continuity. Irrotational flow, vorticity vector, equi-potential surfaces. Streamlines, pathlines, streak lines of the particles, stream tube and stream surface. Mass flux density, conservation of mass leading to equation of continuity. (Euler's form.) Conservation of momentum and its mathematical formulation: Euler's form. Integration of Euler's equation under different conditions. Bernoulli's equation, steady motion under conservative body forces.

Module II: (15 lectures)
Boundary surface, Theory of irrotational motion, Kelvin's minimum energy and circulation theorems, potential theorems. Some two-dimensional flows of irrotational, incompressible fluids. Complex potential. Sources, sinks, doublets and vortices. Milne-Thomson circle theorem, Images with respect to a plane and circles. Blasius theorem.

Module III: (10 lectures)
Vortex motion and its elementary properties. Wave motion in a gas. Speed of Sound. Equation of motion of a gas. Subsonic, sonic and supersonic flows of a gas. Isentropic gas flows. Flow through a nozzle. Normal and oblique shocks.

Module IV: (15 lectures)
Three-dimensional flows. Sources, sinks, doublets. Axi-symmetric flow and Stokes stream function. Butler sphere theorem, Kelvin's inversion theorem and Weiss's sphere theorem. Images with respect to a plane and sphere. Axi- symmetric flows and stream function. Motion of cylinders and spheres.

Suggested Readings

1. A Treatise on Hydrodynamics, W. H. Besant and A. S. Ramsey, CBS.
2. Text book of Fluid Dynamics, F. Charlton, CBS.
3. Fluid Mechanics, P.K. Kundu and I.M. Cohen, Academic Press.
4. Theoretical Hydrodynamics, L.M. Milne Thomson, The Macmillan company, USA.
5. Ideal and incompressible fluid dynamics, N.E. Neill and F. Chorlton, Ellis Horwood Ltd.
6. Fluid Dynamics, D.E. Rutherford, Oliver and Boyd Ltd, London.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M		
CO 2	M	H		
CO 3	M		H	
CO 4			M	H

MARC0038: RIEMANNIAN GEOMETRY AND TENSOR CALCULUS
(4-0-0)

COURSE OUTCOMES

CO 1: Recall the concept of calculating length of a curve and area of a domain in manifold *M.* (Remembering)
CO 2: Explain the Riemannian metric on surfaces embedded in Euclidean space. (Understanding)
CO 3: Apply the properties of geodesics on a Riemannian manifold in Euclidean space and for Lobachevski plane. (Applying)
CO 4: Evaluate Riemann curvature tensor. (Evaluating)

Module I: (15 lectures)
Introduction to Tensor, space of n dimensions, subspaces; transformation of coordinates; scalar; contravariant (tangent) and covariant (cotangent) vectors; scalar product of two vectors; tensor space of rank more than one contravariant and covariant tensors; symmetric and skew-symmetric tensors; addition and multiplication of tensors; contraction; composition of tensors; quotient law; reciprocal symmetric tensors of the second order, relative tensor, group properties.

Module II: (15 lectures)
Riemannian space; fundamental tensor; length of a curve; magnitude of a vector; associated covariant and contravariant

vectors; inclination of two vectors, orthogonal vectors; coordinate hypersurfaces; coordinate curves; field of normals to a hypersurface; principal directions for a symmetric covariant tensor of the second order; Euclidean space of n dimensions.

Module III: (15 lectures)
Levi-Civita tensors; Christoffell symbols and second derivatives; need for covariant derivative; parallel transformations; covariant derivative of a contravariant and covariant vector; curl of a vector and its derivative; covariant differentiation of a tensor; divergence of a vector.

Module IV: (15 lectures)
Gaussian curvature; Riemann curvature tensor; geodesics; differential equations of geodesics; geodesic coordinates; geodesic deviation; Riemannian coordinates; geodesic in Euclidean space; straight lines.

Suggested Readings
1. An Introduction to Riemannian Geometry and Tensor Calculus, Cambridge university Press, C. E. Weatherburn.
2. Aspects of Gravitational Interactions, Nova Science publications Inc., Commack, NY, S. K. Srivastava & K. P. Sinha.
3. Tensor Analysis John Wiley & Sons, Inc., I. S. Sokolnikoff.
4. Tensor Calculus and Riemannian Geometry, Krishna Prakasahan Media (P) Ltd, D C Agarwal.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M	M	
CO 2		H		
CO 3		M	H	
CO 4				H

MANS0039: NUMERICAL SOLUTION OF PDE
(4-0-0)

COURSE OUTCOMES
CO 1: Define matrix norm, normed linear space and related results. (Remembering)
CO 2: Classify initial value problems (IVPs) and Boundary Value Problems (BVPs). (Understanding)
CO 3: Apply different numerical methods to PDEs. (Applying)
CO 4: Analyse accuracy of common numerical methods. (Analysing)
CO 5: Assess different numerical methods in order to find the approximate numerical solution of the PDEs. (Evaluating)

Module I: (10 lectures)
Review normed linear spaces, matrix norm and related results, eigenvalues for tridiagonal matrices. Matrix stability.

Module II: (20 lectures)
Classification of PDEs, Finite difference approximations to partial derivatives. Solution of one-dimensional heat conduction equation by Explicit and Implicit schemes (Schmidt and Crank Nicolson methods), CFL condition, stability and convergence criteria.

Module III: (15 lectures)
Hyperbolic equation, explicit/implicit schemes, method of characteristics. Solution of wave equation. Solution of 1st order Hyperbolic equation. Von Neumann stability.

Module IV: (15 lectures)
Finite difference method for stationary heat conduction, stability and convergence analyse.

Suggested Readings
1. Numerical methods for Ordinary differential equations, J.C. Butcher, John Wiley & Sons, New York.
2. Numerical methods for Ordinary differential systems: The initial value problem, J.D. Lambert, John Wiley & Sons,New York.
3. Numerical solution of ordinary differential equations, John Wiley, New York, K. Atkinson, W. Han and D.E. Stewart.
4. Finite Difference Methods (Oxford Applied Mathematics & Computing Science Series), G. D. Smith.
5. Numerical Solution of Ordinary Differential Equations (Wiley), E. Kendall, Atkinson, Han Weimin, David E. Stewart.
6. Numerical Methods for Scientific and Engineering Computation, M K Jain, S R K Iyengar, R K Jain, New AgeInternational.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M		
CO 2	M	H		

CO 3			H	M
CO 4			H	M
CO 5	M			H

MACN0040: COMPUTATIONAL NUMBER THEORY
(4-0-0)

COURSE OUTCOMES
CO 1: Explain basic of fundamental number theoretic algorithms. (Understanding)
CO 2: Apply finite field theory in cryptography. (Applying)
CO 3: Analyse primality testing algorithms and their uses in Cryptography. (Analysing)
CO 4: Explain the number theoretic foundations of cryptography and the principles behind their security. (Understanding)

Module I: (10 lectures)
Representation of integers and polynomials, Divisibility and the Euclidean algorithm, extended Euclidean algorithm, Congruences, Chinese Remainder theorem, Hensel's lifting lemma, Modular exponentiation - Some applications to factoring.

Module II: (15 lectures)
Finite Fields, Multiplicative generators, Uniqueness of fields with prime power elements, Quadratic residues and reciprocity.

Module III: (20 lectures)
Primality Testing: Probabilities Primality testing, primality testing for numbers of a special form, AKS primality test including detecting perfect powers; Computing the Order of an element and generating primitive roots (and elements ofa certain order), Computing Discrete Logarithms, Factoring Integers, factoring polynomials and tests constricting irreducible polynomials; Solving equations over Finite Fields including computing square roots.
Elliptic curves: The Geometry of elliptic curves, the Algebra of elliptic curves, elliptic curves overs finite fields, The elliptic curve Discrete Logarithm Problem.

Module IV: (15 lectures)
Cryptosystems and basic cryptographic tools: Secret –key cryptosystems, Public-key cryptosystems, block and stream ciphers, message integrity; message authentication codes, Signature schemes, nonrepudiation, certificates, Hash functions; Some simple cryptosystems, Shift cipher, Substitution cipher, Affinecipher, Vigenère cipher, Hill cipher, Permutation cipher, Stream ciphers, Cryptanalysis of affine, substitution, Vigenère, Hill and LFSR stream ciphers. RSA cryptosystem and Rabin encryption.

Suggested Readings
1. Computational Number Theory, Abhijit Das, CRC Press.
2. Prime Numbers and Computer Method for Factorization, Hans Riesel, Birkhauser.
3. Modern Computer Arithmetic, R.P. Brent and Zimmermann, Cambridge University Press.
4. A Course in Number Theory and Cryptography, Neal Koblitz, Springer- Verlag.
5. Hand book of Applied Cryptography, Van Oorschot and Vanstone S.A, CRC Press.
6. Cryptography Theory and Practice. Douglas R. Stinson & Maura B. Paterson, Chapman & Hall/CRC Press, Taylor & Francis.
7. Cryptography. Simon Rubinstein-Salzedo, Springer.
8. An Introduction to Mathematical Cryptography, Jeffrey Hoffstein, Jill Pipher& Joseph H. Silverman, Springer.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2	M	H		
CO 3	M		H	
CO 4				H

MASC0041: SCIENTIFIC COMPUTING
(4-0-0)

COURSE OUTCOMES
CO 1: Classify Initial conditions and boundary conditions specific to the problem. (Understanding)
CO 2: Apply different numerical methods to ODEs. (Applying)
CO 3: Analyse accuracy of iterative numerical methods. (Analysing)
CO 4: Assess the approximate numerical solution of the linear and nonlinear problems. (Evaluating)

Module I: (13 lectures)
Initial value problems (IVPs) for the system of ordinary differential equations (ODEs); Difference equations; Numerical methods; Local truncation errors, Stability analysis; Interval of absolute stability; Convergence and consistency.

Module II: (13 lectures)
Single-step methods: Taylor series method; Explicit and implicit Runge-Kutta methods and their stability and convergence analysis; Extrapolation method; Runge-Kutta method for the second order ODEs; Stiff system of differential equations.

Module III: (16 lectures)
Multi-step methods: Explicit and implicit multi-step methods; General linear multi-step methods and their stability and convergence analysis; Adams-Moulton method; Adams-Bashforth method; Nystrom method; multi-step methods for the second order IVPs.

Module IV: (18 lectures)
Boundary value problems (BVPs): Two-point non-linear BVPs for second order ordinary differential equations; Finite difference methods; Convergence analysis; Difference scheme based on quadrature formula; Difference schemes for linear eigenvalue problems; Mixed boundary conditions; Finite element methods; Assemble of element equations; Variational formulation of BVPs and their solutions; Galerkin method; Ritz method; Finite element solution of BVPs.

Suggested Readings
1. Numerical methods for Ordinary differential equations, J.C. Butcher, John Wiley Sons, New York.
2. Numerical methods for Ordinary differential systems: The initial value problem, J.D. Lambert, John Wiley & Sons,New York.
3. Numerical solution of ordinary differential equations, K. Atkinson, W. Han and D.E. Stewart, John Wiley, New York.
4. Numerical Methods for Scientific and Engineering Computation (New Age International), M K Jain, S R K Iyengar, R KJain.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M		
CO 2		H	M	
CO 3			H	
CO 4				H

MASF0042: SPECIAL FUNCTIONS
(4-0-0)

COURSE OUTCOMES
CO 1: Define the different types of special functions and their properties. (Remembering)
CO 2: Apply the properties of special functions in the mathematical analysis, functional analysis etc. (Applying)
CO 3: Analyse properties of special functions by their integral representations and symmetries. (Analysing)
CO 4: Illustrate purpose and functions of the gamma and beta functions, Fourier series and Transformation.(Understanding)

Module I: (12 lectures)
The Gamma and Beta Functions: Euler's' integral for Γ(z), the beta function, factorial function, Legendre's duplication formula, Gauss's multiplication theorem, summation formula due to Euler, behaviour of log Γ(z) for large |z |.

Module II: (18 lectures)
The Hypergeometric function: An integral representation. Its differential equation and solutions, F(a,b,c;1) as a functionof the parameters, evaluation of F(a,b,c;1), contiguous function relations, the hypergeometric differential equation, logarithmic solutions of the hypergeometric equation, F(a,b,c;z) as a function of its parameters, Elementary series manipulations, simple transformations, relation between functions of Γ(z) and, Γ(1-z) quadratic transformations, theorem due to Kummer, additional properties.

Module III: (18 lectures)
The Confluent Hypergeometric function: Basic properties of 1F1, Kummer's first formula. Kummer's second formula,
Generalized Hypergeometric Series: The function pFq, the exponential and binomial functions, differential equation, contiguous function relations, integral representation pFq, with unit argument, Saalshutz' theorem, Whipple's theorem, Dixon's theorem, Contour integrals of Barnes' type.

Module IV: (12 lectures)

Bessel Functions: Definition, Differential equation, differential recurrence relations, pure recurrence relation, generating function, Bessel's Integral, index half an odd integer, modified Bessel functions, Introduction to Legendre function, Meijer G-function and some basic properties.

Suggested Readings
1. Special Functions, Macmillan, Earl. D. Ranvillie.
2. Special Functions of Mathematics for Engineers, L.C. Andrews, SPIE Press.
3. Orthogonal Polynomials, Gabor Szego, American mathematical society.
4. Generalized Hypergeometric Functions, Reissue edition, L.J. Slater, Cambridge University Press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M	M	
CO 2		H		
CO 3	M		H	
CO 4	M			H

MAAS0046: ADVANCED ANALYSIS

(4-0-0)

COURSE OUTCOMES

CO 1: Apply Holder and Minkowski inequalities in $L_p$spaces and understand completeness of L_p-spaces. (Applying)
CO 2: Explain the concepts of Banach algebras, culminating in the Gelfand-Naimark theorem. (Understanding)
CO 3: Define the concept of signed measure and significance of Hahn decomposition theorem. (Remembering)
CO 4: Assess the product measure by integrals and discuss the applications of Fubini's theorem. (Evaluating)

Module I: (15 lectures)
L_p −space, Holder inequality, Minkowski's inequality, convergence, completeness, bounded linear functional.

Module II: (17 lectures)
Banach Algebra, Gelfand theory, algebra, Gelfand-Naimark-Segal (GNS) construction, normal operators, spectral theorem, Fredholm operator, space, calculus for normal operators.

Module III: (16 lectures)
Signed measure, Hahn decomposition theorem, mutually singular measure, Radon-Nikodym theorem, Lebesgue decomposition, Reisz representation theorem.

Module IV: (12 lectures)
Outer measure, Caratheorory theorem, product measure, Fubini's theorem.

Suggested Readings
1. A first course in functional analysis, Conway J.B., Springer.
2. Banach algebra techniques in operator theory, Douglas R.G., Academic press.
3. Measure Theory, Halmos P.R., Springer-Verlag.
4. Measure theory and integration, Barra G.de, Wiley-Eastern.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		
CO 3		M	H	
CO 4				H

MAGY0047: GRAPH THEORY

(4-0-0)

COURSE OUTCOMES

CO 1: Relate various basic terminologies, properties and results of graph theory. (Remembering)
CO 2: Classify different types of trees according to their properties. (Understanding)
CO 3: Analyse different properties of factorization, covering and colorability of graphs. (Analysing)
CO 4: Determine different results and properties of Eulerian, Hamiltonian and planner graphs. (Evaluating)

Module I: (13 lectures)
Graph, Types of Graphs, Subgraphs, walk, paths, cycles and components, intersection of graphs, Degrees, Degree sequences. operations on graphs, subdivision (of cycles), incentification (of vertices) homomorphism and contraction (of edges).

Module II: (18 lectures)
Trees, Spanning trees, Kruskal's and Prim's algorithm for minimal spanning tree, cycles, cocycles, cycle space, cocycle spaces, Connectivity, cut vertices, cut edges and blocks, connectivity parameters, Menger's theorem. Matching and covers.

Module III: (14 lectures)
Eulerian and Traversable graphs: Characterization theorems, characterization attempts for Hamiltonian graphs: Two necessary and sufficient conditions for a graph to be Hamiltonian, Factorization; Basic concepts, 1- factorization, 2- factorization, coverings, critical points and lines.

Module IV: (15 lectures)
Planarity and colorability: Plane and planar graphs, outer planar graphs, Euler's Polyhedron formula, Kuratowski's theorems. Chromatic number. Five colour theorem, Four Colour conjecture, chromatic polynomial. Adjacency matrix, Spectrum of a graph.

Suggested Readings
1. Graph Theory, F. Harary, Addison Wesley Publishing Co.
2. Introduction to graph theory, D. B. West, Prentice Hall, India (Pearson).
3. Algebraic Graph Theory, N. Biggs, Cambridge university press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M	M	
CO 2		H		
CO 3			H	
CO 4				H

MACA0048: MULTIVARIABLE CALCULUS
(4-0-0)

COURSE OUTCOMES
CO 1: Demonstrate an understanding of the concepts of multivariate and vector-valued functions and their applications. (Understanding)
CO 2: Examine differentiability of vector valued functions on R^n and understand the relation between directional derivative and differentiability. (Analysing)
CO 3: Learn about generalisation of concept of integration and ability to solve higher dimension integrals. (Understanding)
CO 4: Demonstrate an understanding of Green's, Stokes' and Gauss' theorem and of some physical applications of these theorems. (Applying)

Module I: (15 lectures)
Vectors, dot product of vectors, projection, triangle and Cauchy-Schwarz inequality, cross product of vectors and determinants. Non-linear function, parametric equation of curves, level surfaces, vector fields.

Module II: (20 lectures)
Open sets in Rn, sequences and closed sets, function of several variables, limit of a function of several variables, continuity, sequential continuity, partial and directional derivative, differentiability, chain rule, gradient, curl, divergence, Taylor's theorem, inverse function theorem, implicit function theorem, maximum value theorem, critical points, second derivative test.

Module III: (15 lectures)
Introduction to integration of a function of several variables, multiple integrals, iterated integral, fubini's theorem, physical applications, determinant in n-dimensions, Jacobian and change of variables.

Module IV: (10 lectures)
Green's theorem, Stokes' theorem, Divergence theorem. Manifolds in Rn, Differential forms.

Suggested Readings
1. Calculus and Analytic Geometry, Thomas G. B., Finney R.L., Pearson.
2. Advanced Calculus, P. M. Fitzpatrick, AMS, Indian Edition.
3. Analysis on Manifolds, Munkres J.R., Wisley.
4. Principles of Mathematical analysis, Rudin W. McGraw-Hill.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		
CO 3			H	M
CO 4				H

MAAY0049: ALGEBRAIC NUMBER THEORY

(4-0-0)

COURSE OUTCOMES

CO 1: Demonstrate Field extensions and characterization of finite normal extensions as splitting fields and study prime fields. (Understanding)

CO 2: Illustrate cyclotomic polynomials, cyclic extensions, Radical field extensions and Ruler & Compass constructions. (Understanding)

CO 3: Analyse the role of Minkowski's theorem towards the proof of Four-square theorem. (Analysing)

CO 4: Know the important applications of Galois Theory. (Applying))

CO 5: Discuss Artin-Whaples approximation theorem and Hensel's lemma. (Creating)

Module I: (15 lectures)

Integral extension, integral closure of a ring, finitely generated modules, localization of a ring, construction, localization of modules, norm, trace, transitivity of trace and norm, quadratic extension of rationales, discriminant, Dedekind domain, factorization ideals, unique factorization of ideals, the ideal class group.

Module II: (12 lectures)

Factorization of prime ideals in ring extensions, ramification, Ram-Rel identity, lifting of ideals, norms of ideals, norm of a prime ideal, lattices, Minkowski's theorem, the canonical embedding.

Module III: (12 lectures)

The Logarithmic embedding, The Dirichlet's unit theorem, real and imaginary quadratic fields, units in quadratic fields, cyclotomic extensions, an integral basis of a cyclotomic extension.

Module IV: (12 lectures)

Galois extensions, factorization of prime ideals in Galois extensions, decomposition of inertia groups, local fields, absolute values, discrete valuation.

Module V: (9 lectures)

Artin-Whaples approximation theorem, completions, Hensel's lemma.

Suggested Readings

1. Algebraic Theory of Numbers, Samuel P., Herman.
2. Algebraic Number Theory, Richard A. Mollin, CRC Press, Taylor and Francis group
3. Algebraic Number Theory, Stewart I., Tall D., Chapman and Hall.
4. Problems in Algebraic Number Theory, Esmonde J., Murthy M. R., Springer.
5. Algebraic Number Fields, Janusz G.J., AMS.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H			M	
CO 2	H	H			
CO 3			H		
CO 4			M	H	
CO 5					H

MAFL0050: FLUID DYNAMICS II

(4-0-0)

COURSE OUTCOMES

CO 1: Explain the concept of Newtonian and non-Newtonian fluid. (Understanding)

CO 2: Relate entropy principle to various thermal engineering applications. (Understanding)

CO 3: Apply the concept of second law efficiency and exergy principle to various thermal engineering applications.(Applying)

CO 4: Analyse steady state and transient heat conduction problems of real-life Thermal systems. (Analysing)

Module I: (15 lectures)

Stress components in a real fluid. Relations between rectangular components of stress. Connection between stresses and gradients of velocity. Navier-stokes equations of motion. Plane Poiseuille and Couette flows between two parallel plates, steady flow between concentric rotating cylinders, steady flow through cylindrical pipes; Reynolds' number. Theory of Lubrication. Flow through tubes of uniform cross section in the form of circle, annulus, ellipse and equilateral triangle under constant pressure gradient. Unsteady flow over a flat plate.

Module II: (12 lectures)

Boundary layer concept, Boundary layer equations in two-dimensional flow, Boundary layer flow along the flat plates: Blasius solution. Shearing stress, momentum loss thickness, Boundary layer thickness and skin friction. Exact solution of the steady state boundary layer equations in two-dimensional motion. Flow past a wedge. Flow in a convergent channel.

Module III: (13 lectures)
Boundary layer on a surface with pressure gradient, Momentum integral theorems for Boundary layer, The Von Karman integral relation, Application of Momentum integral equation to Boundary layers: Von Karman-Pohlhansen method, Separation of boundary layer flow, Boundary layer control, Methods of Boundary layer control, Introduction to turbulent flow: Origin of turbulence, Reynold's modification of Navier- Stokes equations for turbulent flow, Semi-empirical theory of turbulence.

Module IV: (20 lectures)
Basic concepts of Magnetohydrodynamics, Maxwell's equations, Frame of reference, Lorentz force, Electromagnetic bodyforce, Fundamental equations of MHD, Ohm's law for a moving conductor, Hall current, Conduction current, Kinematic aspect of MHD, Magnetic Reynolds number, MHD waves: alfven's waves, MHD waves in compressible fluid, MHD approximations, Electromagnetic boundary conditions, One dimensional MHD flow, Hartmann flow, MHD Couette flow, MHD Stoke's flow, MHD Rayleigh's flow, Hartmann-Stoke's boundary layer, Alfven's boundary layer, Two dimensional MHD flow (a) Aligned flow (b) Stagnation point flow, MHD flows in a rotating medium, Effects of Hall current on MHD flows in a rotating channel, MHD heat transfer.

Suggested Readings

1. Boundary Layer Theory, H. Schlichting, McGraw Hill Comp.
2. Laminar Boundary Layer, L. Rosenhead, Dover Pub.
3. Fluid Mechanics [Si Units]:, Cengel, Tata McGraw-Hill Education.
4. Magnetohydrodynamics, T. G. Cowling, Interscience Publishers New York.
5. A Text Book of Magnetohydrodynamics, J.A. Shercliff, Pergamo.
6. Magnetohydrodynamics and Plasma Dynamics, S. I. Pai, Springer Verlag, New York.
7. Magnetofluid Dynamics for Engineers and Applied Physicists, K. R. Cramer and S. I. Pai, McGraw-Hill, New York.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		
CO 3			H	M
CO 4			M	H

MACM0051: CONTINUUM MECHANICS

(4-0-0)

COURSE OUTCOMES
CO 1: Define principles, axioms and hypothesis of governing equations of continuum mechanics. (Remembering)
CO 2: Extend the same principles to solve deformed and un-deformed configuration of particles. (Understanding)
CO 3: Develop the general theory to formulate and solve problems in hydrodynamics. (Applying)
CO 4: Examine the concept of macroscopic behaviour of particles. (Analysing)
CO 5: Estimate the elasticity behaviour of particles in continuum media. (Evaluating)

Module I: (15 lectures)
Principles of continuum mechanics, axioms. Forces in a continuum. The idea of internal stress. Stress tensor, Cauchy's stress principle. Equations of equilibrium. Symmetry of stress tensor. Stress transformation laws. Principal stresses and principal axes of stresses. Stress invariants. Stress quadric of Cauchy. Shearing stresses. Mohr's stress circles.

Module II: (20 lectures)
Deformation. Strain tensor. Finite strain components in rectangular Cartesian coordinates. Lagrangian and Eularian descriptions, Infinitesimal strain components. Geometrical interpretation of infinitesimal strain components. Principal strain and principal axes of strain. Strain invariants, strain quadratic of Cauchy's. The compatibility conditions. Compatibility of strain components in three dimensions. Constitutive equations.

Module III: (10 lectures)
Inviscid fluid. Circulation. Kelvins energy theorem. Constitutive equation for elastic material and viscous fluid. Navier and Stokes equations of motion. Motion of deformable bodies.

Module IV: (15 lectures)
Lagrangian and Eulerian approaches to the study of motion of continua. Material derivative of a volume integral. Equation of continuity. Equations of motion. Equation of angular momentum. Equation of Energy. Strain energy density function.

Suggested Readings

1. Schaum's Outline of Continuum Mechanics, G. E. Mase, Mc-Graw Hill.
2. A first course in continuum mechanics, Y.C. Fung, Cambridge University Press.
3. A course in continuum mechanics. Vol – I, L. I. Sedov, Groningen: Wolters-Noordhoff Publishing.
4. The elements of continuum Mechanics, C. Truesdell, Springer-Verlag.
5. Mathematical Theory of Continuum Mechanics, Rabindranath Chatterjee, Narosa.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		M
CO 3		M	H	M
CO 4			H	
CO 5				H

MATR0052: THEORY OF RELATIVITY

(4-0-0)

COURSE OUTCOMES

CO 1: Recall the fundamental principles of inertial frames and uniform motion in relativistic mechanics. (Remembering)

CO 2: Illustrate the concept of vacuum and various physical quantities in flat space as well as curved space time. (Understanding)

CO 3: Apply the concept of relativistic mechanics to define physical quantities in various coordinate system. (Applying)

CO 4: Analyse the path of motion of particles in presence of curved space-time. (Analysing)

CO 5: Assess the relativistic frequency shifts for sources moving in a gravitational field. (Evaluating)

Module I: (20 lectures)

The special theory of relativity: inertial frames of reference; postulates of the special theory of relativity; Lorentz transformations; length contraction; time dilation; variation of mass; composition of velocities; relativistic mechanics; world events, world regions and light cone; Minkowski space- time; equivalence of mass and energy.

Module II: (10 lectures)

Energy-momentum tensors: the action principle; the electromagnetic theory; energy-momentum tensors (general); energy-momentum tensors (special cases); conservation laws.

Module III: (15 lectures)

General Theory of Relativity: introduction; principle of covariance; principle of equivalence; derivation of Einstein's equation; Newtonian approximation of Einstein's equations.

Module IV: (15 lectures)

Solution of Einstein's equation and tests of general relativity: Schwarzschild solution; particle and photon orbits in Schwarzschild space-time; gravitational red shift; planetary motion; bending of light; radar echo delay.

Suggested Readings

1. The Theory of Relativity, 2nd edition, R.K. Pathria, Hindustan Publishing co. Delhi.
2. General Relativity & Cosmology, J.V. Narlikar, Macmillan co. of India Limited.
3. Aspects of Gravitational Interactions, S. K. Srivastava and K. P. Sinha, Nova Science Publishers Inc. Commack, NewYork.
4. Essential Relativity – W. Rindler, Springer-Verlag.
5. General Relativity – R.M. Wald, University of Chicago Press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2	M	H		M
CO 3			H	
CO 4			M	M
CO 5				H

MAFE0053: FINITE ELEMENT METHODS
(4-0-0)

COURSE OUTCOMES

Learn and relate some basic concept of variational methods and finite element method. (Remembering)

CO 1: Relate simple problems into finite elements. (Understanding)

CO 2: Develop finite element models. (Applying)

CO 3: Analyse finite element method in two dimensional problems. (Analysing)

Module I: (15 lectures)

Integral formulations and variational methods: Weighted integral and weak formulations of boundary value problems, Rayleigh-Ritz method, Method of weighted residuals.

Module II: (15 lectures)

Finite element analysis of one - dimensional problems: Discretization of the domain, Derivation of element equations, Connectivity of elements, Imposition of boundary conditions, Solution of equations, Applications.

Module III: (15 lectures)

Time dependent problems in one dimension: Formulation of eigenvalue problem, Finite element models, Applications of semi discrete finite element models for time-dependent problems, Applications to parabolic and hyperbolic equations.

Module IV: (15 lectures)

Finite element analysis of two- dimensional problems: Interpolation functions – Evaluation of element matrices, Assembly of element equations, Imposition of boundary conditions, Solution of equations, Applications to parabolic and hyperbolic equations.

Suggested Readings

1. An Introduction to the Finite Element Method, Reddy J.N., Tata McGraw Hill, New Delhi.
2. Finite Element Analysis, Schaum's Outline Series, Buchanen G.R. and Rudhramoorthy R, Tata McGraw Hill, New Delhi.
3. Fundamentals of Finite Element Analysis, Huttan D.V., Tata McGraw Hill, New Delhi.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	L		
CO 2		H	M	
CO 3			H	
CO 4			M	H

MADN0054: DESIGN AND ANALYSIS OF ALGORITHMS
(4-0-0)

COURSE OUTCOMES

CO 1: Learn the formal definition and importance of analysis of an algorithm and their asymptotic bounds. (Remembering)

CO 2: Outline different design strategies for the design of algorithms. (Understanding)

CO 3: Develop and analyse algorithms for given problems. (Applying)

CO 4: Compare and analysis different design strategies. (Analysing)

CO 5: Assess various algorithms in terms of correctness, computation cost and memory space used. (Evaluating)

Module I: (16 lectures)

a. Model of computations: Algorithms and their complexity, Random access machines, Computational complexity of RAM programs, A stored program model, abstraction of RAM, A primitive model of computation: Turing machine, relationship between Turing machine and RAM model.

b. Algorithms Analysis Techniques: Efficiency of algorithms, analysis of recursive programs, solving recurrence equations, a general solution for large class of recurrences.

c. Algorithms Design Techniques: Data structures: List, queues and stacks; Set representations, Graphs, Trees, Divide and Conquer algorithms, dynamic programming, Greedy algorithms, Backtracking, Local search algorithms, Balancing.

Module II: (10 lectures)

a. Sorting and Order Statistics: The sorting problem, Radix sorting, Sorting by comparison, Heapsort-an O(n logn) comparison sort, quicksort-an O(n logn) expected time sort, Order Statistics, Expected time of order statistics.

b. Data structures for set Manipulation problems: Fundamental operations on set, Hashing, Binary search, Binary search trees, Optimal binary search trees, A simple-disjoint set union algorithm, tree structures for UNION –FIND problem, Application and extensions of the UNION-FIND algorithm, Balanced tree schemes, Dictionaries and priority queues, Mergeable heaps, Concatenable queues, Partitioning.

Module III: (14 lectures)

a. Algorithms on Graphs: Minimum-cost spanning trees, Depth-first search, Bi-connectivity, Depth-first search of a directed graph, strong connectivity, Path- finding problems, A transitive closure algorithm, A shortest path algorithm, Path problems and matrix multiplication, Single- source problems, Dominators in a directed acyclic graph.

b. Matrix multiplications and related Operations: Basics, Strassen's matrix multiplication algorithm, Inversion of matrices, LUP decomposition of matrices, Application of LUP decomposition, Boolean matrix multiplication.

Module IV: (12 lectures)

a. NP-Complete Problems: Nondeterministic Turing machine, The class P and NP, Languages and problems, NP-completeness of the satisfiability problem, Additional NP-Complete problem, Polynomial space –bound problems.

b. Some Provably Intractable Problems: Complexity hierarchies, The space hierarchy for deterministic Turing machine. A problem requiring exponential time and space, A non- elementary problem.

Module V: (8 lectures)

Data structures and Algorithms for External Storage: A model for External computation, External sorting, Storing information in files, External search trees. Memory Management: The issues in memory management, Managing equal- sized blocks, Garbage collection algorithms for equal-sized blocks, storage allocation for objects with mixed sizes, Buddy systems, Storage compaction.

Suggested Readings

1. The Design and Analysis of Computer Algorithms, Alfred V Aho, John E Hopcroft and Jeffrey D Ullman, Addition Wesley.
2. Data Structures and Algorithms, Alfred V Aho, John E Hopcroft and Jeffrey D Ullman, Addition Wesley.
3. Introduction to algorithms- A Creative approach, V Manbar, Addition Wesley.
4. Fundamentals of Computer Algorithms, Ellis Harwitz, Sartaz Sahani, Computer Science Press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2	M	H			
CO 3		M	H		
CO 4			M	H	M
CO 5				M	H

MAIC0055: INTRODUCTION TO CRYPTOGRAPHY

(4-0-0)

COURSE OUTCOMES

CO 1: Define the terms and concepts of symmetric key ciphers. (Remembering)

CO 2: Identify the importance of modular arithmetic, modulo operator and algebraic structures in symmetric key cipher. (Applying)

CO 3: Discuss some asymmetric-key cryptography, Diffie-Hellman Key Exchange, Knapsack Cryptosystem, RSA Cryptosystem. (Analysing)

CO 4: Discuss some primality test algorithms and their efficiencies. (Analysing)

CO 5: Explain the concept of elliptic curve cryptosystems. (Understanding)

Module I: (14 lectures)

Introduction to Cryptography, classical cryptosystem, cryptanalysis on Substitution Cipher, Play Fair Cipher, Block Cipher. Data Encryption Standard (AES), Triple DES, Modes of Operation, Stream Cipher, Pseudorandom Sequence.

Module II: (16 lectures)

LFSR based stream cipher; Modular inverse, Extended Euclid Algorithm, Fermat's Little Theorem, Euler Phi-Function, Euler's theorem, Quadratic Residue, Polynomial Arithmetic. Advanced Encryption Standard (AES), Introduction to Public Key Cryptosystem, Diffie-Hellman Key Exchange, Knapsack Cryptosystem, RSA Cryptosystem.

Module III: (18 lectures)

Primality Testing: Probabilities Primality testing, primality testing for numbers of a special form, AKS primality test including detecting perfect powers; Computing the Order of an element and generating primitive roots (and elements ofa certain order), Computing Discrete Logarithms, Factoring Integers, factoring polynomials and tests constricting irreducible polynomials; Solving equations over Finite Fields including computing square roots. ElGamal Cryptosystem.

Module IV: (12 lectures)

Cubic curves, singular points, Discriminant, Elliptic curves, Elliptic Curve over the Reals, Elliptic Curve Modulo a Prime. Generalized ElGamal Public Key Cryptosystem, Chinese Remainder Theorem, Rabin Cryptosystem, Legendre and Jacobi symbol.

Suggested Readings

1. A Course in Number Theory and Cryptography, A Neal Koblitz, Springer.
2. An Introduction to Mathematical Cryptography, Jill Pipher, Jeffrey Hoffstein, Joseph H. Silverman, Springer.
3. An Introduction to theory of numbers, Niven, Zuckerman and Montgomery, Wiley.
4. Elliptic curves: number theory and cryptography, Lawrence C. Washington, Chapman & Hall/CRC.
5. An Introduction to Cryptography, R.A. Mollin, Chapman & Hall.
6. Rational Points on Elliptic Curves, Silverman and Tate, Springer.
7. Guide to elliptic curve cryptography Hankerson, Menezes, Vanstone, Springer.
8. Elementary Number Theory, Jones and Jones, Springer.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M	M	
CO 2		H		
CO 3		M	H	
CO 4		M	M	
CO 5				H

MADS0059: DYNAMICAL SYSTEMS AND CHAOS

(4-0-0)

COURSE OUTCOMES

CO 1: Define the concepts of nonlinearity, iterated functions, fixed points, differential equations, metric space andtopology. (Remembering)

CO 2: Interpret the link between regular systems and unpredictable systems with chaotic nature. (Understanding)

CO 3: Classify and interpret the dynamical properties for a given problem in a dynamical system. (Analysing)

CO 4: Derive the model on of given physical situations to prove the basic dynamic behaviour with the existence of chaos. (Applying)

CO 5: Determine bifurcation points, Topological entropy, Topological transitivity, Devaney chaos, Li-Yorke chaos.(Evaluating)

Module I: Dynamical Systems and Vector Fields (12 lectures)

The notion of Dynamical systems and Vector Fields, The fundamental theorem on existence and uniqueness, Orbits, Topological conjugacy and orbits, Phase Portraits, Graphical analysis of orbits, Periodic orbits and stability theory, Nonlinear analysis on Logistic map and Tent Map.

Module II: Discrete systems and Bifurcations (12 lectures)

Period doubling bifurcations, Saddle-node bifurcation, Transcritical bifurcation, Pitchfork bifurcation, various universal routes to chaos, Feigenbaum universality, Chaos, Strange attractor, Fractals, Sharkovskii Order, Period 3 implies chaos.

Module III: Continuous systems and Dynamics (12 lectures)

First order continuous autonomous systems, Classification of fixed points of autonomous systems, Attractors and repellors, Second order continuous autonomous systems, Phase curves and fixed points, Classification of fixed points of linear systems.

Module IV: Topological Dynamics (12 lectures)

Topological Dynamical systems, Examples and Basic Properties, Topological transitivity, Mixing, Weak mixing, Devaney chaos, Li-Yorke chaos, Topological entropy and Application.

Module V: Symbolic Dynamics (12 lectures)

Shifts- one-sided and two-sided, Sub shifts and codes, Shift spaces, Languages, The Perron Frobenius theorem, Higher block shifts and Higher Power shifts, Entropy and application , Finite type constraints , Graph representations of shifts of finite type and their properties.

Suggested Readings

1. Nonlinear Dynamics and Chaos with application to Physics, Biology, Chemistry, and Engineering, Steven H Strogatz,West view Press.
2. A First Course in Chaotic Dynamical Systems: Theory and Experiments, Robert L Davaney, CRC Press, Taylor and Francis.
3. An Introduction to Symbolic Dynamics and Coding, Douglas Lind and Brian Marcus, Cambridge University Press.
4. Introduction to Dynamical Systems, Michael Brin and Garrett Stuck, Cambridge university Press.
5. Introduction to Nonlinear Dynamical Systems and Chaos, S Waggins, Springer.
6. Chaos and Fractals, H O Peitgen, H Jurgens and D Saupe , New Frontiers of Science, Springer.
7. Nonlinear Oscillations, Dynamical Systems and Bifurcation of Vector Fields, J Guckenhemer and P Holmes, Springer.
8. Introduction to Dynamical Systems, D K Arrowsmith, Cambridge University Press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M	M		
CO 2	M	H			
CO 3	M		H		
CO 4	M	H	M	H	M
CO 5				M	H

MACO0060: CONVEX OPTIMIZATION

(4-0-0)

COURSE OUTCOMES

CO 1: Define some basic concept of functions and operations research. (Remembering)
CO 2: Analyse and solve a given a mathematical problem, classifying its algebraic structure. (Analysing)
CO 3: Derive the solution of a problem using mathematical methods and computing approach. (Applying)
CO 4: Determine the mathematical and social system solution procedure and analysing the results. (Evaluating)

Module I: Introduction (5 lectures)

Mathematical Optimization, least square and linear programming, convex optimization, nonlinear optimization.

Module II: Convex sets and functions (15 lectures)

Convex sets: Affine and convex sets, examples, operations that preserve convexity, generalised inequalities, separating and supporting hyperplanes, dual cones and generalised inequalities. Convex functions: Basic properties and examples, conjugate function, quasi-convex functions, log- concave and log convex functions, convexity with respect to generalised inequalities.

Module III: Convex optimization problems (20 lectures)

Optimization problems- convex, linear, quadratic, geometric, generalised inequality constraints, vector optimization. Duality: The Lagrange dual functions, geometric interpretation, saddle point, optimality conditions, perturbation andsensitivity analysis, theorem of alternatives.

Module IV: Applications (20 lectures)

Geometric problems- Projection on a set, distance between sets, Euclidean distance and angle, external volume ellipsoid, centering, classifications, placement and location, floor planning. Approximation and fittings- Norm, least- norm, regularised, robust, function fitting and interpolation, some problems involving two quadratic functions.

Suggested Readings

1. Convex optimization, Boyd and Vandenberghe, Cambridge University press.
2. Introductory lectures on convex optimization, YuriiNesterov, Kluwer Academic Publisher.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	M	H	L	
CO 2	L			H
CO 3	M	M	H	M
CO 4				H

MAGT0061: INTRODUCTION TO GAME THEORY

(4-0-0)

COURSE OUTCOMES

CO 1: Define some basics of game theory, concepts of players, strategies, payoff etc. (Remembering)
CO 2: Illustrate different types of game strategies. (Understanding)
CO 3: Apply different methods to solve games and recommend which strategy to implement. (Applying)
CO 4: Analyse real life competitive situations using game theoretic techniques. (Analysing)
CO 5: Determine the methods of solution using simple real-life problem. (Evaluating)

Module I: Introduction (8 lectures)

Basics of game theory, Types of games, zero-sum games, non-zero-sum game, Simultaneous games, Sequential games, Prisoners Dilemma, Other Interesting two person games, Ultimate Game, Public Good Game, Theory of rational choice, Interacting decision makers, Solution of Game by Simplex method.

Module II: Games with Perfect Information (10 lectures)

Strategic games, the Prisoner's Dilemma, Nash equilibrium, Best response functions, Dominated actions, Equilibrium in a single population: symmetric games and symmetric equilibria, Cournot's model of oligopoly, Bertrand's model of oligopoly, Electoral competition, The War of Attrition, Auctions, Accident law.

Module III: Mixed strategy Nash Equilibrium (12 lectures)
Strategic games with randomization, Mixed strategy Nash equilibrium: concept and examples, Correlated equilibrium, Expected Payoffs, Mixed Strategy Equilibrium, Dominated Actions, Formation of Players' beliefs, Information and Bayesian Games: examples, Bayesian game applications, Juries and Information Aggregation, Auctions with Private Information.

Module IV: Extensive Games (12 lectures)
Definitions, Subgame perfect equilibrium, the ultimatum game and the holdup game, Stackelberg's model of duopoly, buying vote, Extensive Games with Perfect Information: Extensions and Discussion, Coalitional Games and the Core, examples, Bayesian Games, Spence Signalling Game, Crawford and Sobel Cheap Talk Game.

Module V: Variants and Extensions (18 lectures)
Strictly Competitive Games and Maximization, Definition and Examples, Rationalizability, Iterated elimination of strictly and weekly dominated actions, Evolutionary Equilibrium, Monomorphic pure strategy equilibrium, Mixed strategies and polymorphic equilibrium, Asymmetric equilibria, Repeated games: The Prisoner's Dilemma, Infinitely repeated games, Strategies, Nash equilibria of general infinitely repeated games, Subgame perfect equilibria of general infinitely repeated games, Finitely repeated games, Bargaining, Repeated ultimatum game, Holdup game.

Suggested Readings
1. Game Theory, D. Fudenberg and J. Tirole, MIT press.
2. An Introduction to Game Theory, Osborne, M.J., Oxford University Press.
3. Microeconomic Theory, Mas-Colell, A., M.D. Whinston and J.R., Green Oxford University Press.
4. Primer in Game Theory, Gibbons, R.A, Pearson Education.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H			M	
CO 2		H			
CO 3			H	M	
CO 4				H	M
CO 5				M	H

MAAN0062: ALGEBRAIC GEOMETRY

(4-0-0)

COURSE OUTCOMES:
CO 1: Show the correspondence between algebraic objects and their geometric counterparts. (Remembering)
CO 2: Explain the interplay between algebraic geometry and commutative algebra. (Understanding)
CO 3: Analyse the connection between algebraic objects and geometric properties. (Analysing)
CO 4: Evaluate the properties of local rings with their validity in more generalized setting. (Evaluating)

Module I: (17 lectures)
Review of properties of polynomial rings on several variables, properties of algebraic sets, Nullstalensatz (weak form), Zariski topology on algebraic sets, correspondence between ideals of zero set and radical ideals, Nullstalensatz (strong form), irreducibility in Zariski topology, affine line and Zariski topology, Noetherian decomposition.

Module II: (15 lectures)
Topological dimension, Krull dimension, height of a prime ideal, ring of polynomial functions on affine variety, open sets and basic open sets in Zariski topology, quasi compactness, characterizing affine varieties, correspondence between k algebras and morphisms, the coordinate ring of an affine variety, automorphism of affine spaces and polynomial rings.

Module III: (16 lectures)
Projective spaces, projective spaces as copies of affine spaces, graded rings and homogeneous ideals, homogeneous localization and related properties, local rings, local rings at a point of a projective space, function fields, global regular functions on projective varieties, category of varieties, properties of homogeneous coordinate rings.

Module IV: (12 lectures)
Isomorphism of local rings, geometric interpretation of isomorphism of local rings, birationality, idea of non-singularity, smooth manifolds, correspondence between hypersurfaces and varieties.

Suggested Readings
1. Abstract Algebra, Dummit D.S., Foote R. M., John Wiley and sons Inc.
2. Undergraduate Commutative Algebra, Reid Miles, Cambridge university press.
3. Elementary Algebraic Geometry, Hulek Klaus, AMS Student mathematical library.

4. Basic Algebraic Geometry I, Shafarevich I.R., Springer-Verlag.
5. Algebraic Geometry, Hartshorne R., Springer-Verlag.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M	M	M
CO 2		H		
CO 3		M	H	
CO 4			M	H

MANO0063: NUMERICAL OPTIMIZATION

(4-0-0)

COURSE OUTCOMES

CO 1: Learn some basic concept of numerical methods and operations. (Remembering)
CO 2: Illustrate the different optimization problem and their solving methods. (Understanding)
CO 3: Classify the algebraic structure and the solution procedure for a given a mathematical problem. (Analysing)
CO 4: Derive the solution of a problem using computing approach. (Applying)
CO 5: Evaluating the mathematical and social system solution procedure and analysing the results. (Evaluating)

Module I: Mathematical Formulation (5 lectures)

Transportation problem, continuous and discrete, constrained and unconstrained, global and local, stochastic and deterministic convexity, and optimization algorithms.

Module II: Fundamental of unconstrained optimization (10 lectures)

Solution of unconstrained problems, local minimum, non -smooth problems. Two strategies- Line search and Trust Region, search direction for linear search methods, models for Trust Region method, steepest Descent method, first order methods-Gauss- Seidel, method of successive approximation or Gradient method.

Module III: Line Search (15 lectures)

General scheme, computing new t, optimal step size, Wolfe's rule. Newton methods- Forcing global convergence, alleviating the method, Quasi- Newton methods, global convergence, local convergence. Conjugate gradient- developing the method, computing the direction, orthogonalization process.

Module IV: Trust Region (18 lectures)

Elementary problems, curvilinear search incidence on the sequence x_k, least square, Gauss- Newton, algorithm based on Cauchy point, improving on the Cauchy point. Quadratic programming-basic mechanism, solution algorithm and convergence.

Module V: Newton's methods in constrained optimization (12 lectures)

Differential calculus, existence and uniqueness of solutions, first order optimality condition, second order optimality condition, speed of convergence, projection onto a closed convex set.

Suggested Readings

1. Numerical Optimization, Jorge Nocedal, Stephen J Wright, Springer publication.
2. Numerical Optimization Theoretical and Practical Aspect, J Frederic Bonnans, J Charles Gibert Claude Lemarechal, Claudia A Sagastizabal, Springer publication.
3. Numerical methods and optimization an introduction, Sergiy Butenko, Panos M Pardalos, CRC press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				M
CO 2	M	H			
CO 3			H		
CO 4				H	
CO 5				M	H

MAML0064: MACHINE LEARNING

(4-0-0)

COURSE OUTCOMES

CO 1: Explain the basic concepts of Machine learning, Data Mining and AI and their importance in real life. (Understanding)
CO 2: Illustrate the various characteristics machine learning. (Understanding)
CO 3: Utilize the ML algorithms for finding solutions of real-life problem. (Applying)
CO 4: Analyse ML methods for identifying problems. (Analysing)

CO 5: Determine the performances of ML by implementing Python. (Evaluating)

Module I: Introduction to Statistics and Machine learning (8 lectures)
Statistical Inference, Types of Variables, Probability Distribution, Normality, Measures of Central Tendencies, Normal Distribution, Fundamentals of Machine Learning, Data Science vs Machine Learning, Introduction to AI, Machine Learning Concepts and types, KNN methods, Productive Models.

Module II: Supervised Learning (12 lectures)
Classification, Regression, Random Forest, Decision tree, Linear Regression, Gradient Descent, Polynomial Regression, Learning Curves, Regularized Linear Models, Logistic Regression, Ridge Regression.

Module III: Unsupervised Learning (12 lectures)
Clustering, Partitioning Clustering, Hierarchical Clustering, Grid based clustering, Clustering algorithms, K-means algorithm, Applications of Clustering in different fields.

Module IV: Advanced Machine Learning concepts and techniques (10 lectures)
Ensemble methods, Boosting, Support Vector Machines, Linear SVM Classification, Nonlinear SVM Classification, SVM Regression, ANN, Deep Learning, Semi-supervised learning, Tensor flow, Evaluation in ML.

Module V: Dimensionality Reduction (8 lectures)
The Curse of Dimensionality, Main Approaches for Dimensionality Reduction, PCA, Kernel PCA, LLE, Other Dimensionality Reduction Techniques.

Module VI: Introduction Python in Machine Learning (10 lectures)
Introduction to Python, Python Basics, Variables and Data Types, Decision Making and Loops, Functions, Modules and Packages, Exception handling, File and Directories, Classes and objects, Regular expressions, Socket programming.

Suggested Readings
1. The Elements of Statistical Learning, T. Hastie, R. Tibshirani, J. Friedman; Springer Series in Statistics.
2. Machine Learning, Tom Mitchell, McGraw Hill.
3. Introduction to Machine Learning with Python, Andreas C. Muller and Sarah Guido, Sebastopol.
4. Pattern Recognition and Machine Learning, Chris Bishop, Springer.
5. Lecture notes in Machine Learning, Zdravko Markov, Tioga Publishing Co.
6. Data Mining Techniques, Arun Kumar Pujari, University Press.
7. Pattern classification, Richard O. Duda, Peter E. Hart, David G. Stork, Wiley, New York.

Mapping of Cos to syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H					
CO 2		H	M			
CO 3			H	H		
CO 4					H	M
CO 5					M	H

MAPD0065: PLASMA DYNAMICS

(4-0-0)

COURSE OUTCOMES

CO 1: Understand and use the basic mathematical formalism needed for describing the dynamics of continuous media (Understanding)
CO 2: Have a very good knowledge of mathematical models for plasma and will be able to distinguish the dynamics of plasmas and neutral fluid media. (Remembering)
CO 3: Use the general theory to formulate and modify the basic dynamic fluid equations to account for the dynamics of plasma media at different levels: from MHD to kinetic scales (Applying)
CO 4: Able to describe the propagation of waves in plasmas, plasma turbulence, instabilities and derive the dispersion relation for these waves (Analyzing)
CO 5: Solve complex model for the various astrophysical regions, and obtain analytical expressions for some characteristic quantities (Evaluating)

Module I (10 lectures) Introduction
Basic properties of plasmas: Definition, occurrence and importance of plasmas, Debye shielding, Quasi-neutrality, plasma parameter, plasma frequency, Larmor orbits (basics), Non-ideal plasmas

Module II (10 lectures) Elements of plasma dynamics
Single particle motion: Cyclotron motion, Electrodynamic equations for a conducting fluid (Maxwell's equations, Conservation

of electric charge, Generalized Ohm's law etc.) **,** Guiding center drifts: ExB, curvature and gradient.**,** Magnetic moment, adiabatic invariants, magnetic mirrors

Module III (18 lectures) Plasma as fluids
Introduction: The fluid equation of motion (Continuity equation, Momentum balance equation, Equations of state, Two-fluid equations, Plasma resistivity.
Waves in plasmas : Plasma oscillations, Langmuir waves, ion-acoustic waves ;Electromagnetic waves (parallel and perpendicular to B0)

Module IV (12 lectures) Kinetic plasma theory
Vlasov and Boltzmann equations, Obtaining fluid equations from Boltzmann equation, From the two-fluid to MHD description of plasmas;Longitudinal and transverse waves in an unmagnetized plasma. Solution of initial value problem by Landau's method. Landau damping.

Module V: (10 lectures) Nonlinear effects in plasmas
Introduction, The Sagdeev potential, Derivation of KdV equation for ion-acoustic waves, Soliton solution in one dimension, Elementary ideas about the ponderomotive force and parametric instability.

Suggested Readings:
1. Introduction to Plasma Physics and Controlled Fusion, F. F. Chen, Plenum Press, New York, Second Edition, Vol. 1, 1984.
2. Fundamentals of Plasma Physics, J. A. Bittencourt, Springer-Verlag New York, 2008.
3. Elements of Plasma Physics, S. N. Goswami, New Central Book Agency (P) Ltd, 2011.
4. Methods in Nonlinear Plasma Theory, R. C. Davidson, Academic Press, New York and London, 1972.
5. Waves in Plasmas, Thomas H. Stix, American Institute of Physics, USA, 1992.
6. Introduction to Plasma Physics, R. J. Goldston and P. H. Rutherford, IOP Publishing, Bristol & Philadelphia, 1995.

Mapping COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	M			M	
CO 2	H	H			M
CO 3	M	M	H	M	
CO 4		M			
CO 5			M	H	H

MAFG0154: FRACTAL GEOMETRY AND APPLICATIONS
(2-0-0)

COUSE OUTCOMES
CO 1: Explain the basic concepts of fractals and their mathematical constructions. (understanding)
CO 2: Develop fractal dimensions and study their applications. (Applying)
CO 3: Categorize Mandelbrot set and Julia sets, and classify their graphical representation and geometric properties. (Analysing)
CO 4: Interpret random fractals, and study their applications to Health science and Stock markets. (Evaluating and Applying)
CO 5: Demonstrate various chaos, renormalization, universality of chaos, and their significance. (Understanding and Creating)
CO 6: Elaborate various applications in different fields of science and technology. (Creating)

Module I: Regular Fractals and Self-similarity (5 lectures)
Self-similarity, Examples of self-similarity, Fractals, Cantor Set, Koch Curve, Sierpinski gasket, Menger Sponge, Initiators and Generators, Geometry of Plane Transformations, Iterated Function Systems(IFS), Inverse problems, Random IFS, Driven IFS, Architecture.

Module II: Natural Fractals and Dimensions (5 lectures)
Ineffective way to measure, Fractal Dimensions and calculation, Hausdorff measure and dimension, Box counting dimension, Similarity dimension, The Moran formula, other dimensions, Area-Perim, Dim Algebra, Natural Fractals,Manufactured Fractals.

Module III: The Mandelbrot Set and Julia Sets (5 lectures)
Complex iteration, Julia sets, Julia sets of quadratic functions, The Mandelbrot set, Combinatorics of the Mandelbrot set, The boundary of the Mandelbrot set, Scaling in the Mandelbrot set, Complex Newton's method, Universality of the Mandelbrot set, Fractal in arts.

Module IV: Random Fractals and the Stock Market (5 lectures)
Self-similar distributions, Random Cantor set, Brownian motion, Fractional Brownian motion , Diffusion Limited aggregation , Levy Stable processes, Percolation , Bacterial Growth, Galaxy distributions, Internet traffic , Random fractal Cartoons, Stock

market surrogates.

Module V: Chaos and Fractals (5 lectures)
Doubling, Introduction to Chaos, Test functions, Graphical iterations, Time series, Histograms, Bifurcation diagrams, Return map, Driven IFS, Kelly plot, Fixed points, Cycles, Period doubling bifurcations, Dust in the Tent map, Tent and Logistic bifurcation diagrams, Tangent bifurcations, Intermittency, Discontinuous bifurcations, Scaling, Universality, Renormalization, Control of chaos, Synchronization of chaotic processes.

Module VI: Fractal Applications (5 lectures)
Fractal growth, Singularities of Electrostatic and gravitational potentials, Fractal Antennas, Fractal in Finance, Self-Affine set and dimension, Application to encoding images, Panorama of Fractals and their uses, Animations, application of fractal geometry to Computer science, Telecommunications, and Medicine .

Suggested Readings

1. A Text by Michael Frame and Amelia Urry, Fractal Worlds, Yale University Press.
2. Fractal Geometry; mathematical foundations and Applications, Kenneth Falconer, John Wiley & Sons Ltd, England.
3. Fractal Geometry and Applications, Michel L Lapidus, A Jubilee of Benoit Mandelbrot,
4. The Fractal Geometry of Nature, Benoit Mandelbrot, W.H. Freeman and Co.
5. Fractal Geometry, Mathematical methods, Algorithms, Applications, A K Evans, Woodhead Publishing.
6. Fractals Everywhere, Michael Barnsley, Dover Books on Mathematics.
7. Chaos and Fractals: New Frontiers of Science, Heinz, Otto Peitgen, Springer and Verlag.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H	M				
CO 2		H		M	L	
CO 3			H	H	M	
CO 4			M	H		L
CO 5				M	H	H
CO 6		H				H

MAMR0153: STATISTICAL METHODS AND SOFTWARE IN RESEARCH

(3-0-0)

COURSE OUTCOMES

CO 1: Explain the basis necessity and application of Statistics in different fields of Science and Social Sciences. (Remembering and understanding)
CO 2: Develop the significance of data analysis and interpretation. (Applying)
CO 3: Categorize Correlation and Regression, and interpret graphical representation. (Analysing and creating)
CO 4: Elaborate various software to study different problems in Statistics. (Creating)

Module I: Importance, Functions, Limitations (5 Lectures)
Importance, Statistics in States, Statistics in Economics, Statistics in Business, statistics in Astronomy, Statistics in Education, Statistics in Mathematics, Functions of Statistics, Limitations of Statistics.

Module II: Collection of Data, Classification and Tabulation (10 lectures)
Primary and Secondary data, Choice of methods, Direct personal observations, Information through Agencies, Sources of Secondary data, Meaning of Classification, rules of Classification, Statistical series, Frequency distribution, Continuous or Grouped Frequency Distribution Class Group Frequency, Structure and rules of Tabulation, and applications.

Module III: Correlation and Regression (10 lectures)
Significance of the study of Correlation, Correlation and Causation, Karl Pearson’s coefficient of correlation, Rank Coefficient of correlation, Correlation of time series, Significance of Regression study, Correlation and Regression, Regression equations, Standard error of estimate.

Module IV: Statistical Analysis Software (20 lectures)
Importance of Software in Statistical problems, SPSS (IBM) ,(Statistical Package for Social Sciences), R Foundation for Statistical Computing, MATLAB (MathWorks), Microsoft Excel ,their algebraic results and Applications.

Suggested Readings

1. Statistics (Theory and Practice), RSN Pillai, and Bagavathi, S Chand & Company Ltd, New Delhi.
2. All of Statistics: A Concise Course in Statistical Inference, Larry A Wasserman, Springer Publishing Co.

3. A Second Course in Probability, Sheldon M Ross and Erol A. Pekoz, Pekozbooks.
4. Statistical Software (Free Websites).

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M		
CO 2		H	M	
CO 3		L	H	M
CO 4				H

MAML0152: ESSENTIAL MATHEMATICS FOR MACHINE LEARNING

(2-0-0)

COURSE OUTCOMES

CO 1: Comprehend the basic and core concepts of vector space, matrices, matrix decompositions. (Understanding)
CO 2: Apply the concepts statistics and linear algebra in Dimension reductions. (Applying)
CO 3: Gain extensive knowledge of probability and statistics for analysis of data. (Analysing)
CO 4: Apply the fundamentals of calculus to evaluate partial derivatives, gradient and other concepts of vector calculus. (Applying)

Module I: (8 lectures)

Vector Spaces: Definitions and examples, Vector Subspaces: Examples and Properties, Basis and Dimensions, Linear Transformations, MATRIX THEORY- Norms and spaces, eigenvalues and eigenvectors, Special Matrices and their properties, least squared and minimum normed solutions.

Module II: (8 lectures)

Matrix Decomposition Algorithms- SVD: Properties and applications, low rank approximations, Gram Schmidt process, polar decomposition, DIMENSIONS REDUCTION ALGORITHMS and JCF- Principal component analysis, linear discriminant analysis, minimal polynomial and Jordan canonical form

Module III: (8 lectures)

Probability – Basic concepts of probability: conditional probability, Bayes' theorem, independence, theorem of total probability, expectation and variance, few discrete and continuous distributions, joint distributions and covariance.

Module IV: (6 lectures)

Calculus – Basic concepts of calculus: partial derivatives, gradient, directional derivatives, Jacobean, hessian, convex sets, convex functions and its properties.

Suggested Readings

1. Mathematics for Machine Learning, Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong, Cambridge University Press.
2. Analysis for Applied Mathematics. W. Cheney, New York: Springer Science Business Media.
3. Linear Algebra Done Right, Third Edition, S. Axler, Springer International Publishing.
4. Numerical Optimization. J. Nocedal and S. J. Wright, New York: Springer Science Business Media.
5. A First Look at Rigorous Probability Theory, Second Edition, J. S. Rosenthal, Singapore: World Scientific Publishing.

Mapping COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M		
CO 2	L	H		
CO 3		L	H	
CO 4				H

MASL0200: COMMUNITY ENGAGEMENT AND SERVICE LEARNING

(2-0-0)

COURSE OUTCOMES

CO 1: Develop understanding on Community University Engagement. (Remembering)
CO 2: Acquire knowledge of the measures taken by HEIs towards community engagement. (Understanding)
CO 3: Analyse a problem pertaining to the community by applying methods of participatory research. (Analysing)
CO 4: Apply various tools of CPBR to address real life issues of the communities. (Applying)
CO 5: Decide a suitable tool to connect with a certain community by identifying the major barriers. (Evaluating)

Module I: (Service Learning and Community University Engagement) (10 lectures)

Definition of Service Learning (SL), goals and objectives of SL. Meaning of community university engagement (CUE), Historical overview of Higher Educational Institutes (HEIs) in India, role played by various commissions in CUE, various policies adopted by University Grants Commission (UGC), objectives and structure of schemes adopted by UGC, measures taken by HEIs towards community engagement.

Module II: (Role of HEI fostering social responsibility) (10 lectures)
Understanding social responsibility of higher education institutes, forms of community engagement, notion of engaged teaching, engaged research, engaged service, meaning of an active citizen. Meaning of Community Based Participatory Research (CBPR), methods and tools associated with CBPR. Skills to utilize CPBR fostering social responsibility especially post emergency like pandemic etc.

Module III: Assignments (10 lectures)

a. Visiting nearby villages to collect data on the percentage of students enrolling into schools per year and represent the same using various Mathematical models.
b. To conduct fact finding visits in local areas to address a particular problem by helping the community understanding the situation employing tools like maps and meetings.

Suggested Readings
Where’s the learning in service learning, J. Eyler, D.E. Giles Jr.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H		
CO 2	M		
CO 3		M	
CO 4		H	M
CO 5			H

LABORATORY COURSES

MARS6001: RESEARCH SEMINAR

(2-0-0)

Objective

Objective of the Research seminar is to conduct a research literature survey which may lead to the development of a proposed project model to be executed in the 4th semester. This will help the students to familiarize themselves with the current literature on recent trends in the chosen area.

Tasks to be performed by the students will include.

- Literature survey on the chosen topic.
- Presentation on the chosen topic, comprising the following components:
    - Presentation.
    - Report.
    - Viva Voce examination.

COURSE OUTCOMES

CO 1: Find the steps required to do research and projects (Remembering)
CO 2: Illustrate the methodology of research and journaling. (Understanding)
CO 3: Apply the research presentation skills in seminars and conferences. (Applying)
CO 4: List topics to pursue research in the field of pure and applied mathematics. (Analysing)
CO 5: Defend their research dissertations and reports. (Evaluating)
CO 6: Develop research topics and present the research ideas. (Creating)

MACP6002: COMPUTER PROGRAMMING IN C LAB

(0-0-1)

COURSE OUTCOMES

CO 1: Understand the fundamentals of OS, file handling, creating and editing simple C programs. (Understanding)
CO 2: Develop programming skills using the fundamentals and basics of C Language. (Applying)
CO 3: Develop programs using the basic elements like control statements, Arrays and Strings. (Applying)
CO 4: Effective usage of arrays, structures, functions and pointers. (Applying)

List of programs

1. Introduction to OS; file handling, directory structures, creating and editing simple C programs.
2. C programming using variables, assignment and simple arithmetic expressions.
3. Determination of roots of quadratic equations, ax2+bx+c=0, a≠0.
4. Arranging given set of numbers in increasing/decreasing order, calculation of Mean.
5. Calculation of GCD/LCM of two integers.
6. Evaluation of factorial of a positive integer and evaluation of binomial coefficients.
7. Evaluation of factorial of binomial coefficients mod 2.
8. Sieve method for primality test.
9. Generation of twin primes.
10. Solution of congruence using complete residue system.
11. Addition, subtraction and multiplication of matrices.
12. Transpose, determinant .

Suggested Readings

1. Programming in ANSI C, E. Balaguruswamy, McGraw-Hill.
2. A first book of ANSI C, J. Brosin, Cengagedelmer Learning India P.Ltd.
4. C Programming Language, Brain W. Kernighan & Dennis Ritchie, PHI.
5. Let us C, Kanetkar Y, BPB Publications, New Delhi.

Mapping of COs to Syllabus

Course Outcomes	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CO 1	H	M										
CO 2		H	H	M								
CO 3			H	H	H	H	H	H	H	H	M	M
CO 4				H				H		H	H	H

MARP6003: RESEARCH PROJECT

(8 credits)

Objective

The objective of the research project is to train students to carry out research/investigation in a field that is of relevance to Mathematical science. During the project period, students will start a research project/investigation applying the knowledge acquired in the first three semesters and also incorporating the recent trends in the chosen area. In the project course, the student should be able to undertake detailed literature review as a way of information search, carry out detailed investigations as a way of solving project problems, write and put together a detailed report of the investigations carried out at the end of the fourth semester.

The mode and components of evaluation, supervisors and the weightages attached to them shall be published by the Department at the beginning of the semester.

COURSE OUTCOMES

CO 1: Identify different areas of research in the field of Mathematical sciences or in computing. (Remembering)
CO 2: Explain the importance of research in the chosen topic of interest. (Understanding)
CO 3: Apply theoretical knowledge to find out an appropriate topic of importance for research in the graduate level. (Applying)
CO 4: Analyse when a chosen approach does not yield the expected result. (Analysing)
CO 5: Evaluate the project and present in an appropriate form. (Evaluating)
CO 6: Learn to choose a methodology or technique or approach to fulfil a set of objectives or prove or disprove a hypothesis. (Creating)

MACM6004: COMPUTATIONAL SKILL DEVELOPMENT: MATHEMATICA

(2 Credits- 30 Lectures)

COURSE OUTCOMES

CO 1: Learn how to use Mathematica, a powerful coding language in science and engineeringcomputing (Remembering).
CO 2: Apply the application-oriented principle to various real-life problems (Applying)
CO 3: Evaluate simple math computations, modeling and simulation problems, data analysis andprocessing, as well as visualization techniques. (Evaluating)

Module I (10 Lectures)

Introduction to Mathematica and to the Wolfram Language (knowledge-based language, built- in support for real-world entities, Wolfram Alpha and the Wolfram Demonstrations Project), Notebook Interfaces, Text-Based Interfaces, Numerical Calculations: Arithmetic, Exact and Approximate Results, Some Mathematical Functions, Arbitrary-Precision Calculations, Complex Numbers, Getting Used to Mathematica, Mathematical Notation in Notebooks, Defining Variables, Making Lists of Objects, Manipulating Elements of Lists, The Four Kinds of Bracketing in Mathematica, Sequences of Operations.

Module II (10 Lectures)

Lists, strings, rules, patterns and pattern matching, different programming paradigms (procedural, functional and rule- based), Graphics and image manipulation (the 30+ members of the plot family, pixelsand voxels, the built-in image editor).

Module III (10 Lectures)

Linear and polynomial algebra. Exact and numerical optimization. Calculus and differential equations (analytic and numerical solutions of ODEs and PDEs). Plane and solid geometry. Probability and statistics(descriptive statistics, built-in support for 100+ distributions).

Suggested Readings

1. The Mathematica Book, S. Wolfram, 5th edition, Wolfram Media, 2003
2. Mathematica Basic Training Course Li Han Long, Sui Ying Deng, National Defense Industry Press,2016
3. Introduction to Mathematica with Applications, M. Muresan, Springer, 2017

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	M		
CO 2		M	M
CO 3			H

MACS6005: COMPUTATIONAL MATHEMATICS WITH SAGE MATH

(2 Credits- 30 Lectures)

COURSE OUTCOMES

CO 1: Learn and understand the basic Python programming language. (Understanding)

CO 2: Understand how to use Sagemath software and its applications. (Understanding)

CO 3: Solve problems in Calculus, Applied Linear Algebra, Numerical Method and differential equations using Sagemath.(Evaluating)

Module I (10 lectures)

Installation of Python; Getting Started with Python Python as an advanced calculator; For loop in Python; While loop in Python; Use of SciPy and SymPy in Python; Classes in Python - Part 01; Classes in Python - Part 02;

Module II (12 lectures)

Solving Equations in SageMath;2d Plotting with SageMath;3d Plotting with Sage Math; Calculus of one variable with Sagemath, Integration with Sage Math; Improper Integral using SageMath; Application of integration using SageMath; Partial derivative with sage math, limit and continuity of real valued functions; working with vectors in sagemath; Solving systems of linear equation in sage math, vector space in sage math, Matrix Spaces with SageMath; Linear Transformations with SageMath, eigenvalues and eigenvectors with sage math;

Module III (8 lectures)

Finding Roots of algebraic and transcendental equations in Sage Math; Numerical solutions of linear equations and numerical integration with sagemath; Solving 1st and 2nd order ODE with Sage Math; Euler's Method to solve 1st order ODE with SageMath.

Suggested Readings

1. Computational Mathematics with SageMath, Paul Zimmermann , Siam
2. Mathematical Computational with Sagemath, Paul Zimmermann Alexandre Casamayou Nathann Cohen Guillaume Connan Thierry Dumont
3. An introduction to Sage Programming: With applications to SAGE Interacts for Numerical methods, Razvan A Mezei, Springer

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H		
CO 2		H	M
CO 3			H

DEPARTMENT OF PHYSICS

VISION:

To endow the students with profound understanding of physics, the foundation for all natural sciences, and drive them towards critical thought for further study and research, to pave the way for suitable career opportunities and enable them to be of service to the society as responsible human beings.

MISSION:

- To strengthen the fundamental concepts of physics and provide advanced understanding of physicalphenomena by emphasizing on the correlation between theory and observation.
- To spark creative interest towards the pursuit of innovative research in fundamental and appliedphysics.

PROGRAM OUTCOMES – MSC PROGRAMME

PO 1: **Critical Thinking**: Inculcate critical thinking to carry out scientific investigation objectively . Formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. Critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.

PO 2: **Knowledge Skil**l: Equip the student with skills to analyse problems, formulate an hypothesis, evaluate and validate results, and draw reasonable conclusions thereof .Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems , rather than replicate curriculum content knowledge .

PO 3: **Scientific Communication Skills**: Imbibe effective scientific and / or technical communication in both oral and writing. Ability to show the importance of the subject as precursor to various scientific developments since the beginning of the civilization.

PO 4: **Ethics**: Continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in the subject concerned .Ability to identify unethical behaviour such as fabrication, falsification or misrepresentation of data and adoptive objective, unbiased and truthful actionsin all aspects.

PO 5: **Enlightened Citizenship**: Create awareness to become an enlightened citizen with commitment to deliver one's responsibilities within the scope of bestowed rights and privileges

PO 6: **Analytical Reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyse and synthesise data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.

PO 7: **Multicultural Competence**: Development of a set of competencies in order to enhance and promote the growth of multicultural sensitivity within universities. Integrating multicultural awareness such as race, gender, physical ability, age, income and other social variables, and by creating an environment that is , "welcoming for allstudents" .

PO 8: **Lifelong Learning**: Ability to think, acquire knowledge and skills through logical reasoning and to inculcatethe habit of self-learning throughout life, through self- paced and self- directed learning aimed at personal development, and adapting to changing academic demands of work place through knowledge/ skill development/reskilling .

PO 9: **Leadership Qualities**: Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination in a smooth and efficient way.

PO 10: **Research Skills**: Prepare students for pursuing research or careers in industry in concerned subject and allied fields. Capability to use appropriate software to solve various problems and to apply programming concepts of C++ and Mathematica/ Matlab to various scientific investigations , problem solving and interpretation

PROGRAMME SPECIFIC OUTCOMES FOR MSC PHYSICS

PSO 1: **Understand the advanced theoretical concept of physics:** Understand the advanced theoretical principlesof physics.

PSO 2: **Acquire analytical and logical skill for research**: Acquire the ability to analyse critical research orientedproblems logically.

PSO 3: **Expertise in experimental physics and learn to use sophisticated instruments safely:** Learn to handle sophisticated experiments perfectly and safely.

COURSES OFFERED IN MSC PHYSICS

Sl. No.	**Course Name**
1.1	Classical Mechanics
1.2	Quantum Mechanics I
1.3	Mathematical Physics

1.4	Electronics I
1.5	Physics Laboratory I
1.6	Value Added Course
2.1	Quantum Mechanics II
2.2	Condensed Matter Physics
2.3	Electrodynamics
2.4	Nanophysics I
2.5	Physics Laboratory II
3.1	Atomic and Molecular Physics
3.2	Nuclear Physics
3.3	Research Methodology
3.4	Computer Oriented Numerical Methods
3.5	Computer Oriented Numerical Methods Laboratory
3.6	Project Phase I
3.7	Particle Physics
3.8	Plasma Physics I
3.9	Electronics II
3.10	Nanophysics II
3.11	Physics and Service Learning
3.12	Value Added Course
4.1	Statistical Mechanics
4.2	Project Phase II
4.3	Study Tour
4.4	Gauge Theories
4.5	General Theory of Relativity and Cosmology
4.6	Astrophysics
4.7	Plasma Physics II
4.8	Plasma Physics Laboratory
4.9	Electronics III
4.10	Electronics Laboratory
4.11	Nanophysics III
4.12	Nanophysics Laboratory

MSC Physics- Mapping of Courses to PO/PSO

Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
1.1	H	H	M			M		H		M	H	M	
1.2	H	H	M			M		H		M	H	M	
1.3	H	H	M			M		H		M	H	M	
1.4	H	H	M			M		H		M	H	M	
1.5	M	M	L	M		M	M	M	M	L		L	H
1.6			H							H		H	
2.1	H	H	M			M		H		M	H	M	
2.2	H	H	M			M		H		M	H	M	
2.3	H	H	M			M		H		M	H	M	
2.4	H	H	M			M		H		M	H	M	
2.5	M	M	L	M		M	M	M	M	L		L	H
3.1	H	H	M			M		H		M	H	M	
3.2	H	H	M			M		H		M	H	M	
3.3	M	M	M	H	H	M		H	M	H	L	H	M
3.4	H	H	M			M		H		M	H	M	
3.5	H	H	L			H		H		M	H	H	
3.6	H	H	H	H		M	H	H	H	H	M	H	H
3.7	H	H	M			M		H		M	H	M	
3.8	H	H	M			H		H		M	H	M	
3.9	H	H	M			M		H		M	H	M	

3.10	H	H	M			M		H		M	H	M	
3.11			H	H	H		H	H	H				M
3.12			H							H		H	
4.1	H	H	M			M		H		M	H	M	
4.2	H	H	H	H		M	H	H	H	H	M	H	H
4.3		H	H		H		H	H	H	M	M	M	H
4.4	H	H	M			M		H		M	H	M	
4.5	H	H	M			M		H		M	H	M	
4.6	H	H	M			M		H		M	H	M	
4.7	H	H	M			H		H		M	H	H	
4.8	M	M	L	M		M	M	M	M	L		L	H
4.9	H	H	M			M		H		M	H	M	
4.10	M	M	L	M		M	M	M	M	L		L	H
4.11	H	H	M			M		H		M	H	M	
4.12	M	M	L	M		M	M	M	M	L		L	H

THEORY COURSES

PSCM0020: CLASSICAL MECHANICS

(4-0-0)

COURSE OUTCOMES

CO 1: Explain Hamilton's and Lagrange's equations and use them for solving problems in physics. (Understanding)
CO 2: Build the concepts of Canonical transformation. (Creating)
CO 3: Explain the motion of rigid body and visualise the Euler rotations. (Understanding)
CO 4: Solve rigid body problems. (Applying)
CO 5: Develop the theory of special relativity in terms of four vector notation. (Creating)

Module I: (12 lectures)
Hamilton's variational principle; derivation of Lagrange's equations; velocity dependent forces; dissipation. Charged particles in an electromagnetic field. Space time symmetries and conservation Laws. Varial theorem. Space transformation.

Module II: (12 lectures)
Two-body problem; central forces; classification of orbits; differential equation for orbits. Kepler problem; scattering in laboratory and centre of mass frames, transformation of cross sections, energies. Rutherford scattering. Kinematics of decay of particles (into two particles).

Module III: (12 lectures)
Rigid body motion: fixed and moving coordinate systems; orthogonal transformations. Euler angles; angular momentum; rotational kinetic energy. Principal axes transformation; Euler equations; force free motion of a rigid body symmetric top.

Module IV: (12 lectures)
Legendre transformation; Hamiltonian equations; Significance of the Hamilton function. Cyclic coordinates and conservation theorems. Poisson Brackets – Poisson Bracket of Angular momentum with coordinates. Canonical Transformation Theory. Contact transformation; integral invariants.

Module V: (12 ectures)
Special theory of relativity: Lorentz transformations. Four dimensional formulation. Force momentum and energy inrelativistic mechanics. Properties of space-time in relativity. Two body decay of a particle.

Suggested Readings

1. Classical Mechanics, H. Goldstein, C. Poole and J. Safko, Pearson Education Asia.
2. Classical Mechanics, N. C. Rana and P. S. Joag, Tata McGraw Hills.
3. Classical Mechanics of Particles and Rigid bodies, K. C. Gupta, Wiley Eastern.
4. Principles of Dynamics, D. T. Greenwood, Prentice Hall.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H			H	
CO 2			H		
CO 3		H			
CO 4			H		
CO 5					H

PSQM0021: QUANTUM MECHANICS I

(4-0-0)

COURSE OUTCOMES

CO 1: Conceptualise different interpretations of quantum mechanics. (Understanding)
CO 2: Apply the concepts of quantum mechanics to different problems in physics. (Applying)
CO 3: Make use of variational method and WKB approximation. (Applying)
CO 4: Inspect how to encounter spin. (Analysing)
CO 5: Comprehend the idea of symmetry in quantum mechanics. (Analysing)

Module I: (10 lectures)
Introduction and revision: inadequacy of classical mechanics; basic postulates of quantum mechanics; ensemble and Copenhagen interpretation. Schrödinger equation; continuity equation; Ehrenfest theorem; admissible wave functions; stationary states. One dimensional problems; potential well and barriers; harmonic oscillator.

Module II: (10 lectures)
Equation of motion: Schrodinger, Heisenberg and Dirac representations; equation of motion in the respective representations. Application to linear harmonic oscillator.

Module III: (10lectures)
Three dimensional problems: Separation of variables; orbital angular momentum; spherical harmonics. Harmonic oscillator in Cartesian and polar coordinates. A free particle and a particle in 3-D box in Cartesian and polar coordinates, Coulomb problem in spherical and parabolic coordinates - regular and irregular solutions.

Module IV: (11 lectures)
Spinors and their transformation properties. Pauli spin matrices. Identical particles and statistics. Addition of angular momenta. Clebsch-Gorden coefficients. Winger-Eckart Theorem.

Module V: (8 lectures)
Symmetry in quantum mechanics. Reflections, time reversal, space inversion, particle exchange. Displacement in space and time, space translation and rotational symmetry. Selection rule and conservation laws.

Module VI: (11 lectures)
Variational methods for bound states; lower and upper limits in simple cases. WKB approximation; connection with classical limits, validity of WKB approximation. Connection formulae; application to bound states, tunneling in one dimension. Application to radial Schrodinger equation.

Suggested Readings
1. Quantum Mechanics, E. Merzbacher, John Wiley.
2. Quantum Mechanics, G. Ahruldhas, Prentice Hall.
3. Quantum Mechanics, L. I. Schiff, McGraw Hill.
4. Quantum Mechanics, V. K. Thankappan, New Age Int. Pub.
5. Quantum Mechanics, P. T. Mathews and Venkatesan, Tata McGraw Hill.
6. Principles of Non-Relativistics and Relativistic Quantum Mechanics, K. D. Krori, PHI.
7. Quantum Mechanics (3 volumes), L. D. Landau and E. M. Lifshitz, Pergamon Press.
8. Quantum Mechanics, Albert Messiah, Dover Publications.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H	H				
CO 2			H	M	M	M
CO 3						H
CO 4				H		
CO 5					H	

PSQM0024: QUANTUM MECHANICS II
(4-0-0)

COURSE OUTCOMES
CO 1: Explain relativistic quantum mechanics. (Understanding)
CO 2: Interpret path integral approach to quantum mechanics. (Understanding)
CO 3: Apply the concept of quantum mechanics to the problems of scattering. (Applying)
CO 4: Build concept about perturbation theory. (Applying)
CO 5: Develop concepts on advanced topics like Hartree- Fock equation. (Applying)

Module I: (11 lectures)
Stationary perturbation theory: Non Degenerate case; first and second order of energy and wave functions, perturbation of one dimensional harmonic oscillator by potentials of the bx^2 and cx^3. Degenerate case; first order Stark effect in hydrogen; Zeeman effect without electron spin.

Module II: (9lectures)
Time dependent perturbation theory; first order transition probabilities; constant perturbation. Transition to continuum; Harmonic perturbation; Fermi's golden rule; Sudden and adiabatic approximations.

Module III: (10 lectures)
Many Electron Atoms: Indistinguishable particles; Pauli's Principle; inclusion of spin; spin functions for two and three electrons; the Helium atom; central field approximation, Thomas-Fermi model of the atom; Hartree equation, Hartree- Fock equation.

Module IV: (13 lectures)
Scattering theory: asymptotic behaviour of scattering wave function; relation to cross sections, Green's function for scattering problem; Green's function with different boundary conditions; scattering integral equations; Born approximation and its validity criteria; scattering by screened Coulomb potential; Born series. Partial waves and phase shifts. Scattering amplitude; optical theorem; low energy scattering. Effective range; scattering length; resonance.

Module V: (12lectures)
Relative wave equations: Klein-Gordon equation. Difficulty with probability interpretation. Dirac equation; four component solutions for free particle; negative energy solutions – particles and antiparticles. Covariant form of Dirac equation; 4-current density. Properties of γ-matrices. Dirac equation in the presence of electromagnetic field; non- relativistic reduction; spin and magnetic moment.

Module VI: (5 lectures)
Path integral approach to quantum mechanics: Feynman's Path Integral method, equivalence of Feynman and Schrödinger equations, Dirac-Feynman Action Principle.

Suggested Readings
1. Quantum Mechanics, E. Merzbacher, John Wiley.
2. Quantum Mechanics, G. Aruldhas, Prentice Hall.
3. Quantum Mechanics, L. I. Schiff, McGraw Hill.
4. Quantum Mechanics, V. K. Thankappan, New Age Int. Pub.
5. Quantum Mechanics, P. T. Mathews and Venkatesan, Tata McGraw Hill.
6. Quantum Mechanics Theory and Applications, Ghatak and Lokanathan, Laxmi Publications.
7. Principles of Non-Relativistics and Relativistic Quantum Mechanics, K. D. Krori, PHI.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1					H	
CO 2						H
CO 3				H		
CO 4	H	H				
CO 5			H			

PSCP0025: CONDENSED MATTER PHYSICS
(4-0-0)

COURSE OUTCOMES
CO 1: Explain about crystal structure in details. (Understanding)
CO 2: Illustrate physics of phonons. (Understanding)
CO 3: Identify free electron and nearly free electron models. (Applying)
CO 4: Discuss about advanced topics like plasmons, polaritons, polarons, etc. (Creating)

Module I: (11lectures)
Crystal structure. Diffraction of waves by crystal. Scattered wave amplitudes, Brillouin zones. Fourier analysis of the basis. Crystal binding and elastic constants.

Module II: (9 lectures)
Phonons: quantisation of lattice vibrations, dispersion relation for acoustic and optical phonon, energy gap, density ofstates, heat capacity, thermal conductivity and thermal expansion.

Module III: (8 lectures)
Free electron Fermi gas: Fermi energy, density of states, heat capacity, thermal conductivity and electrical conductivity. Wiedemann-Franz law.

Module IV: (10 lectures)
Nearly free electron gas: Schrodinger equation of an electron in a periodic potential, Bloch theorem, energy gaps at the zone boundary, approximation solution near a zone boundary, energy bands and their role in properties of metals, insulators and semiconductors. Holes on energy bands. Hall effect.

Module V:(12 lectures)
Shape of fermi surfaces in the free electron and nearly free electron models. Tight binding approximations. Electron orbits, hole orbits and open orbits. Quantization of orbits in a magnetic field. De Hass-van Alphen effect and its role in experimental

determination of Fermi surfaces.

Module VI: (10 lectures)
Plasmons, polaritons and polarons: dielectric functions of the electron gas, plasmons, electrostatic screening, Mott metal-insulator transition, polaritons, polarons. Peierls instability of linear metals.

Suggested Readings
1. Introduction to Solid State Physics, C. Kittel, John Wiley and Sons, Inc.
2. Quantum Theory of Solids, C. Kittel, John Wiley and Sons, Inc.
3. Quantum Theory of the Solid State, J. Callaway, Academic Press, New York.
4. Solid State Physics, H. Ibach and H. Luth, Narosa Pub. House.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H					
CO 2		H				
CO 3			H	H	H	
CO 4						H

PSED0026: ELECTRODYNAMICS
(4-0-0)

COURSE OUTCOMES
CO 1: Explain various phenomena from the standpoint of electrodynamics. (Remembering)
CO 2: Outline the origin and propagation of electromagnetic waves. (Understanding)
CO 3: Explain the nature of electromagnetic radiation. (Understanding)
CO 4: Infer the extension of classical electrodynamics to the generalized 4-dimensional case. (Analysing)
CO 5: Apply the laws of electrodynamics to solve various physical problems. (Applying)

Module I: (7 lectures)
Maxwell's equations: review of Maxwell's equations; boundary conditions at interface between different media; Poisson's and Laplace's equations

Module II: (8 lectures)
Electromagnetic waves: linear and circular polarisation; Stoke's parameters; Poynting theorem of complex field vectors; frequency dispersion (normal and anomalous); characteristics of dielectrics, conductors and plasma and their interaction with electromagnetic waves.

Module III: (10 lectures)
a. Simple radiating systems: Gauge invariance; Green's function for the wave equation; concept of retarded potential, radiation from an oscillating dipole and its polarisation. Electric dipole fields, magnetic dipole and electric quadrupole fields; centre fed linear antenna, scattering at long wavelengths – viz. by dipoles induced in a small scatterer, scattering by a small dielectric sphere.
b. Diffraction: Scalar diffraction theory; vectorial diffraction theory, Scattering in a short wavelength limit.
c. Guided waves: waveguides, TE waves in a rectangular waveguide, coaxial transmission lines.

Module IV: (15 lectures)
Radiation from accelerated charge: Lienard-Wiechart potentials; radiated power from accelerated charge at low velocities. Larmor 's power formula. The fields of a point charge in arbitrary and uniform motion. Radiation from an ultra-relativistic particle. Angular and frequency distribution of radiation from moving charges.

Module V: (12 lectures)
Special theory of relativity: matrix representation of Lorentz transformation; infinitesimal generators; Thomas precession; invariance of electric charge; covariance of electrodynamics; transformation of electromagnetic fields

Suggested Readings
1. Classical Electrodynamics, J. D. Jackson, John Wiley and Sons.
2. Classical Electrodynamics, S. P. Puri, Tata McGraw Hill Publishing Company Ltd.
3. Electrodynamics, S. L. Gupta, V. Kumar and S. P. Singh, Pragati Prakashan.
4. Introduction to Electrodynamics, D. J. Griffiths, Prentice Hall of India.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V

CO 1	H				
CO 2		M	M	M	
CO 3		M	M	M	
CO 4					H
CO5	M	M	M	M	M

PSAM0028: ATOMIC AND MOLECULAR PHYSICS

(4-0-0)

COURSE OUTCOMES

CO 1: Explain atomic and molecular spectroscopy in details. (Understanding)
CO 2: Understand interaction of radiation with atoms. (Understanding)
CO 3: Analyse bond formation. (Analysing)
CO 4: Apply the concept of symmetry to molecules. (Applying)

Module I: (15 lectures)

Introduction of atomic spectrum; fine structure and hyperfine structure of energy levels. Angular momentum and magnetic moment. Doublet structure energy levels and single electron atom. Term symbols and fine structure of energy levels of two electron atoms using L-S coupling and j-j coupling schemes; identification of ground state. Interaction of nuclear and electronic magnetic moments and hyperfine structure with examples.

Module II: (10 lectures)

Interaction of radiation with atoms; spontaneous and stimulated emission; absorption; transition. Einstein's A and B coefficients. Working principles of He-Ne laser.

Module III: (12 lectures)

Theories of molecular bond formation; van der Waals bonding, ionic bonding, valence bond and molecular orbital models of covalent bonding. Homonuclear diatomic molecules and the term symbols and their ground states.

Module IV: (8 lectures)

Vibronic states of molecules and nature of vibronic spectra; harmonic and anharmonic vibrations and potential constants; rotational spectrum and moment of inertia of molecules.

Module V: (15 lectures)

Symmetry of molecules; symmetry elements and points group; proper and improper rotations and their matrix representation. Introduction to character table of point group; reducible and irreducible representation for simple molecules such as H_2O, NH_3, etc.Normal coordinates and normal modes of vibrations. Infrared absorption and Raman scattering form molecular vibrations and rotations, and selection rules.

Suggested Readings

1. Introduction to Atomic Spectra, H. E. White, Mc-Graw Hill.
2. Atoms and Molecules, Martin Karplus and Richard N. Porter, W. A. Benjamin.
3. Spectra of Diatomic Molecules, G. Hertzberg, Van Vostrand.
4. Principles of Lasers, O. Svelto, Plenum Press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H			H	
CO 2		H			
CO 3			H		
CO 4					H

PSCN0030: COMPUTER ORIENTED NUMERICAL METHODS

(2-0-0)

COURSE OUTCOMES

CO 1: Explain the concept of numerical methods. (Understanding)
CO 2: Apply numerical techniques to solve different problems in Physics. (Applying)
CO 3: Understand high level language through Fortran. (Understanding)

Module I: Numerical Analysis (10 lectures)

a. Introduction to numerical methods: approximate and significant figures, absolute and relative errors, general formula for errors, application of the error formula to the fundamental operations of arithmetic and to logarithms. The error of a sum, the error of a difference, the error of a product and number of correct digits, the error of quotients and number of correct digits, the relative error of a power, the relative error of a root, successive approximation, Taylor 's series, principle of least square, law of error of residuals.

b. Matrices and linear equations: addition, subtraction and multiplication of matrices, inversion of matrices, Jacobi transformation of a symmetric matrix, determinant of a matrix, transpose of a matrix, solution of equations by matrix method, Gauss-Jordan elimination Method, eigenvalues and eigenvectors.
c. The solution of numerical, algebraic and transcendental equations: Equations in one unknown: Finding approximate values of the roots, finding roots by repeated application of location theorem, bisection method, the Newton- Raphson method; their convergence and geometric significance.

Module II: Solutions of Ordinary Differential Equations (9 lectures)

a. Equations of the first order: Euler 's method and its modification, the Runge-Kutta method, checks, errors and accuracy.
b. Equations of the second order and systems of simultaneous equations: Milne's-predictor and corrector methods, boundary value problems, conditions for convergence.
c. Minimization or maximization of functions: golden selection search in 1-D, parabolic interpolation and Brent 's method in 1-D, 1-D search with 1 derivatives, Downhill simplex method in multidimensions, Direction set (Powell's method in Multidimensions).

Module III: (5 lectures)

a. Numerical Integration: Classical formulae for equispaced abscissae: Simpson's rule, trapezoidal rule, Gaussian
b. quadrature formula.
c. Computation of factorials, computation of square roots, recurrence relations.

Module IV: Review of FORTRAN Language I (6 lectures)

a. Introduction to computing
b. Constants, variables, expressions, operations, statements, functions and built in functions.
c. Conditional and looping structures, arrays, subprograms and subroutines.
d. File operations.

Suggested Readings

a. Theory and problems of Programming with FORTRAN, Seymour Lipschutz and Arthur Poe, McGraw-Hill.
b. FORTRAN 77 and numerical methods, C. Xavier and R. Rajaraman, New Age International Publishers
c. FORTRAN 77 Programming, V. Rajaraman, Prentice Hall of India.
d. Numerical Analysis, V. Rajaraman, Wiley Eastern.
e. Numerical Recepies in FORTRAN, W. H. Press, S. S. Tenkulsky, W. T. Wettering and B. P. Flannery, CambridgeUniversity Press.
f. Introductory Methods of Numerical Analysis, S. Sastry, Prentice Hall of India.
g. Numerical Methods for Scientific and Engineering Computation, M. K. Jain et al., New Age International Publications.
h. Introduction to Numerical Analysis, F. B. Hildebrand, McGraw-Hill Book Company Inc.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	H	H	
CO 2	H	H	H	
CO 3				H

PSSM0034: STATISTICAL MECHANICS

(4-0-0)

COURSE OUTCOMES

CO 1: Appreciate the connection between statistical mechanics and thermodynamics. (Analysing)
CO 2: Conceptualise quantum statistical mechanics. (Understanding)
CO 3: Understand the physics of phase transition. (Understanding)
CO 4: Understand non-equilibrium physics. (Understanding)

Module I: Essentials (17 lectures)

a. Probability theory: the random walk problem, binomial, Poisson and Gaussian distributions, central limit theorem.
b. Classical equilibrium statistical mechanics: concept of equilibrium; Ergodic hypothesis; microcanonical, canonical and grand canonical Ensembles; partition functions and their relation to thermodynamics.

c. Classical nonequilibrium statistical mechanics: approach to equilibrium, Liouville's theorem, Boltzmann's H theorem

Module II: Quantum Statistics (15 lectures)

a. Quantum statistical mechanics: Schrödinger and Heisenberg Picture; pure and mixed states, the density matrix, quantum mechanical Liouville's theorem; the fundamental postulates.
b. Quantum statistics: quantum gases of independent particles; partition functions; Bose Einstein's and Fermi Dirac's distributions; electrons in metals; black body radiation; Bose Einstein's Condensation

Module III: Phase Transitions (15 lectures)

a. Phenomenology: first and second order phase transitions; elementary ideas of critical phenomena; universalityof critical exponents; scaling of thermodynamic functions.
b. Theory: theLandau theory of phase transition with examples. c) Exact solutions: Ising model in one dimension.

Module IV: Non Equilibrium Phenomena and Irreversible Processes (13 lectures)

a. Non equilibrium phenomena: transport theory; Boltzmann equation; Maxwell-Boltzmann distribution.
b. Irreversible processes: fluctuations; Brownian motion; Langevin's equation; Wiener Khintchine relations, Nyquist theorem, Fluctuation-Dissipation theorem; Fokker Planck equation.

Suggested Readings

1. Fundamental of Statistical and Thermal Physics, FederickReif, McGraw Hill, Singapore.
2. World Scientific, Shang-Keng Ma, Statistical Mechanics, Singapore.
3. Wiley-Interscience, John Wiley and Sons Inc., Richard E. Wilde, and Surjit Singh, Statistical Mechanics: Fundamentaland Modern Applications, New York.
4. Statistical Physics: Statics, Dynamics and Renormalisation, Leo P.Kadanoff, World Scientific, River Edge, New Jersey.
5. Statistical Mechanics, K. Huang, John Wiley and Sons Inc., New York.
6. Statistical Physics, D. J. Amit and J. Verbin, World Scientific, Singapore.
7. Statistical Physics, L. D. Landau, E. M. Lifshitz, Butterworth-Heinemann.
8. Statistical Mechanics, R. K. Pathria, Academic Press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		
CO 3			H	
CO 4				H

PSPL0036: PLASMA PHYSICS I

(4-0-0)

COURSE OUTCOMES

CO 1: Understand and explain the basic theoretical concepts of plasma physics. (Remembering)
CO 2: Understand the behaviour of a single charged particle in electric and magnetic fields. (Understanding)
CO 3: Understand the purpose, principles and techniques of various plasma diagnostic. (Application)
CO 4: Understand the underlying principles of some laboratory and naturally occurring plasma. (Analysing)
CO 5: Know various applications of plasma. (Analysing)

Module I: Introduction to Plasma Physics (12 lectures)

Role of temperature in occurrence of plasma; definition of plasma: quasineutrality and collective behaviour of plasma; concept of temperature; Debye shielding; criteria for plasma; classification of plasma; occurrence of plasma in nature.

Module II: Single Particle Motion (12 lectures)

Uniform electric and magnetic fields; non-uniform magnetic field: grad-B drift, curvature drift, magnetic mirrors, the loss cone; non-uniform electric field; time-varying electric field; time- varying magnetic field; adiabatic invariants.

Module III: Plasma Diagnostics (14 lectures)

Langmuir probe: I-V characteristics, measurement of plasma potential, floating potential, electron temperature and electron density; double probe; optical emission spectroscopy: radiation from plasma, plasma models, temperature measurement by Boltzmann plot and line intensity ratio method, line broadening in plasma, Doppler broadening and stark broadening, applications; absorption spectroscopy; calorimetric methods; laser and microwave interferometer.

Module IV: Laboratory and Space Plasma (10 lectures)

Glow discharge plasma; production and stabilization of thermal plasma, principle of DC, AC and high frequency discharges, RF and ECR plasmas, dielectric barrier discharge plasma, laser produced plasmas; sun and solar winds, Van Allen belts, the ionosphere, formation of, accretion disks, dusty plasmas.

Module V: Applications of Plasma (12 lectures)
Thermal plasma: nanoparticle synthesis, plasma spraying, waste management; plasma sputtering; plasma nitriding; plasma processing; plasma enhanced vapour deposition; plasma assisted surface engineering; biomedical applications; the magneto-hydrodynamic generator; plasma propulsion.

Suggested Readings
1. Introduction to Plasma Physics and Controlled Fusion, F. F. Chen, Plenum.
2. Fundamentals of plasma physics, J. A. Bittencourt, Springer.
3. Principles of plasma diagnostics, I. H. Hutchinson, Cambridge University Press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H			
CO 3			H		
CO 4				H	
CO 5					H

PSEC0037: ELECTRONICS II
(4-0-0)

COURSE OUTCOMES
CO 1: Know about different types of transistors. (Understanding)
CO 2: Understand the application of transistors for circuit design. (Application)
CO 3: Utilize Describe devices like thyristors, operational amplifiers,oscillators, etc. (Analysing)
CO 4: Understand the digital electronics design using analog devices. (Understanding)
CO 5: Understanding the application of analog devices for electronic instruments and sensors (Application)

Module I: (20 lectures)
a. Bipolar junction transistor: BJT biasing: fixed bias, emitter bias, voltage divider bias, D.C. collector feedback bias; DC and AC load line, Q- point, stability considerations. BJT modeling: two port representation of BJT with z, y, h- parameters; re and hybrid models of C-E, C-B, C-C configuration.
b. Hybrid-pi model of C-E amplifier in voltage divider bias configuration, frequency response in low, mid and high frequency conditions, respective voltage gain, current gain, input and output impedances.
c. Field effect transistors: FET biasing: self bias, fixed bias, voltage divider bias, stabilization of Q-point. Small signal AC equivalent circuit of FET as amplifier, hybrid parameters. JFET amplifiers: CS, CD amplifiers; enhancement mode MOSFET amplifier, depletion mode MOSFET amplifiers; Introduction to CMOS, characteristics, structure of MOSFET, CMOS.

Module II: (25 lectures)
a. Thyristors: four layer diode, SCR, Photo SCR, gate controlled switch, silicon controlled switch, Diac, Triac, UJT;
b. Op-Amp - ideal operational amplifiers: Input impedance. DC offset parameters, frequency parameters, gain- bandwidth, CMRR, SVRR, SR. Op-Amp applications in constant gain multiplier, voltage summing, log - antilog amplifier, subtractor, comparator – zero crossing detector, Schmitt trigger, integrator, differentiator and controlled sources. instrumentation amplifier. Active filters: low, high and bandpass filters; ADC and DAC.
c. 555 timer: block diagram, monostable operation, astable operation, bistable operation, voltage controlled oscillator, ramp generator.

Module III: (15 lectures)
a. Feedback configurations: voltage series, voltage shunt, current series, current shunt.
b. Oscillators: introduction and classification, general form of LC oscillator, e.g. Hartley oscillator, Colpitts oscillator, RC phase shift oscillator, Wein Bridge oscillator, crystal oscillator.
c. Regulated power supply: voltage feedback regulation, current limiting characteristics, power supply characteristics, 3 terminal IC regulators, current boosters, switching regulators.
d. Characteristics of instruments: static characteristics, span, accuracy and precision, linearity, tolerance, error, repeatability, sensitivity, calibration, hysteresis, input impedance, resolution, bias and drift.

Suggested Readings
1. Electronic Devices and Circuit Theory, Robert L. Boylestad andLowisNashelsky, Pearson Education.
2. Millman’s Electronic Devices and Circuits, Jacob Millman, Christos C. Halkias and Satyabrata Jit, Tata McGraw Hill.
3. Electronic Devices and Circuits, S. Salivahanan, N. Suresh Kumar and A. Vallavaraj, Tata McGraw- Hill.

4. Solid State Electronic Devices, Streetman and Banerjee, Prentice Hall.
5. Electronic Devices and Circuits, David A. Bell, Prentice Hall of India.
6. Integrated Electronics, Jacob Millman, Christos C.Halkias, McGraw Hill Int.
7. Op-amps and Linear Integrated Circuits, Ramakant A. Gayakwad, PHI.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H		
CO 2	H	M	M
CO 3		H	M
CO 4	H	H	M
CO 5	M	M	H

PSNS0041: NANOPHYSICS II

(4-0-0)

COURSE OUTCOMES

CO 1: Explain different properties of nanomaterials. (Understanding)
CO 2: Know about different methods for the synthesis of nanomaterials. (Applying)
CO 3: Appreciate the technology associated with characterization of nanomaterials. (Applying)

Module I: (15 lectures)

Surfaces and interfaces in nanostructures; ceramic interfaces, superhydrophobic surfaces, grain boundaries in nanocrystalline materials, defects associated with interfaces; thermodynamics of nanomaterials, natural nanomaterials; toxicology of nanomaterials.

Module II: (25 lectures)

Chemical routes for synthesis of nanomaterials: electrochemical synthesis, photochemical synthesis; synthesis in supercritical fluids. hydrothermal growth of nanoparticles and different nanostructures. Ostwald ripening; zeta potential; fabrication of nanomaterials by physical methods: -inert gas condensation, arc discharge, plasma arc technique, RF plasma, MW plasma, ion sputtering, laser ablation, laser pyrolysis, ball milling, molecular beam epitaxy, physical and chemical vapour deposition method; electrodeposition. Core-shell quantum dots.

Module III: (20 lectures)

Nanostructures: zero-, one-, two- and three- dimensional structure, size control of metal nanoparticles; properties: optical, electronic, magnetic properties; surface plasmon resonance, structural characterization X-ray diffraction, small angle x-ray scattering, optical microscope and their description, scanning electron microscopy (SEM), scanning probe microscopy (SPM), TEM and EDAX, SAED analysis, scanning tunneling microscopy (STM), atomic force microscopy (AFM). Spectroscopic characterizations: basic concepts of spectroscopy, operational principle and application for analysis of nanomaterials, UV-VIS-IR spectrophotometers, principle of operation and application for band gap measurement (Taucplot).

Suggested Readings

1. A. Rao Introduction to nanoscience, G. L. Hornyak, J. Dutta and H. F. Tibbals, CRC Press.
2. Nano: The Essentials, T. Pradeep, McGraw Hill.
3. Nanotechnology and Global Sustainability, D. Maclurcan and N. Radywyl (Eds.), CRC Press.
4. Fundamentals of Nanoelectronics, G. W. Hanson, Pearson.
5. Springer Handbook of Nanomaterials, R. Vajtai (Ed.), Springer.
6. Springer Handbook of Nanotechnology, B. Bhushan (Ed.), Springer.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H		H
CO 2		H	
CO 3			H

PSGR0044: GENERAL THEORY OF RELATIVITY AND COSMOLOGY

(4-0-0)

COURSE OUTCOMES

CO 1: Relate the concepts from special theory of relativity with generalized tensor calculus. (Remembering)
CO 2: Explain Einstein's field equation from basic principles. (Understanding)
CO 3: Illustrate the implications of the general theory of relativity. (Understanding)
CO 4: Extend Einstein's gravity to the cosmological scale. (Understanding)
CO 5: Identify Newtonian gravity as a special case of general relativity. (Applying)

Module I: Theoretical Background of Relativity (15 lectures)

a. Foundations of relativity: postulates of relativity, GR units, space-time intervals, proper time; special Lorentz transformations in Minkowski space-time; four-vectors.
b. Review of tensor calculus in Euclidean space; tensor calculus in Riemannian space: generalized N-dimensional spaces, covariant and contravariant tensors; Riemann-Christoffel curvature tensor, Christoffel symbols, Einstein's tensor, geodesics; metric tensor, covariant differentiation, Bianchi Identities, Ricci tensor.

Module II: General Theory of Relativity (30 lectures)

a. Motion of a free particle in a gravitational field, equations of electrodynamics in the presence of a gravitational field; gravitational field equations – action for gravitational field, energy-momentum tensor, extremum principle, Einstein field equations, energy-momentum pseudotensor.
b. Field of gravitating bodies – Schwarzschild solution, Birkhoff 's theorem, motion in a centrally symmetric gravitational field, precession of perihelion of Mercury, deflection of light, gravitational lensing; black holes – Schwarzschild black holes, Kruskal space, black hole thermodynamics; gravitational waves – plane waves, weak field approximation, gravitational radiation, transverse-traceless gauge.

Module III: Fundamentals of Cosmology (15 lectures)

a. Cosmological principle, cosmological time; spaces of constant curvature, Hubble's constant, Hubble's Law, red-shift of galaxies, big bang, age and density of universe; cosmological constant
Einstein space, de Sitter space, anti-de Sitter space; Robertson-Walker metric, introduction to Friedmann-Robertson-Walker (FRW) universe.
b. The observed universe and its dynamics, Friedmann-Lemaitre-Robertson-Walker (FLRW) metric, Friedmann equation and its solutions; composition of the universe – origin of matter, big bang nucleosynthesis, abundance of light elements, dark matter and dark energy, cosmological constant as dark energy, origin of matter-antimatter asymmetry, baryogenesis.

Suggested Readings

1. Introduction to Tensor Calculus, Relativity and Cosmology, D. F. Lawden, Dover Publications.
2. A First Course in General Relativity, B. Shutz, Cambridge University Press.
3. Introduction to Cosmology, B. Ryden, Cambridge University Press.
4. Gravitation, C. W. Misner, K. S. Thorne and J. A. Wheeler, Princeton University Press.
5. The Classical Theory of Fields, L. D. Landau and E. M. Lifshitz, Butterworth-Heinmann.
6. The Meaning of Relativity, A. Einstein, Oxford & IBH.
7. General Theory of Relativity, P. A. M. Dirac, Prentice-Hall of India.
8. Feynman Lectures on Gravitation, R. P. Feynman, F. B. Moronigo and W. G. Wagner, Addison-Wesley.
9. Gravitation and Cosmology, S. Weinberg, Wiley.
10. Introduction to Cosmology, J. V. Narliker, Cambridge University Press.
11. Modern Cosmology, S. Dodelson, Academic Press.
12. Physical Foundations of Cosmology, V. Mukhanov, Cambridge University Press.
13. Fundamentals of Special and General Relativity, K. D. Krori, PHI.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H		
CO 2		H	
CO 3		H	H
CO 4		H	H
CO 5		H	

PSAR0045: ASTROPHYSICS
(4-0-0)

COURSE OUTCOMES

CO 1: Define and spell out fundamental concepts of Astronomy. (Remembering)
CO 2: Outline the various parameters describing the behaviour of stars and their evolution. (Understanding)
CO 3: Classify the various types of interstellar media. (Analysing)
CO 4: Explain the physical processes underlying the energy generation in stars. (Understanding)
CO 5: Apply astrophysical models to various observational scenarios. (Applying)

Module I: Fundamentals of Astronomy (12 lectures)
Astronomy fundamentals: celestial coordinate systems, telescope and its operational principles and mounting, atmospheric extinctions, magnitude systems. Radiation mechanism, flux density and luminosity, specific intensity, (emission/absorption coefficients, source functions), basics of radiative transfer and radiative processes.

Module II: Stellar Parameters (18 lectures)
Magnitudes, motions and distances of stars: absolute stellar magnitude and distance modulus, bolometric and radiometric magnitudes, colour-index and luminosities of stars, stellar positions and motions, velocity dispersion, statistical and moving cluster parallax, extinction, stellar temperature, effective temperature, brightness temperature, color temperature, kinetic temperature, excitation temperature, ionization temperature, spectral classification of stars, utility of stellar spectrum, stellar atmospheres. Binaries, variable stars, clusters, open and globular clusters, compact objects, shape, size and contents of our galaxy, normal and active galaxies.

Module III: Interstellar Medium (10 lectures)
Neutral and ionized gas, gaseous nebulae, HII regions, supernova remnants, photo-dissociation regions, different phases of the interstellar medium: cold neutral medium, warm neutral and ionized medium, hot medium, diffuse clouds, dense clouds.

Module IV: Stellar Physics (20 lectures)
Introduction to stars: HR diagram, a discussion on the variety of stellar phenomena, stellar structure, stellar opacities, stellar polytropes, energy generation in stars: calculation of thermonuclear reaction rates for non-resonant and beta-decay reactions, various reaction chains: pp-I, II, III, CNO, He-burning, C-burning, Si-burning, stellar degeneracy and equations of state: stellar degeneracy, Chandrasekhar mass, EoS of matter at near-nuclear and nuclear densities, final stages of stellar evolution: supernovae and neutron stars.

Suggested Readings
1. An Introduction to Astronomy and Astrophysics, P. Jain, CRC Press.
2. An Introduction to Astrophysics, B. Basu, PHI Learning Pvt. Ltd.
3. Astrophysics: Stars and Galaxies, K. D. Abhayankar, Universities Press.
4. Introduction to Stellar Astrophysics, Erika Böhm-Vitense, Cambridge University Press.
5. Gravity: Introduction to Einstein’s General Relativity, J. B. Hartle, Pearson Education.
6. Physical Cosmology, P. J. E. Peebles, Princeton University Press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	L	L	
CO 2		H		
CO 3			H	
CO 4				H
CO 5				H

PSPM0046: PLASMA PHYSICS II
(4-0-0)

COURSE OUTCOMES

CO 1: Understand fluid and kinetic model of plasma and their uses in the study of plasma. (Understanding)
CO 2: Explain the theory of various kinds of waves existing in plasma. (Understanding)
CO 3: Explain the phenomenon of diffusion in plasma and its consequences. (Analysis)
CO 4: Explain some basic instabilities and non linear phenomena in plasma. (Remembering)
CO 5: Understand the principles and challenges involved in energy production by fusion. (Analysis)

Module I: Plasma as fluids and Plasma Kinetic Theory (20 lectures)
Introduction to fluid model; equation of motion; continuity equation; fluids drifts perpendicular to B; fluids drifts parallel to B;

the plasma approximation; Introduction to kinetic theory; equations of kinetic theory; derivation of the fluid equation; plasma oscillation; Landau damping: meaning and physical derivation.

Module II: Waves in Plasma (10 lectures)
Representation of waves; group velocity; plasma oscillation; electron plasma waves; sound waves;ion waves; validity of plasma approximation; ion acoustic waves; Alfven waves.

Module III: Diffusion and Resistivity (10 lectures)
Diffusion and mobility; plasma decay by diffusion; steady state solution; recombination; diffusion across a magnetic field;the single MHD diffusion equation; solutions of the diffusion equation.

Module IV: Instability and Non-linear Effects (10 lectures)
Hydro-magnetic equilibrium; diffusion of magnetic field into a plasma; classifications of instability; two stream instability; plasma sheaths; ion acoustic shock waves; the ponderomotive force; parametric instabilities; plasma echoes; nonlinear Landau Damping.

Module V: Controlled Fusion (10 lectures)
Controlled fusion and problems; magnetic confinement: toruses, mirrors, pinches; laser fusion;plasma heating; fusion technology; tokamaks; ITER.

Suggested Readings

1. Introduction to Plasma Physics and Controlled Fusion, F. F. Chen, Plenum.
2. Fundamentals of plasma physics, J. A. Bittencourt, Springer.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	L	L		
CO 2		H			
CO 3			H		
CO 4				H	
CO 5					H

PSER0047: ELECTRONICS III

(4-0-0)

COURSE OUTCOMES

CO 1: Illustrate advanced topics of digital electronics. (Understanding)
CO 2: Explain microprocessor, microcontroller and assembly language. (Understanding)
CO 3: Apply the knowledge in advanced digital structures. (Applying)
CO 4: Understand digital circuit design (Application)
CO 5: Analyse the working of processor for execution of computer program (Analysing)

Module I: (15 lectures)

a. Number system: representation of signed integers, binary arithmetic on signed and unsigned integers and detection of overflow and underflow, weighted binary Codes: BCD, 2421, non- weighted codes: excess-3 codes, gray codes, error detecting codes, error correcting codes, alphanumeric codes: ASCII code, EBCDIC codes.
b. Boolean algebra and logic gates: rules (postulates and basic theorems) of Boolean algebra, dual and complement ofa Boolean expression, sum of products and product of sums forms. canonical forms. Conversion between different forms, conversion between Boolean expression and truth table; implementing logic expressions with logic gates (logic circuits).
c. Digital logic families: designing of basic logic gates with diode and transistor; elementary idea of DTL, TTL, RTL, ECL, I2L logic family and characteristics.

Module II: (15 lectures)

a. Combinational circuit: Simplification of Boolean expressions using algebraic method, Karnaugh map method and Quine-McCluskey method, Don't Care conditions. Multiplexer, demultiplexer, encoder, decoder, half-adder, hull- adder, magnitude comparator, parity checkers: basic concepts, design of parity checkers, parity generation, code converters, binary –to- gray and gray-to-binary Code converter; concept of magnitude comparator.
b. Sequential circuit: simple R-S flip-flop or Latch, clocked R-S Flip-flop, D flip-flop. J-K flip-flop, T flip-flop, master-slave flip-flop, J-K Master-Slave flip-flop. Asynchronous preset and clear, edge triggering and level triggering. Registers: shift registers, parallel/serial in, parallel/serial out. Buffer counter design: different types of counters like asynchronous and synchronous, up and down, ring, Johnson etc. counter design using state diagram, state table and state equation.

c. Semiconductor memory: classification of memories, main memory and secondary memory, sequential access memory, static and dynamic memory, volatile and nonvolatile memory, concept of ROM, PROM, EPROM, RAM, DRAM, SDRAM, PSRAM, memory decoding.

Module III: (30 lectures)

a. History and evolution of microprocessor; introduction to CPU: components of CPU, block diagram, buses-data, control and address; ALU, control unit; main memory and secondary memory; I/O devices; memory addressing- memory mapped I/O and I/O mapped I/O; address decoding; memory and I/O interfacing.
b. Introduction to 8085; block diagram, registers, use of register pairs, PSW, accumulator; addressing modes; Instruction set of 8085: data transfer, arithmetic, logic, branch and machine control instructions; instruction cycle: fetch, decode and execute. Delay and counter; stack and its application; interrupt and its application; assembly level language programming of 8085.
c. Interfacing: Memory interfacing; I/O interfacing; interfacing small devices like keyboard,7-segment display, relay, event counter etc.; idea of PPIs like 8251, 8255, 8257 and 8279 (block diagram and function only); serial communication standard (RS-232C).
d. Example of 16-bit processors (introduction to 8086); microcontroller (block diagram and application of 8051).

Suggested Readings

a. Digital Logic and computer Design, M. Mano, PHI.
b. Modern Digital Electronics, R. P. Jain, TMGH.
c. Digital Fundamentals, Jain and Floyd, Pearson Education.
d. Digital Electronics, Malvino and Leach, Pearson Education.
e. Digital Computer Electronics, Malvino, TMGH.
f. Digital Design, Principles and Practices, Morris Mano, Pearson Education.
g. Digital Circuits and Design, S. Salivahanan and S. Arivazhagan, Vikash Publishing House Pvt. Ltd.
h. Digital Techniques, P. H. Talukdar, N. L. Publications.
i. Fundamentals of Digital Circuits, Anand Kumar, PHI.
j. Introduction to Microprocessors, Gaonkar, New age Publication.
k. Fundamentals of Microprocessor, B. Ram, Dhanpat Rai.
l. 8085 Microprocessor Programming and Interfacing, N. K. Srinath, PHI.
m. Microprocessor Based Design, Slater, PHI.
n. Microprocessors, Gilmore, McGraw Hill Publication.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H	H	
CO 2		M	H
CO 3	M	H	M
CO 4	H	H	
CO 5			H

PSNY0048: NANOPHYSICS III

(4-0-0)

COURSE OUTCOMES

CO 1: Explain properties of nanomaterials in detail. (Understanding)
CO 2: Explain quantum effects on nanostructures. (Understanding)
CO 3: Give outline nanomechanics. (Understanding)
CO 4: Take part in higher studies and research in nanophysics. (Analysing)

Module I: (15 lectures)

Absorption and scattering of EM waves from nanoparticles based on bulk properties. Electronic phenomena in nanostructures: electronic structures and effective mass theory for bulk Si , Ge, GaAs; excitons. Boltzmann electron transport in bulk. Electron energy states in quantum confined systems, semiconductor heterojunctions.

Module II: (20 lectures)

a. X-ray photoelectron spectroscopy (XPS): fundamentals: photoelectric effect, binding energy and chemical shift,ultraviolet photoelectron spectroscopy (UPS): information.
b. Extracted: band structure, occupied band states of clean solid surfaces as well as bonding orbital states of adsorbed molecules; fundamentals of Fourier transform infrared radiation (FTIR) and Raman spectroscopy.
c. 2-DEG systems, quantum wires, quantum dots. Transmission in nanostructures: tunneling in planar barrier, resonant

tunnel diodes. Ballistic transport, Landauer formula, electron transport in quantum wave-guide structures.

Module III: (15 lectures)
Single electron phenomena: electronic states in quantum dots, without and with magnetic fields, single electron tunneling and Coulomb blockade, single electron tunneling, elastic, inelastic, spin polarized tunneling, surface density of states for different dimensions, role of tip geometry, lithography and atomic manipulation; single electron transistor. Spin-orbit interaction and spin effects.

Module IV: (10 lectures)
Nanomechanics: introduction to NEMS, CNT oscillation, nanoscale electrometer, bolometer nanophotonics; science of Graphene.

Suggested Readings
1. Transport in Nano-Structures, D. K. Ferry and S. M. Goodnick, Cambridge University Press.
2. Electronic Transport in Mesoscopic Systems, S. Datta, Cambridge University Press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H		L	L
CO 2		H		
CO 3				H
CO 4			H	

PSEL0049: ELECTRONICS I
(4-0-0)

COURSE OUTCOMES
CO 1: Explain about passive components and DC networks, digital electronics (Understanding)
CO 2: Understanding physics of electronic devices and circuits (Understanding)
CO 3: Explain electronic communication. (Understanding)
CO 4: Experiment with electronic devices and circuits. (Applying)

Module I: Passive Components and DC Networks (15 lectures)
a. Passive components: resistors, capacitors and inductors-types, characteristics and applications;
b. DC networks: voltage and current sources, dependent sources, KCL, KVL, current division rule, voltage division rule, Y-Delta conversion, mesh analysis, node analysis, Thevenin’s theorem, Norton’s theorem, superposition theorem, maximum power transform theorem.

Module II: Electronic Devices and Circuits (20 lectures)
a. Semiconductor concepts: semiconductor material, intrinsic semiconductor, extrinsic semiconductor, energy levels, concept of hole and electron, mobility, conductivity, n-type and p-type, majority and minority carriers, mechanism of current flow.
b. Semiconductor diode: PN junction and various biasing conditions, V-I characteristics, diode equation, diode resistance, equivalent circuit, transition capacitance and diffusion capacitance; rectifier circuit with filter, clipper, clamper, voltage multiplier.
c. Special purpose diodes: Zener diodes, LED, 7 segment display, photo diode, photo transistor, opto coupler, Schottky diode, varactor diode, tunnel diode.
d. Transistor - BJT: construction, npn, pnp, operation and configuration, V-I characteristics, introduction to FET- JFET, MOSFET.
e. OP-AMP: block diagram, ideal op-amp equivalent circuit, ideal characteristics, transfer curve, open loop and closed loop configurations, op-amp as an inverting amplifier, non-inverting amplifier, adder, subtractor.

Module III: Digital Circuits (12 lectures)
Number systems, Boolean algebra, De-Morgan’s law, AND, OR, NOT, Universal gates, combinational logic circuits.

Module IV: Communication (13 lectures)
a. Introduction: communication process, source of information, communication channels, modulation types andneed, block diagram of communication systems, AM, FM, PAM, PWM, PPM.
b. Introduction to digital modulation: ASK, PSK, FSK.

Suggested Readings
1. Electronic Devices and Circuits, S. Salivahanan, McGraw Hill Publications.
2. Communication System, R. D. Singh and S. D. Sapre, TMGH.

3. Networks and Systems, D. Roy Choudhury, New Age International.
4. Electronic Devices and Circuits, David A. Bell, Oxford University Press.
5. Digital electronics, Moris Mano, EEE.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	L	H	
CO 2	M	H	H	
CO 3	M	M		H
CO 4	H	H	M	

PSNP0050: NANOPHYSICS I

(4-0-0)

COURSE OUTCOMES

CO 1: Explain basic concepts of nanophysics. (Remembering)
CO 2: Explain the working principle of various characterization techniques. (Understanding)
CO 3: Explain various fabrication techniques. (Understanding)
CO 4: Analyse the relation between nanoparticles size and their properties. (Analysing)
CO 5: Understand various natural nanomaterials and bio-molecular nanoscience. (Understanding)

Module I: Introduction (20 lectures)

Distinction between nanoscience and nanotechnology, requisite definitions; historical perspectives; nanomaterials: overview, definitions, and examples; structurally confined materials: nanoparticles, islands, nanowires, thin films; metal nanoparticles: fundamentals and applications; self- assembled monolayers, semiconductor quantum dots: fundamentals and applications; ceramic nanomaterials: fundamentals and applications; carbon nanomaterials(Fullerenes and carbon nanotubes and nanofibers): fundamentals and applications; magnetic nanoparticles: fundamentals and applications; bionanomaterials, computational nanomaterials, composite nanomaterials and applications.

Module II: Characterization tools (10 lectures)

Electron microscopy, atomic force microscopes, X-ray spectroscopy, surface enhanced Raman spectroscopy, lithography, computer modelling and simulation.

Module III: General Fabrication Methods (12 lectures)

Background; top down fabrication: mechanical methods, thermal methods, high energy methods, chemical fabrication methods, lithographic methods; bottom up fabrication: gaseous phase methods, liquid phase methods, template synthesis

Module IV: Basic Properties of Nanomaterials (10 lectures)

Importance of surface: natural, inorganic and the nano perspectives; particle shape and surface; surface: geometricsurface to volume ratio, specific surface area; atomic structure: crystal systems.

Module V: Natural and Bio-nanoscience (8 lectures)

Natural nanomaterials: inorganic natural nanomaterials, nanomaterials from the animal kingdom, nanomaterials derived from cell walls, nanomaterials in insects; Introduction to biomolecular nanoscience: history, biomolecular nanoscience, nano perspective

Suggested Readings

1. Introduction to nanoscience, G. L. Hornyak, J. Dutta and H. F. Tibbals, A. Rao, CRC Press.
2. Nano: The Essentials, T. Pradeep, McGraw Hill.
3. Nanotechnology and Global Sustainability, D. Maclurcan and N. Radywyl (Eds.), CRC Press.
4. Environmental Chemistry for a Sustainable World, Vol.2, E. Lichtfouse, J. Shwarzbauer and D. Robert, Springer Verlag.
5. Introduction to nanotechnology, G. L. Hornyak, J. Dutta, H. F. Tibbals and A. Rao, CRC Press.
6. Fundamentals of Nanoelectronics, G. W. Hanson, Pearson.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H			L	
CO 2		H			
CO 3			H		
CO 4				H	

CO 5					H

PSRM0051: RESEARCH METHODOLOGY

(3-0-0)

COURSE OUTCOMES

CO 1: Understand the meaning, significance and ethics of research. (Understanding)
CO 2: Conduct literature survey. (Understanding)
CO 3: Present and defend their project accurately, both orally and written. (Applying)
CO 4: Present and defend their research results accurately, both orally and written at specialized levels. (Creating)
CO 5: Appreciate statistics as a tool for designing research, analysing data and drawing validconclusions therefrom. (Analysing)

Module I: Introduction to Research (6 lectures)

Definition of research; objectives of research, importance of research, motivation in research, research methods and research methodology, importance of research methodology; types of research: Basic Research and Applied Research, theoretical; simulations and experimental research. Various stages of research; ethics in scientific research: ethical values of science, ethics of researcher, personal and internal code of conduct, conduct guidelines, ethical standards of publication, scientific fraud and malpractice; plagiarism.

Module II: Literature Survey (6 lectures)

Functions of the literature review in research, conducting a literature survey, sources of information, use of internet, technical and scientific documents, characteristics and quality indices of journals, developing theoretical and conceptual frameworks, writing literature review.

Module III: Research Documentation and Presentation (8 lectures)

Structure of scientific documents; types of scientific reports: research papers, patents, dissertation, posters, slide presentation; skills for academic writing, online communication technologies, preparation of research projects, monitoring and evaluation processes; writing dissertation using LaTeX documents and beamers; citing references and bibliography, thesis defense.

Module IV: Statistics in Research (10 lectures)

Discrete distributions – binomial, geometric, Poisson; continuous distributions – Gaussian, log-normal, gamma, chi- squared; central limit theorem; populations and samples, sample statistics – averages, variance, standard deviation, moments, covariance and correlation; standard errors and confidence limits; Bayesian inference; hypothesis testing – Neyman-Pearson test, Student's t-test, Fisher's F-test; goodness-of-fit.

Suggested Readings

1. Research Methodology: A Step-by-Step Guide for Beginners, Ranjit Kumar, Sage Publications Ltd.
2. Research Methodology: Methods and Techniques, C. R. Kothari, New Age International (P) Ltd.
3. Methodology of Educational Research, Lokesh Koul, Vikas Publishing.
4. The A-Z of PhD Trajectory, Eva O. L. Lantsoght, Springer.
5. Writing for Publication, Mary RenckJalongo and Olivia N. Saracho, Springer.
6. Mathematical Methods for Physicists: A Comprehensive Guide, George B. Arfken, Hans J. Weber and Frank E. Harris,Associated Press.
7. Bayesian Statistics for Beginners: A Step-by-Step Approach, Therese M. Donovan and Ruth M. Mickey, Oxford UniversityPress.
8. Data Analysis: A Bayesian Tutorial, D. S. Sivia and J. Skilling, Oxford University Press.
9. Mathematical Methods for Physics and Engineering, K. F. Riley, M. P. Hobson and S. J. Bence, Cambridge University Press.
10. Writing for Publication, Mary RenckJalongo and Olivia N. Saracho, Springer.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		
CO 3			H	
CO 4			H	
CO 5				H

PSHP0052: HIGH ENERGY PHYSICS I
(4-0-0)

COURSE OUTCOMES
CO 1: Summarize the mathematical skills like group theory, tensors, kinematics, etc. (Understanding)
CO 2: Explain different groups like Lorentz group, Lie group and their algebra. (Understanding)
CO 3: Explain scalar field quantisation. (Analysing)
CO 4: Explain quantum field theory and hence identify quantum electrodynamics. (Applying)

Module I: Preliminaries (8 lectures)
Tensors,covariant and contravariant tensors, Lorentz covariance and four vector notation; Klein-Gordon equation; Dirac equation and its covariant form.

Module II: Group theory and Tensors (10 lectures)
Introduction to group theory, Lie group and Lie Algebra, representation theory, Representations of both Lorentz and Poincaré groups, Irreducible representations of the Lorentz group; Young tableau.

Module IV: Quantum field theory (22 lectures)
Concepts of fields and quantisation, Lagrangian field theory, Hamiltonian field theory, Noether's Theorem and Conserved Currents, canonical quantization of freefields (Scalar, complex, EM and Dirac fields), conservation ofenergy, momentum and charge of the field, The concept of vacuum and Fock space in field theory; C, P, T transformation of scalar and E. M. fields.

Module V: Quantum Electrodynamics (20 lectures)
Concepts of Causality, propagator and Feynman propagator, Green's function, Interaction picture and time evolution operator, S-matrix, path integral formalism, Covariant perturbation theory, Feynman rules in momentum space, Wick's theorem, reduction of time-ordered products, calculation of second order process, Compton scattering, Klein-Nishima formula, Mott scattering, Basics of renormalization.

Suggested Readings
1. Introduction of Elementary Particle, D. Griffiths, Wiley-vch Verlag Gmbh.
2. Quarks and Leptons: An Introductory Course in Modern Particle Physics, F. Halzen and A. D. Martin, Wiley India.
3. Quantum Field Theory, L. H. Ryder, Cambridge University Press.
4. Introduction to High Energy Physics, D. H. Perkins, Addison-Wesley.
5. Particle Physics, Brian R. Martin and Graham Shaw, Wiley.
6. An introduction to Quantum Field Theory, Michael E. Peskin and Daniel V. Schroeder, Westview Press Inc.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H			
CO 3			H		
CO 4				H	H

PSEP0053: HIGH ENERGY PHYSICS II
(4-0-0)

COURSE OUTCOMES
CO 1: Explain gauge theories. (Understanding)
CO 2: Familiarise with physics of spontaneous symmetry breaking and Higgs mechanism. (Analysing)
CO 3: Explain standard model and physics beyond standard model. (Understanding)
CO 4: Build the theory of neutrino physics. (Analysing)
CO 5: Recall group theory and learn how to apply it to gauge theory. (Applying)

Module I: Introduction (10 lectures)
Introduction to Gauge symmetries – global and local gauge transformations, abelian group U(1) (QED), Yang-Mills (Non-Abelian) groups – SU(2) (isospin), SU(3)C (QCD).

Module II: Spontaneous Symmetry Breaking (SSB) (12 lectures)
Ground state with spontaneous symmetry breaking, some examples; global symmetry breaking and Goldstone bosons, proof of Goldstone theorem, local symmetry breaking and Higgs mechanism for giving masses to vector bosons, examples U(1), SU(2).

Module III: Standard Model (SM) (12 lectures)
Standard model of electroweak unification, gauge bosons W^+, W^-, Z^0, charged weak current and neutral current, Higgs particle, experimental status.

Module IV: Beyond Standard Model (12 lectures)
a. Introduction to Grand Unified Theories (GUTs) – SU(5) and SO(10), and proton decay predictions;
b. Minimal Supersymmetric Standard Model (MSSM) and its extension, its predictions;
c. Introduction to String Theories and Planck scale physics.

Module V: Neutrino Physics (14 lectures)
Solar and atmospheric neutrino puzzles, theory of neutrino oscillations in vacuum and medium (MSW mechanism), neutrino masses and leptonic mixings, survey of various neutrino oscillation experiments, seesaw mechanism for small neutrino masses.

Suggested Readings
1. Gauge Theory of elementary particle physics, Ta-Pei Cheng and Ling-Fong Li, Oxford University Press.
2. Quarks and leptons: An introductory Course in Modern Particle Physics, Francis Halzen and Alan D. Martin,John Wiley & Sons.
3. Introduction to Elementary Particles, David Griffiths, John Wiley & Sons.
4. A First Course in String theory, Barton Zwiebach, Cambridge Univ. Press.
5. Grand Unified theories, Graham G Ross, Oxford University Press.
6. Massive Neutrinos in Physics and Astrophysics, R. N. Mohapatra and P. B. Pal, World Scientific, Singapore.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				
CO 2		H			
CO 3			H	H	
CO 4					H
CO 5	H				

PSNP0054: NUCLEAR AND PARTICLE PHYSICS
(4-0-0)

COURSE OUTCOMES
CO 1: Explain the properties of nucleus in details. (Understanding)
CO 2: Describe Shell model and learn to calculate the spin and parity of nuclear ground state. (Analysing)
CO 3: Knowledge of nuclear reaction and learn the selection rules for nuclear transitions. (Analysing)
CO 4: Classify the elementary particles and explain the quark model. (Understanding)

Module I: General Properties of Nuclei (6 lectures)
Nuclear size, shape and charge distribution, spin, parity and isospin of nucleon and nuclei. Determination of nuclear size and charge density, concept of magnetic dipole moment and electric quadrupole moment, Binding energy.

Module II: Nuclear Two Body Problem and Nuclear Force (12 lectures)
Properties of deuteron bound state and low energy n-p scattering in terms of scattering length and effective range, spin dependence, charge independence of nucleon force. Non-central part of nucleon force, exchange forces, Yukawa theory of nuclear force, magnetic moment and electric quadrupole moment of deuteron.

Module III: Nuclear Models (10 lectures)
Semiempirical mass formula, liquid drop model, Failure of Liquid drop model, Evidence of shell structure, magic numbers, effective single particle potentials (square well, harmonic oscillator, Wood-Saxon with spin orbit interaction), extreme single particle model and its successes and failures in predicting ground state spin, parity, Nordheim rule, rotational and vibrational model.

Module IV: Nuclear Reactions (12 lectures)
Kinematics governing nuclear reactions, Q-value, cross section of nuclear reactions, neutron reactions at low energies, Coulomb effects in nuclear reactions, neutron reactions, compound nucleus hypothesis, Breit Wigner one level formula for resonance reactions. Elements of direct reactions (qualitative), energies of fission and fusion, neutron induced fission, chain reaction.

Module V: Nuclear Decay (8 lectures)
Fermi theory of decay, selection rules, non-conservative of parity. Gamma decay, electric and magnetic multipole transitions,

selection rules, examples of beta and gamma decay.

Module VI: Particle Physics (12 lectures)
Classification of fundamental forces, Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.), Symmetries and conservation laws, SU(2) and SU(3), CPT theorem, CP violation in K decay, Gell-Mann Nishijima relation, quark model, baryons and mesons, coloured quarks and gluons, Relativistic kinematics.

Suggested Readings
1. Atomic and Nuclear Physics, Vol-II, S. N. Ghosal, S. Chand and company Ltd.
2. Introductory Nuclear Physics, S. M. Wong, Prentice Hall Inc.
3. Concepts of Nuclear Physics, B. L. Cohen, Tata McGraw Hill Publishing Company Ltd.
4. The Atomic Nucleus, R. D. Evans, Tata McGraw Hill Publishing Company Ltd.
5. Nuclear Radiation Detectors, S. S. Kapoor and V. S. Ramamurthy, Wiley Eastern Ltd.
6. An introduction to nuclear Physics, W. N. Cottingham and D. A. Greenwood, Cambridge University Press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H					
CO 2		H				
CO 3			H	H	H	
CO 4						H

PSMP0055: MATHEMATICAL PHYSICS-I
(3-1-0)

COURSE OUTCOMES
CO 1: Explain the concepts and applications of the function of complex variables. (Remembering)
CO 2: Apply the advanced concepts of vector spaces in solving physical problems. (Applying)
CO 3: Utilize the concepts and applications of some special functions. (Applying)
CO 4: Illustrate some of the basic concepts of residue theorem. (Understanding)
CO 5: Analyse physical scenarios using the concepts of vector space. (Analysing)

Module I: (16 lectures)
Functions of complex variable: Analytic functions; derivatives of an analytic function. Series of analytic functions: Taylor series, Laurent series; zeros and isolated singular points of analytic functions; the calculus of residues: theorem of residues; evaluation of integrals; Jordan's lemma; Principal value of an integral; multi-valued functions; Riemann surfaces; evaluation of an integral involving a multi- valued function; analytic continuation; dispersion relations.

Module II: (16 lectures)
Review of vector analysis; definition of vector spaces; finite dimensional vector spaces: linear independence, basis and dimensionality, inner product of vectors and norm of vector, Schemidt's orthogonalization method, Schwarz's and Bessel's inequalities; matrices: orthogonal, Hermitian, unitary and normal matrices; linear operators: matrix representation of linear operators; linear transformation: similarity transformation, orthogonal and unitary transformations; eigenvectors and eigenvalues, diagonalization of matrices (or operators); infinite dimensional vector space: Hilbert space, Fock space.

Module III: (20 lectures)
Special functions: associated Legendre differential equation and functions; generating functions; spherical harmonics; orthonormality. Bessel's equation; Bessel function; Spherical Bessel function, Neumann and Hankel functions; expansion of a plane wave into partial waves. Laguerre and associated Laguerre differential equation and functions; generating functions; recurrence relations; orthonormality. Hypergeometric and confluent hypergeometric functions.

Module IV: (8 lectures)
Integral transforms: general properties of Laplace transforms; inverse Laplace transform; application of Laplace transforms; convolution theorem; solution of differential equations using Laplace transform.

Suggested Readings
1. Mathematical Methods for Physicists, G. Arfken, H. Weber and F. Harris, Elsevier.
2. Mathematical Methods of Physics, J. Mathews and R. L. Walker, The Benjamin-Cumminngs Publishing Company.
3. Mathematics for Physicists, P. Dennery and A. Krzywicki, Harper and Row.
4. A.W.Joshi, Matrices and Tensors in Physics, 3rd Edition, New Age Int. (2005)
5. S. Andrilli & D.Hecker, Elementary Linear Algebra, Academic Press (2006).
6. J. Brown and R.V.Churchill, Complex Variables and Applications, McGraw-Hill, 8th Edition (2008)

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module II
CO 1	H				
CO 2		H			
CO 3			H		
CO 4					H
CO 5				H	

PSMP0056: MATHEMATICAL PHYSICS-II

(3-1-0)

COURSE OUTCOMES

CO 1: Explain the concepts and applications of the special function (Applying)

CO 2: Illustrate some of the basic concepts of tensor analysis and its application to different brances of physics. (Understanding, Applying)

CO 3: Analyse Illustrate some of the basic concepts of group theory and its application to different brances of physics. (Understanding, Applying)

Module I: (20 lectures)

Special functions-II

Power series solution, Frobenius method, Sturm-Liouville theory and boundary value problems, boundary value problems on Laplace equation, Poisson equation and diffusion equation, Green’s functions and method involving Green’s function and its applications; method of separation of variables for different wave equations in Cartesian and curvilinear coordinates involving special functions like Legendre, Hermite, Laguerre and Bessel functions

Module II: (20 lectures)

Tensor Calculus

Manifolds and coordinate systems. Transformation of coordinates: Galilean and Lorentz transformations. Tangent vectors and gradients, inner and outer products, contraction, symmetric and antisymmetric tensors, metric tensor, covariant and contravariant derivatives. Metric tensor in different curved spaces. Four vectors and physical examples from special relativity and electrodynamics. Covariant derivatives and parallel transport. Geodesics. Idea of curvature. Calculation of Laplacian in curved spaces.

Module III: (20 lectures)

Group Theory

Group axioms, permutation groups (S2 and S3) and symmetry operations of equilateral triangle, multiplication table, subgroup, classes and characters, finite groups (Zn), cosets, factor group, normal subgroup, point symmetry group, direct and semi direct product of groups, homomorphism and isomorphism, direct and semi-direct products, block diagonalisation - reducible and irreducible representation, group representation by matrix [unitary representation and conservation laws], Lie groups and algebras [generators, SO(2), SO(3) and SU(2)]; unitary group, special unitary group, Lorentz group, rotation group, direct product, Young Tableau, Dynkin diagrams.

Suggested Readings

1. Mathematical Methods for Physicists, G. Arfken, H. Weber and F. Harris, Elsevier.
2. Mathematical Methods of Physics, J. Mathews and R. L. Walker, The Benjamin-Cumminngs Publishing Company.
3. Mathematics for Physicists, P. Dennery and A. Krzywicki, Harper and Row.
4. A.W.Joshi, Matrices and Tensors in Physics, 3rd Edition, New Age Int. (2005)
5. M. Hamermesh, Group Theory and Its Applications to Physical Problems, Dover (1989)
6. D.B. Lichtenberg, Unitary symmetry and elementary particles, second edition, Academic Press (1978).

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 2		H	
CO 3			H
CO 4			

PSPS0200: PHYSICS AND SERVICE LEARNING

(2-0-0)

COURSE OUTCOMES

CO 1: Explain the meaning of service learning and active learning. (Understanding)

CO 2: Illustrate engaged teaching and engaged research. (Understanding)
CO 3: Organise service learning. (Applying)
CO 4: Illustrate CBPR. (Understanding)
CO 5: Find the regulations of educational statutory bodies on social responsibility. (Remembering)

Module I: (6 lectures)
Understanding social responsibility of educational institutes; meaning of community university engagement (CUE), engaged teaching, engaged research. Community Based Participatory Research (CBPR). Statutory bodies of higher educational institutions and social responsibility.

Module II: (9 lectures)
Active learning. Service learning; principles of service learning; classification of service learning models; difference between service learning and other community experiences; historical context of university community partnership;physics students and service learning. Service Learning for a postgraduate physics student and its scope in research.

Module III: (15 lectures)
Conceptualisation of the idea of service learning through any two of the following practical implementations: (i) conducting awareness programmes on scientific temper for nearby communities, (ii) organising demonstrations of scientific experiments for school children to eradicate the fear of pursuing higher studies in science, (iii) surveying the need of the communities and find out various possibilities of providing the solutions from physics point of view, (iv) providing consultancy to school students for various inter school science competitions, (v) providing video lectures and/or demonstrations for school students. (vi) Radiation measurement activity and awareness campaign by students.

Suggested Readings
1. Service-Learning Essentials: Questions, Answers, and Lessons Learned, Barbara Jacoby, Jossey-bass.
2. Where's the Learning in Service-Learning?,Janet Eyler and Dwight E. Giles Jr., Jossey-bass.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1		H	
CO 2	H		
CO 3			H
CO 4	H		
CO 5	H		

LABORATORY COURSES

PSPL6003: PHYSICS LABORATORY II

(0-0-4)

COURSE OUTCOMES

CO 1: Explain the characteristics of SCR. (Understanding)
CO 2: Find out resistivity of a semiconductor. (Application)
CO 3: Determine of difference in wavelengths of Na using Fabry-Perot interferometer. (Application)
CO 4: Verify the Beer-Lambert law using UV visible spectrometer. (Analysis)
CO 5: Use nuclear radiation detectors. (Application)
CO 6: Understand phonon dispersion using simulator. (Understanding)
CO 7: Have some fundamental understanding of plasma experiments. (Understanding)

At least 10 experiments should be performed from the following:

1. To study the characteristic of SCR using the breadboard.
2. To study resistivity of a semiconductor by probe method.
3. Determination of difference in wavelengths of Na using Fabry-Perot interferometer.
4. To verify the Beer-Lambert law using UV visible spectrometer.
5. Verification of inverse square law for gamma ray using GM counter.
6. To study attenuation of beta rays using GM counter.
7. To determine the activity of a gamma emitter.
8. To study gamma ray spectrum of Cs-137 source and determine the resolution of agamma-ray spectrometer.
9. To calibrate the scintillation spectrometer and determine the energy of gamma raysfrom an unknown source.
10. To study attenuation of gamma-rays from Cs-137 source by using different absorbers.
11. To study the decay curve for half-life components of irradiated 115In by a neutron source.
12. To study phonon dispersion of a monatomic chain of atoms using electronicanalogue of the chain.
13. Experimental verification of Paschen law in a glow discharge system.
14. To find the floating potential of a plasma using the Langmuir probe.

Mapping of COs to the syllabus

Course Outcomes	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp 10	Exp 11	Exp 12	Exp 13	Exp 14
CO 1	H													
CO 2		H												
CO 3			H											
CO 4				H										
CO 5					H	H	H	H	H	H	H			
CO 6												H		
CO 7													H	H

PSPL6009: PHYSICS LABORATORY I

(0-0-4)

COURSE OUTCOMES

CO 1: Demonstrate the validity of various network theorems. (Understanding)
CO 2: Explain the working of various circuits containing semiconductor devices. (Understanding)
CO 3: Construct various rectifier circuits. (Applying)
CO 4: Build various filter circuits. (Applying)
CO 5: Illustrate the working of various transistor circuits. (Understanding)
CO 6: Explain the behaviour of Op-Amp circuits. (Understanding)
CO 7: Demonstrate the working of logic circuits. (Understanding)
CO 8: Explain the transmission of electromagnetic waves through optical fibers. (Understanding)

At least 10 experiments should be performed from the following:

1. Verification of KCL and KVL using discrete components.
2. Verification of Thevenin's theorem.
3. VI characteristics of PN junction diode.
4. Series voltage regulation using zener diode and transistor.
5. Design and study the clipper circuit.
6. Design and study the clamper circuit.

7. VI characteristics of Zener diode.
8. Design of Half wave and Full wave rectifier with and without filter.
9. RC low pass and high pass filter realization.
10. Static Characteristics of a Bipolar Junction Transistor (CE Mode).
11. Static Characteristics of a Bipolar Junction Transistor (CB Mode).
12. Design of voltage multiplier: voltage doubler / quadrupler.
13. Design BJT as a switch.
14. Op-Amp as Inverting and Non Inverting amplifier.
15. Realization of basic gates using discrete components.
16. To measure attenuation and bending losses of an optical fibre.
17. To study and verify the truth table of logic gates.
18. To realize half/full adder and half/full subtractor.

Mapping of COs to the syllabus

Course Outcomes	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9
CO 1	H	H							
CO 2			H	H	H	H	H		
CO 3								H	
CO 4									H

Course Outcomes	Exp 10	Exp 11	Exp 12	Exp 13	Exp 14	Exp 15	Exp 16	Exp 17	Exp 18
CO 5	H	H	H	H					
CO 6					H				
CO 7						H		H	H
CO 8							H		

PSCN6010: COMPUTER ORIENTED NUMERICAL METHODS LAB

(0-0-8)

COURSE OUTCOMES

CO 1: Find out inverse, eigenvalues and eigenvectors of a matrix. (Application)
CO 2: Perform numerical integration and differentiation and solution of differential equations. (Application)
CO 3: Understand special functions and orbitals. (Understanding)
CO 4: Numerical solutions of algebraic equations. (Application)
CO 5: Numerical solutions of simultaneous equations. (Application)
CO 6: Understand chaos. (Understanding)
CO 7: Apply Monte-Carlo simulations. (Application)
CO 8: Study LCR circuits. (Application)
CO 9: Model data. (Analysing)
CO 10: Compute Fourier transform. (Application)

At least 10 experiments should be performed from the following:

(All experiments are to be done using the Fortran, C Language)

1. Basic operations using a matrix A.
    a. To find the transpose of A.
    b. To find the inverse of A.
    c. To verify the accuracy of AA-1= I.
    d. To diagonalise a given matrix.
    e. To find the eigenvalues and eigenvectors.
2. Numerical differentiation.
    a. To find the derivative of a given function f(x) using the standard formula where h is the step size.
    b. To determine the second derivative of a given function f(x) using the standard formula.
    c. Plot the case (a) as a function of x.
    d. Plot the case (b) as a function of x.
    e. Compare the above cases (a) and (b) with the results obtained analytically in specific cases.
3. Numerical method of solving Schrödinger equation.
    a. Obtain numerical solution for the time independent Schrodinger equation in one dimension for a given potential using Runge-Kutta Method or Fox Godwin method.
    b. To plot the wave function obtained from above versus x.

   c. Obtain numerical solution for the time independent Schrodinger equation in three dimension for a given potential using Runge-Kutta method or Fox Godwin Method.
   d. To plot the wave function obtained from above versus r.
   e. To evaluate the eigenvalues and eigenvectors for case (a).
   f. To evaluate eigenvalues and eigenvectors for case (b).
   g. To count the number of nodes of the function determined in (a) above and see if it is consistent with the theoretical expectation.
   h. To determine the boundary value problems for cases (a) and (c).
4. Spherical harmonics.
   a. To compute the Legendre polynomials.
   b. To plot spherical harmonics as a function of polar angles.
   c. To compute the spherical Bessel function (regular and irregular).
   d. To plot the case (c).
5. Numerical integration.
   a. To integrate a given function numerically by Simpson's Rule.
   b. To compare the results obtained form (a) with those obtained analytically.
   c. To integrate a given function numerically by Trapezoidal rule.
   d. To compare the results obtained from (b) with those obtained analytically.
   e. To integrate a given function numerically by Gauss-Legendre integration.
   f. To compare the results obtained form (c) with those obtained analytically.
6. Solution of algebraic equations.
   a. Solve a given equation numerically using Newton Raphson method.
   b. Compare the result of (a) with those obtained numerically.
   c. To solve a given equation using bisection method.
   d. Comparative study of (a), (b) and (c).
7. Solution of simultaneous equations.
   a. Using Gauss-elimination and Gauss Jordan elimination method.
   b. Compare (a) with solutions obtained analytically or algebraically.
8. Logistic systems.
   To explore the regions of (a) stable fixed points (b) periodic and (c) chaotic solution.
9. Radioactivity.
   a. Use Monte-Carlo method to simulate radioactive decay.
   b. Write a program for a radioactive series, when the daughter is also radioactive and soon.
   c. Plot N (number of nuclei) Vs time t.
   d. From the slope calculate the activity at different times.
10. LCR circuits.
   a. To compute the charge and discharge of an RC circuit using DC source.
   b. To compute the charge and discharge of RC circuits using AC source.
   c. Analyse the energy in the RL circuit using the Runge-Kutta method.
   d. Study the energy dissipated in a series LCR circuit. Plot it versus time t.
11. Modelling of data.
   a. To compute for a given sample of data.
   b. To fit a given sample of data by least square method by a straight line.
   c. To fit by minimizing by straight line.
   d. To make a polynomial fit by least square method.
   e. To make a polynomial fit by minimizing.
12. Fourier transform special methods.
   a. To compute Fourier transform of discretely sampled data.
   b. To compute Fast Fourier transform of real functions and Sine and CosineTransformations.
   c. To compute Fourier transform of a given function in two or more dimensions.

Mapping of COs to the syllabus

Course Outcomes	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp 10	Exp 11	Exp 12
CO 1	H											
CO 2		H	H		H							
CO 3				H								
CO 4						H						
CO 5							H					

CO 6								H				
CO 7									H			
CO 8										H		
CO 9											H	
CO 10												H

PSPM6013: PLASMA PHYSICS LABORATORY
(0-0-4)

COURSE OUTCOMES
CO 1: Explain the breakdown mechanism of gasses. (Remembering)
CO 2: Understand the electrical properties of a gas discharge. (Understanding)
CO 3: Operate and conduct experiments in plasma devices. (Application)
CO 4: Collect and analyse data from plasma devices. (Analysing)
CO 5: Use plasma diagnostic tools. (Application)

At least 10 experiments should be performed from the following:
1. Experimental determination of minimum breakdown voltage in a glow discharge system.
2. To study the effect of variation in chamber pressure on different regions of a glow discharge.
3. To study the effect of variation in discharge voltage on different regions of a glow discharge.
4. To plot the I-V characteristics of a glow discharge plasma.
5. To find the variation in resistance of a glow discharge plasma with chamber pressure.
6. To find the variation in resistance of a glow discharge plasma with discharge voltage.
7. To find the variation in floating potential with discharge voltage of a plasma using Langmuir probe.
8. To find the variation in floating potential with chamber pressure of a plasma using Langmuir probe.
9. To find the plasma potential of a plasma using Langmuir.
10. To find the electron temperature of a plasma using the Langmuir probe.
11. To find the electron density of a plasma using the Langmuir probe.
12. Identification of different ions/atoms/molecules in plasma by optical emission spectroscopy(OES).
13. To find the plasma density by optical emission spectroscopy (OES) using Stark Broadening of hydrogen lines.
14. To find the plasma temperature by optical emission spectroscopy (OES) using line intensity ratio method.
15. To find the plasma temperature by optical emission spectroscopy (OES) using Boltzmann Plot method.

Mapping of COs to Syllabus

Course Outcomes	Exp1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp10	Exp11	Exp12	Exp13	Exp14	Exp15
CO 1	H	M	M												
CO 2				H	M	M									
CO 3	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
CO 4	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
CO 5							M	M	M	M	M	M	M	M	M

PSEL6014: ELECTRONICS LABORATORY
(0-0-4)

COURSE OUTCOMES
CO 1: Explain transistor operation. (Remembering)
CO 2: Understand amplifier design using transistor. (Understanding)
CO 3: Operational Amplifier and Timer applications. (Application)
CO 4: Analyse Logic Gates. (Analysis)
CO 5: Application of gates for Digital circuits. (Application)

At least 10 experiments should be performed from the following:
1. Design of amplifiers: Transistor amplifiers with and without feedback.
2. Design of Integrator and Differentiator using Op-amp.
3. Op-amp linear applications: adders, subtractors, comparator.
4. Op-amp based active filters.
5. 555 timer as monostable multivibrator.
6. 555 timer as astablemultivibrator.
7. 555 timer as bistablemultivibrator
8. To verify the truth table of MUX and DEMUX.

9. Realization of 2:4 decoder and 4:2 encoder design.
10. To verify the truth table of one bit and four bit comparators using logic Gates.
11. Truth table verification of Flip-Flops: (i) RS-Type, (ii) D- Type, (iii) T- Type, (iv) J-K Master Slave
12. To study shift register in all its modes i.e. SIPO/SISO, PISO/PIPO.

Mapping of COs to the syllabus

Course Outcomes	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp 10	Exp 11	Exp 12
CO 1	H	H										
CO 2	M	H			M	M						
CO 3			H	M	H	M	M	M				
CO 4	M				M	M	M	M	M	M	M	M
CO 5							M	M	M	H	M	M

PSNY6015: NANOPHYSICS LABORATORY

(0-0-4)

COURSE OUTCOMES

CO 1: Calculations of molarity. (Remembering)
CO 2: Understanding hydrothermal synthesis. (Understanding)
CO 3: Understanding characterization techniques. (Understanding)
CO 4: Application of characterization techniques on synthesized material. (Application)
CO 5: Analysis of characterizing results. (Analysis)

At least 10 experiments should be performed from the following:

1. Calculate molarity for different solutions. Learn to use the scientific balance (adjustments, taring,etc.).
2. Prepare stock solution of the following (100 ml)
   - 10mM $Zn(NO_3)_2 . 6H_2O$
   - 10mM 100ml $C_6H_{12}N_4$
   - 25 mM $Na_3C_6H_5O_7$
3. Synthesize ZnO nanoparticles using hydrothermal process.
4. Perform seeding of pre-synthesized ZnO nanoparticles on glass substrate. Also perform directseeding of ZnO particles on glass substrate by thermal oxidation.
5. Grow ZnO nanorods on glass substrate hydrothermally.
6. Synthesize ZnS nanoparticles using hydrothermal process.
7. Synthesize manganese doped ZnS nanoparticles using hydrothermal process.
8. Make film of ZnO nanoparticles on glass substrate using the LBL machine.
9. Use Super-hydrophobicity testing machine to find out the roll-off and contact angle of ananoparticle coated surface.
10. Synthesize CdS nanoparticles using hydrothermal process. Observe colour variations with sizewhen illuminated with UV light.
11. Synthesize gold nanoparticles using Turkevitch process.
12. Sample preparation for different characterization techniques.
13. UV-vis spectroscopy to study optical properties of nanomaterials.
14. Tauc's plot to determine band gap of semiconductors.
15. Electron Microscopy Imaging of metallic and semiconducting nanoparticles.
16. Analysing SAED patterns.
17. Measurement of lattice fringes in TEM images using ImageJ software.
18. Analysing EDS plots.
19. Extracting information from XRD plots.
20. Measurement of WCA and ROA for different nanomaterial coated substrates.
21. PL spectroscopy on luminescent nanoparticles.

Mapping of COs to the syllabus

Course Outcomes	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp 10	Exp 11
CO 1	H	H	M	M	M	M	M	M			
CO 2	M	H			M	M	M	M	M	M	M

Course Outcomes	Exp 12	Exp 13	Exp 14	Exp 15	Exp 16	Exp 17	Exp 18	Exp 19	Exp 20	Exp 21
CO 2	M	M								

CO 3		H	M	H	M	M	M	M	M	M
CO 4		M	M	M	M	M	M	M	M	
CO 5						M	M	M	H	M

PSST6016: STUDY TOUR

Study Tour is a mandatory non-credited course to be taken up in the final semester of M.Sc. (physics) with an objective to provide students an exposure to higher studies and research in physics in other reputed institutes of the county. The study tour will not be less than 2 days and will not exceed 14 days. During the tour, the focus will be on visiting different higher educationalinstitutes and/ or research institutes. A report will be submitted and a presentation will be given at the end of the tour by each student based on which he/she will be declared "Pass"/"No Pass" in the course**.**

PSPP6017: PROJECT PHASE I

(2 credits)

During this phase the student will start a project applying the knowledge acquired during the first two semesters and also incorporating the recent trends in the chosen area. It should include phases of design, implementation and reporting. This project is to be executed individually within or outside the campus. The mode and components of evaluation and the weightages attached to them shall be published by the Department/Institute at the beginning of the semester.

E-resource for learning:

LaTeX

PSPR6018: PROJECT PHASE II

(3 credits)

During this phase the student will complete the project started in the previous semester. The final implementation of the project and report writing shall be done in this semester. The student shall be required to make a number of presentations to report on the progress of the project. There will be a viva voce examination which shall follow the final submission of the project report. The mode and components of evaluation and the weightages attached to them shall be published by the Department/Institute at the beginning of the semester.

PSCP6120: COMPUTATIONAL PHYSICS USING PYTHON

(2-0-0)

COURSE OUTCOMES

CO 1: Outline the fundamental elements of Python computing. (Understanding)
CO 2: Estimate the accuracy and speed of a Python code. (Applying)
CO 3: Develop Python code for solving definite integrals and finding derivatives. (Applying)
CO 4: Solve systems of equations using Python arrays. (Applying)
CO 5: Develop optimized numerical solutions of ordinary differential equations. (Applying)
CO 6: Make use of Monte Carlo methods in random processes for solving physical problems. (Applying)
CO 7: Propose computational solutions to physical problems using Python. (Creating)

Module I: Elements of Python programming (9 lectures)

Data types, basic mathematical operations, variables; lists: indexing, slicing, altering, appending and deleting elements, concatenation; tuples and dictionaries; conditional statements; loops: while and for loops, nested-for loops; Python libraries: installing packages, importing packages; NumPy arrays and matrices, example: eigenvalues and eigenvectors; basics of data handling using Pandas; introduction to SciPy; data visualization using Matplotlib and Seaborn.

Module II: Accuracy and speed (2 lectures)

Variables and data ranges; numerical error; program speed.

Module III: Numerical integrals and derivatives (4 lectures)

Fundamental integral evaluation methods: trapezoidal rule, Simpson's rule; error estimation of integrals; Romberg integration; Gaussian quadrature; numerical differentiation: forward and backward differences, central differences, second derivatives, partial derivatives, differentiation error estimation.

Module IV: Solving linear and non-linear equations (6 lectures)

Linear equations: Gaussian elimination, back-substitution, pivoting, LU decomposition, matrix inverse, tridiagonal and banded matrices; nonlinear equations: binary search, Newton's method, secant method

Module V: Numerical solutions of ordinary differential equations (4 lectures)

First-order differential equations with one variable: Euler's method, Heun's method, 4^{th} order Runge-Kutta method; differential equations with multiple variables; second-order differential equations; boundary value problems: shooting method, relaxation method; eigenvalue problems.

Module VI: Random processes (5 lectures)
Random numbers generators and seeds; non-uniform random numbers, Gaussian random numbers; Monte Carlo integration: mean value method, integrals in many dimensions, importance sampling; importance sampling; Markov chain methods.

Suggested Readings

1. Mark E.J. Newman, Computational Physics, Createspace Independent Pub.
2. Rubin H. Landau, Manuel J. Paez and Cristian C. Bordeianu, Computational Physics: Problem Solving with Python, Wiley.
3. Wes McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, O'Reilly Media.
4. David Beazley and Brian K. Jones, Python Cookbook: Recipes for Mastering Python 3, O'Reilly Media.
5. Jake VanderPlas, Python Data Science Handbook: Essential Tools for Working with Data, O'Reilly Media.
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Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H					
CO 2		H	M	M	M	M
CO 3			H			
CO 4				H		
CO 5					H	
CO 6						H
CO 7		M	M	M	H	H

SCHOOL OF LIFE SCIENCES

SCHOOL OF LIFE SCIENCES
DEPARTMENT OF BIOSCIENCES
MASTER OF SCIENCE IN BIOCHEMISTRY

Type of Course/Category	Course Code	Course Name	Credits T-L-P	Page
SEMESTER I				
Core Course (Theory)	BTTE0009	Thermodynamics and Enzymology	3-0-0	729
Core Course (Theory)	MBCG0011	Cell Biology and Genetics	4-0-0	746
Core Course (Theory)	BCFB0013	Fundamentals of Biochemistry	4-0-0	710
Core Course (Theory)	BCAT0014	Analytical Techniques	4-0-0	714
Core Course (Lab)	BCFB6009	Fundamentals of Biochemistry Lab	0-0-1	721
Core Course (Lab)	BTTE6009	Thermodynamics and Enzymology Lab	0-0-1	739
Core Course (Lab)	BCAT6010	Analytical Techniques Lab	0-0-1	721
Core Course (Lab)	MBCB6011	Cell Biology and Genetics Lab	0-0-1	753
	BTIV6011	Industrial/Laboratory visit	0-0-1	
	BCRT6012	Remedial Teaching & NET Coaching course	NC	
	MBNT6013	NPTEL Course	NC	
Service Learning	BCSL0200	Service Learning in Bio Sciences	NC	718
Total Credits			20	
SEMESTER II				
Core Course (Theory)	BTGE0005	Genetic Engineering	3-0-0	727
Core Course (Theory)	BTCA0010	Computer Applications and Bioinformatics	3-0-0	730
Core Course (Theory)	MBBM0014	Basic Microbiology	2-0-0	749
Core Course (Theory)	BCMB0015	Molecular Biology	4-0-0	712
Core Course (Theory)	BCFI0016	Fundamentals of Immunology	4-0-0	713
Core Course (Lab)	BTGE6004	Genetic Engineering Lab	0-0-1	737
Core Course (Lab)	BTCA6010	Computer Applications and Bioinformatics Lab	0-0-2	739
Core Course (Lab)	MBBM6012	Basic Microbiology Lab	0-0-1	753
Core Course (Lab)	BCMB6013	Molecular Biology Lab	0-0-1	722
Core Course (Lab)	BCFI6014	Fundamentals of Immunology Lab	0-0-1	723
Elective Skill Enhancement Courses				
Skill Enhancement Course 1	MBWM0012	Waste Management	1-0-0	747
Skill Enhancement Course 2	BTFF0013	Fermentation and Food Microbiology	1-0-0	732
Skill Enhancement Course 3	MBMC0013	Mushroom cultivation	1-0-0	748
Skill Enhancement Course 4	BCHD0017	Herbal Drug Technology	1-0-0	714
	MBIT6014	Internships/Summer Training	NC	
	BCRT6015	Remedial Teaching & NET Coaching	NC	
	BCSL0200	Service Learning in Biosciences	NC	718
Total Credits			23	
SEMESTER III				
Core Course (Theory)	BTRM0003	Research Methodology &Biostatistics	4-0-0	726
Core Course (Theory)	BCBM0010	Medical Biochemistry	3-0-0	708
Core Course (Theory)	BCPY0011	Physiology	3-0-0	709
Core Course (Lab)	BCIM6004	Medical Biochemistry Lab	0-0-1	719
Core Course (Lab)	BCPY6005	Physiology Lab	0-0-1	719
Core Course (Theory)	BCNM0019	Nutritional Biochemistry & Metabolism	3-0-0	715
Core Course (Theory)	BCBE0018	Bioenergetics	3-0-0	714
Core Course (Lab)	BCNM6013	Nutritional Biochemistry & Metabolism Lab	0-0-1	722
Core Course (Lab)	BCBM6006	Bioenergetics Lab	0-0-1	
	BCDI6007	Dissertation Phase I	0-0-2	720
	BCRT6015	Remedial Teaching & NET Coaching	NC	
Core Course (Theory)	BTIE0014	IPR & Entrepreneurship	1-0-0	733
Core Course (Lab)	BCSC6017	Scientific Writings and Communications	0-0-1	723
Service Learning	BCSL0200	Service Learning in Biosciences	NC	
Value Added Course	BTCL6014	Clinical Laboratory Techniques	NC	741
Value Added Course	BTBB6015	Basic Bioinformatics	NC	742
Total Credits			24	
SEMESTER IV				
Core Course (Theory)	BCOB0020	Omics Biology and its Tools	4-0-0	716

Elective courses				
Elective Course 1 (Theory)	BTAT0017	Agriculture Technology	2-0-0	735
Elective Course 2 (Theory)	MBNB0016	Nanobiology	2-0-0	751
Elective Course 3 (Theory)	BCBM0021	Bioresource Management	2-0-0	717
	BCDI6008	Dissertation Phase II	0-0-16	720
Service Learning	BCSL0200	Service Learning in Biosciences	NC	718
Total Credits			22	
Total Programme Credits			89	

MASTER OF SCIENCE IN BIOTECHNOLOGY

SEMESTER I				
Type of Course/Category	**Course Code**	**Course Name**	**Credits T-L-P**	**Page**
Core Course (Theory)	BTTE0009	Thermodynamics and Enzymology	3-0-0	729
Core Course (Theory)	MBCG0011	Cell Biology and Genetics	4-0-0	746
Core Course (Theory)	BCFB0013	Fundamentals of Biochemistry	4-0-0	710
Core Course (Theory)	BCAT0014	Analytical Techniques	4-0-0	714
Core Course (Lab)	BCFB6009	Fundamentals of Biochemistry Lab	0-0-1	721
Core Course (Lab)	BTTE6009	Thermodynamics and Enzymology Lab	0-0-1	739
Core Course (Lab)	BCAT6010	Analytical Techniques Lab	0-0-1	721
Core Course (Lab)	MBCB6011	Cell Biology and Genetics Lab	0-0-1	753
	BTIV6011	Industrial/Laboratory visit	0-0-1	
	BCRT6012	Remedial Teaching & NET Coaching course	NC	
	MBNT6013	NPTEL Course	NC	
Service Learning	BCSL0200	Service Learning in Biosciences	NC	718
Total Credits			20	
SEMESTER II				
Core Course (Theory)	BTGE0005	Genetic Engineering	3-0-0	727
Core Course (Theory)	BTCA0010	Computer Applications and Bioinformatics	3-0-0	730
Core Course (Theory)	MBBM0014	Basic Microbiology	2-0-0	749
Core Course (Theory)	BCMB0015	Molecular Biology	4-0-0	712
Core Course (Theory)	BCFI0016	Fundamentals of Immunology	4-0-0	713
Core Course (Lab)	BTGE6004	Genetic Engineering Lab	0-0-1	737
Core Course (Lab)	BTCA6010	Computer Applications and Bioinformatics Lab	0-0-2	739
Core Course (Lab)	MBBM6012	Basic Microbiology Lab	0-0-1	753
Core Course (Lab)	BCMB6013	Molecular Biology Lab	0-0-1	722
Core Course (Lab)	BCFI6014	Fundamentals of Immunology Lab	0-0-1	723
Elective Skill Enhancement Courses				
Skill Enhancement Course 1	MBWM0012	Waste Management	1-0-0	747
Skill Enhancement Course 2	BTFF0013	Fermentation and Food Microbiology	1-0-0	732
Skill Enhancement Course 3	MBMC0013	Mushroom cultivation	1-0-0	748
Skill Enhancement Course 4	BCHD0017	Herbal Drug Technology	1-0-0	714
	MBIT6014	Internships/Summer Training	NC	
	BCRT6015	Remedial Teaching & NET Coaching	NC	
Service Learning	BCSL0200	Service Learning in Biosciences	NC	
Total Credits			23	
SEMESTER III				
Core Course (Theory)	BTRM0003	Research Methodology &Biostatistics	4-0-0	726
Core Course (Theory)	BTBE0007	Bioprocess Engineering	3-0-0	728
Core Course (Theory)	BTPB0011	Plant Biotechnology	3-0-0	731
Core Course (Theory)	BTAB0012	Animal Biotechnology	3-0-0	731
Core Course (Theory)	BTPE0015	Pharmaceutical & Environmental Biotechnology	3-0-0	733
Core Course (Lab)	BTAP6003	Animal Biotechnology Lab	0-0-1	737
Core Course (Lab)	BTBE6006	Bioprocess Engineering Lab	0-0-1	738
Core Course (Lab)	BTBP6011	Plant Biotechnology Lab	0-0-1	740
Core Course (Lab)	BTPE6012	Pharmaceutical & Environmental Biotechnology Lab	0-0-1	740
	BTDI6007	Dissertation Phase I	0-0-2	738
	BCRT6015	Remedial Teaching &NET Coaching	NC	

Core Course (Theory)	BTIE0014	IPR and Entrepreneurship	1-0-0	733
Core Course (Lab)	BCSC6017	Scientific Writings and Communications	0-0-1	723
Service Learning	BCSL0200	Service Learning in Bio Sciences	NC	718
Value Added Course	BTCL6014	Clinical Laboratory Techniques	NC	741
Value Added Course	BTBB6015	Basic Bioinformatics	NC	742
Total Credits			24	
SEMESTER IV				
Core Course (Theory)	BTTB0016	Trends in Biotechnology	4-0-0	734
Elective courses				
Elective Course 1 (Theory)	BTAT0017	Agriculture Technology	2-0-0	735
Elective Course 2 (Theory)	MBNB0016	Nanobiology	2-0-0	751
Elective Course 3 (Theory)	BCBM0021	Bioresource Management	2-0-0	717
	BTDI6008	Dissertation Phase II	0-0-16	738
Service Learning	BCSL0200	Service Learning in Bio Sciences	NC	718
Total Credits			22	
Total Programme Credits			89	

MASTER OF SCIENCE IN MICROBIOLOGY

SEMESTER I				
Type of Course/Category	**Course Code**	**Course Name**	**Credits T-L-P**	**Page**
Core Course (Theory)	BTTE0009	Thermodynamics and Enzymology	3-0-0	729
Core Course (Theory)	MBCG0011	Cell Biology and Genetics	4-0-0	746
Core Course (Theory)	BCFB0013	Fundamentals of Biochemistry	4-0-0	710
Core Course (Theory)	BCAT0014	Analytical Techniques	4-0-0	714
Core Course (Lab)	BCFB6009	Fundamentals of Biochemistry Lab	0-0-1	721
Core Course (Lab)	BTTE6009	Thermodynamics and Enzymology Lab	0-0-1	739
Core Course (Lab)	BCAT6010	Analytical Techniques Lab	0-0-1	721
Core Course (Lab)	MBCB6011	Cell Biology and Genetics Lab	0-0-1	753
	BTIV6011	Industrial/Laboratory visit	0-0-1	740
	BCRT6012	Remedial Teaching & NET Coaching course	NC	722
	MBNT6013	NPTEL Course	NC	
Service Learning	BCSL0200	Service Learning in Bio Sciences	NC	718
Total Credits			20	
SEMESTER II				
Core Course (Theory)	BTGE0005	Genetic Engineering	3-0-0	727
Core Course (Theory)	BTCA0010	Computer Applications and Bioinformatics	3-0-0	730
Core Course (Theory)	MBBM0014	Basic Microbiology	2-0-0	749
Core Course (Theory)	BCMB0015	Molecular Biology	4-0-0	712
Core Course (Theory)	BCFI0016	Fundamentals of Immunology	4-0-0	
Core Course (Lab)	BTGE6004	Genetic Engineering Lab	0-0-1	737
Core Course (Lab)	BTCA6010	Computer Applications and Bioinformatics Lab	0-0-2	739
Core Course (Lab)	MBBM6012	Basic Microbiology Lab	0-0-1	753
Core Course (Lab)	BCMB6013	Molecular Biology Lab	0-0-1	722
Core Course (Lab)	BCFI6014	Fundamentals of Immunology Lab	0-0-1	723
Elective Skill Enhancement Courses				
Skill Enhancement Course 1	MBWM0012	Waste Management	1-0-0	747
Skill Enhancement Course 2	BTFF0013	Fermentation and Food Microbiology	1-0-0	732
Skill Enhancement Course 3	MBMC0013	Mushroom cultivation	1-0-0	748
Skill Enhancement Course 4	BCHD0017	Herbal Drug Technology	1-0-0	714
	MBIT6014	Internships/Summer Training	NC	
	BCRT6015	Remedial Teaching & NET Coaching	NC	
Service Learning	BCSL0200	Service Learning in Bio Sciences	NC	
Total Credits			23	
SEMESTER III				
Core Course (Theory)	BTRM0003	Research Methodology &Biostatistics	4-0-0	726

Core Course (Theory)	MBVM0003	Virology and Mycology	3-0-0	744
Core Course (Theory)	MBEM0009	Environment Microbiology	3-0-0	745
Core Course (Theory)	MBMM0010	Medical Microbiology	3-0-0	746
Core Course (Theory)	MBIM0015	Infection and Molecular Diagnostics	3-0-0	750
Core Course (Lab)	MBVM6008	Virology and Mycology Lab	0-0-1	754
Core Course (Lab)	MBEM6009	Environment Microbiology Lab	0-0-1	754
Core Course (Lab)	MBMM6010	Medical Microbiology Lab	0-0-1	755
Core Course (Lab)	MBIM6015	Infection and Molecular Diagnostics Lab	0-0-1	755
	MBDI6006	Dissertation Phase I	0-0-2	756
	BCRT6015	Remedial Teaching &NET Coaching	NC	
Core Course (Theory)	BTIE0014	IPR & Entrepreneurship	1-0-0	733
Core Course (Lab)	BCSC6017	Scientific Writings and Communications	0-0-1	723
Service Learning	BCSL0200	Service Learning in Bio Sciences	NC	718
Value Added Course	BTCL6014	Clinical Laboratory Techniques	NC	741
Value Added Course	BTBB6015	Basic Bioinformatics	NC	
Total Credits			24	
SEMESTER IV				
Core Course (Theory)	MBIF0018	Industrial and Food Microbiology	4-0-0	751
Elective courses				
Elective Course 1 (Theory)	BTAT0017	Agriculture Technology	2-0-0	735
Elective Course 2 (Theory)	MBNB0016	Nanobiology	2-0-0	751
Elective Course 3 (Theory)	BCBM0021	Bioresource Management	2-0-0	717
	MBDI6007	Dissertation Phase II	0-0-16	756
Service Learning	BCSL0200	Service Learning in Bio Sciences	NC	
Total Credits			22	
Total Programme Credits			89	

- Non- credit courses (NCC) are mandatory and assess the student performance by grading their score in internal and final examinations as – satisfactory (S) or Unsatisfactory (US) based on the performance of the students. Students securing 60% or above may be considered satisfactory (S).
- NPTEL -students can select any one course from NPTEL and produce a certificate as the end of the examination.
- Industrial or laboratory visit is mandatory on the basis of applicability and mentoring of the students. A report on the experience and learning can be submitted to respective mentors.
- Remedial Teaching & NET Coaching will be one hour/week
- Skill development program; options include Fermentation technology; herbal drug formulation; mushroom cultivation; waste management; (any 1)
- Value added course will be open for all and on completion of the course the student will receive a certificate to the learning
- Students will go for internships during the semester break between – I and II semester or II and III semester or III and IV Semester and produce a certificate and report of the training.
- Semester - IV- One Core course (4 credits) + One elective (2 credits) + Dissertation (16 credit)

DEPARTMENT OF BOTANY
MASTER OF SCIENCE IN BOTANY
MSc COURSE STRUCTURE

Type of Course/Category	Course Code	Course Name	Credits T-L-P	Page
SEMESTER I				
Core Course (Theory)	BOMP0021	Mycology and Phycology	4-0-0	761
Core Course (Theory)	BOBP0022	Bryophytes, Pteridophytes and Gymnosperms	4-0-0	761
	BOAN0023	Angiosperms	4-0-0	762
Core Course (Lab)	BOMP6026	Mycology and Phycology Lab	0-0-3	785
Core Course (Lab)	BOBA6027	Bryophytes, Pteridophytes and Gymnosperms and Angiosperms Lab	0-0-3	785
Value added course	BOBF6035	Bio-Fertilizer Technology	NC	
Value added course	BOBC6038	Biomass Conversion, Biorefinery & Circular Bioeconomy	NC	
Service Learning	BOSL0100	Service Learning on Ethno Botanical Practices	NC	
Total Credits			18	
SEMESTER II				
Core Course (Theory)	BOCM0024	Cell and Molecular Biology	4-0-0	763
Core Course (Theory)	BOPB0025	Plant Physiology and Biochemistry	4-0-0	764
Core Course (Theory)	BOPP0026	Plant Microbiology and Plant Pathology	4-0-0	765
Core Course (Lab)	BOCB6028	Cell and Molecular Biology and Plant Physiology and Biochemistry Lab	0-0-3	786
Core Course (Lab)	BOPP6029	Plant Microbiology and Plant Pathology Lab	0-0-3	786
		MOOCS/NPTEL Course		
Service Learning	BOSL0100	Service Learning on Ethno botanical Practices	NC	
Total Credits			**18**	
SEMESTER III				
Core Course (Theory)	BOCP0027	Cytogenetics and Plant Breeding	4-0-0	766
Core Course (Theory)	BOPE0028	Plant Ecology and Phytogeography	4-0-0	767
Core Course (Theory)	BOBB0029	Biochemicals, Molecular Techniques and Bioinformatics	4-0-0	768
Core Course (Theory)	BOTC0030	Plant Cell and Tissue Culture	4-0-0	769
Core Course (Lab)	BOPE6030	Plant Ecology Lab	0-0-3	787
Core Course (Lab)	BOCT6031	Cytogenetics, Molecular Techniques and Tissue Culture Lab	0-0-3	787
Value added course	BOHM6036	Herbal Medicine	NC	
Value added course	BOFI6037	Forest Inventory and Mensuration	NC	
Core Course (Lab)	BODI6032	Dissertation Phase I	0-0-4	788
Total Credits			**26**	
SEMESTER IV				
Core Course (Theory)	BOER0031	Environmental Management, Research Methodology and Biostatistics	4-0-0	770
Core Course (Lab)	BOER6033	Environmental Management, Research Methodology and Biostatistics Lab	0-0-2	788
		Plant Biotechnology		
Discipline Specific Elective	BOFP0032	Fundamentals of Plant Biotechnology	4-0-0	771
Discipline Specific Elective	BOAB0033	Advances in Plant Biotechnology	4-0-0	771
		Genetics and Plant Breeding		
Discipline Specific Elective	BOGT0034	Genetics, Plant Breeding and Transformation	4-0-0	772
Discipline Specific Elective	BOMB0035	Molecular Genetics and Bioinformatics	4-0-0	773
		Angiosperm Taxonomy		
Discipline Specific Elective	BOTS0038	Taxonomy of Angiosperms and Biosystematics	4-0-0	774
Discipline Specific Elective	BOBE0039	Economic Botany and Ethnobotany	4-0-0	775
		Plant Ecology		
Discipline Specific Elective	BOEG0040	Ecology, Environment and Global concerns	4-0-0	776
Discipline Specific Elective	BORG0042	Restoration Ecology and Geoinformatics	4-0-0	777
		Plant Pathology and Microbiology		
Discipline Specific Elective	BOPY0043	Plant Pathology	4-0-0	778

Discipline Specific Elective	BOMA0044	Microbial Genetics and Applied Microbiology	4-0-0	779
		Plant Physiology and Biochemistry		
Discipline Specific Elective	BOPP0045	Advanced Plant Physiology	4-0-0	780
Discipline Specific Elective	BOBM0046	Plant Biochemistry and Metabolism	4-0-0	781
		Advances in Plant Science		
Discipline Specific Elective	BOBB0047	Biomass, Biorefinery and Circular Bioeconomy	4-0-0	781
Discipline Specific Elective	BOPD0048	Bioprospecting of Plant Diversity and Automation	4-0-0	782
Service Learning	BOSL0100	Service Learning on Ethno Botanical Practices	4-0-0	
Core Course (Dissertation)	BODI6034	Dissertation Phase II	0-0-12	789
Total Credits			**26**	
Total Programme Credits			**88**	

DEPARTMENT OF ZOOLOGY
MASTER OF SCIENCE IN ZOOLOGY

SEMESTER I				
Type of Course/Category	**Course Code**	**Course Name**	**Credits T-L-P**	**Page**
Core Course (Theory)	ZGBE0027	Biosystematics and Evolution	4-0-0	813
Core Course (Theory)	ZGCI0028	Cell Biology and Immunology–Theory and Applications	4-0-0	815
Core Course (Theory)	ZGBG0029	Molecular Biology and Genetics	4-0-0	816
Core Course (Theory)	ZGAP0030	Animal Physiology	4-0-0	817
Core Course (Theory)	ZGEE0031	Ecology and Environmental Biology	4-0-0	818
Core Course (Lab)	ZGBE6019	Biosystematics and Environmental Biology Lab	0-0-2	832
Core Course (Lab)	ZGCI6020	Cell Biology, Genetics and Basic Bioinformatics Lab	0-0-2	
Total Credits			**24**	
SEMESTER II				
Core Course (Theory)	ZGDB0005	Developmental Biology	4-0-0	796
Core Course (Theory)	ZGEB0032	Endocrinology and Biochemistry	4-0-0	819
Core Course (Theory)	ZGAZ0033	Applied Zoology	4-0-0	820
Core Course (Theory)	ZGEP0034	Ethology and Population Genetics	4-0-0	822
Core Course (Lab)	ZGDB6021	Developmental Biology and Biochemistry Lab	0-0-2	833
Core Course (Lab)	ZGEP6022	Ethology and Population Genetics Lab	0-0-2	834
Value Added Course	ZGPR6004	Project Management, Reporting and Documentation	NC	824
Service Learning Course	ZGSL0200	Service Learning in Zoology	NC	823
Total Credits			**20**	
SEMESTER III				
Core Course (Theory)	BTRM0003	Research Methodology and Biostatistics	4-0-0	726
Discipline Specific Elective	**Specialization 1: Entomology**			
	ZGIF0008	Insects- Structure & Function	4-0-0	798
	ZGIP0009	Insect Physiology	4-0-0	798
	ZGEE6011	Specialization Lab I- Entomology and Environmental Biology	0-0-2	828
	Specialization 2: Cell and Molecular Biology			
	ZGCB0010	Cell and Molecular Biology –I	4-0-0	799
	ZGIY0011	Immunology I	4-0-0	800
	ZGCM6012	Specialization Lab I- Cell and Molecular Biology	0-0-2	828
	Specialization 3: Fishery Science			
	ZGTF0012	Taxonomy and Functional Anatomy	4-0-0	801
	ZGAF0013	Aquaculture and Fish Genetics	4-0-0	803
	ZGFS6013	Specialization Lab I - Fishery Science	0-0-2	829
	Specialization 4: Animal Ecology and Wildlife Biology			
	ZGEB0014	Animal Ecology and Biogeography	4-0-0	804
	ZGWM0015	Wildlife Conservation and Management	4-0-0	805
	ZGAW6014	Specialization Lab I- Animal Ecology and Wildlife Biology	0-0-2	829
	ZGDI6006	Dissertation (Phase I)	0-0-4	826
Value Added Course	ZGWP6011	Introduction to Wildlife Photography	NC	826
Total Credits			**18**	
SEMESTER IV				
Discipline Specific Elective		**Specialization 1: Entomology**		
	ZGIG0017	Insect Ecology	4-0-0	806
	ZGPM0035	Applied Entomology and Principles of Pest Management	4-0-0	807
	ZGEE6015	Specialization Lab II- Entomology and Environmental Biology	0-0-2	830
		Specialization 2: Cell and Molecular Biology		
	ZBMB0019	Cell and Molecular Biology –II	4-0-0	808
	ZGIM0020	Immunology II	4-0-0	809
	ZGCM6016	Specialization Lab II- Cell and Molecular Biology	0-0-2	830
		Specialization 3: Fishery Science		

	ZGCP0021	Capture fishery and Post-harvest Technology	4-0-0	809
	ZGLF0022	Limnology, Fishery economics, Ornamental Fishery and Fish pathology	4-0-0	811
	ZGFS6017	Specialization Lab II - Fishery Science	0-0-2	831
		Specialization 4: Animal Ecology and Wildlife Biology		
	ZGRE0025	Wildlife Resource management, Laws and Techniques in population study	4-0-0	812
	ZGWC0026	Techniques in Wildlife study, Wildlife Health, Forensics and Conflict	4-0-0	813
	ZGAW6018	Specialization Lab II- Animal Ecology and Wildlife Biology	0-0-2	831
Core Course (Dissertation)	ZGDS6009	Dissertation (Phase II)	0-0-8	827
Value Added Course	ZGTM6010	Teaching Methodology and Class room Management	NC	827
Total Credits			**18**	
Total Programme Credits			**80**	

Note: Mandatory Course EDPC0201: Indian Polity and Constitution

SCHOOL OF LIFE SCIENCES
DEPARTMENT OF BIOSCIENCES
PROGRAMME: MASTER OF SCIENCE (MSC) BIOCHEMISTRY

PROGRAMME OUTCOMES

PO 1: **Skill Development**: Master academic, technical, managerial and crucial soft skills to qualify for careers in research, industry, education, administration and management or for higher studies where a holistic understanding of applied biosciences is required.

PO 2: **Research:** Develop a scientific mindset with the capacity for analytical and innovative thinking and practical knowhow to formulate, design and ethically implement scientific research in frontier areas of Biochemistry, Biotechnology and Microbiology

PO 3: **Communication:** Acquire effective communication and creative expression skills in the form of writing, design, presentation and networking to convincingly articulate scientific ideas in biosciences and related fields

PO 4: **Employment and Entrepreneurship:** Acquire the necessary knowledge and proficiencies to become employable or get self- employed and thereby create job opportunities through entrepreneurship in heath, agriculture, industry, environment and alliedareas of applied biosciences and thereby affirmatively contribute to scientific social responsibility.

PROGRAMME SPECIFIC OUTCOMES

PSO 1: **Confidence:** Demonstrate a comprehensive understanding of chemical and biological structure, principles, techniques, andapplications

PSO 2: **Knowledge based Skill**: To develop better understanding and improve skills that would enable them to begin a career in research laboratories, industries as well as to generate self-employability

PSO 3: **Scientific Social Responsibility:** To develop linkages between scientific community and society to build trust, partnershipand responsibility of science towards achieving social goals

PSO 4: **Research and analysis**: Realize the impact of science in society and plan to pursue research, and learn to work as a teamas well as independently to retrieve information, carry out research investigations and result interpretations

PSO 5: **Diagnostic skills**: Attain a remarkable understanding of biochemical principles of bioenergetics, metabolism, physiologyand disorders through diagnostic laboratory procedures.

PSO 6: **Technical and analytical skills:** Acquire a thorough knowledge on omics biology, high-throughput omics approaches toanalyse biological samples such as genomics, transcriptomics, proteomics, metabolomics and comprehensive analysis approach.

Mapping of Courses with POs/PSOs

Courses	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
Thermodynamics and Enzymology	H	H	L	M	H	M	L	M		
Cell Biology and Genetics	H	H	H	M	H	M	L	M	L	L
Fundamentals of Biochemistry	H	M	H	H	H	H	L	H	M	L
Analytical Techniques	H	H	M	H	H	H	M	H	L	L
Lab I- Fundamentals of Biochemistry	H	H	M	M	H	H	L	H	M	L
Lab II- Thermodynamics and Enzymology	H	H	M	M	H	M		M		
Lab III- Cell Biology and Genetics	H	H	H	M	H	H	L	H	M	L
Lab IV- Analytical Techniques	H	H	M	H	H	H	M	H	L	L
Industrial/ Laboratory visit	H	H		H	M	H		H	M	H
Genetic Engineering	H	H	L	M	M	H	M	M		L
Computer Applications and Bioinformatics	H	H	M	M	M	H	L	M		H
Basic Microbiology	L	H	L	L		H		L		
Molecular Biology	H	M	M	M	M	H	L	M	L	L
Fundamentals of Immunology	H	H	H	H	M	H	H	M	L	L
Lab I- Genetic Engineering	H	H	M	M	M	H	M	M		M
Lab II- Computer Applications and Bioinformatics	H	L	M	M		H		H		H
Lab III- Basic Microbiology	H	H	H	H		H		L		
Lab IV- Molecular Biology	H	H	M	M	M	H	L	H	L	L
Lab V- Fundamentals of Immunology	H	H	H	H	M	H	L	M	L	L
Waste Management (Skill Development course)	H	H	M	H	M	H	H	H	L	M
Fermentation and Food Micorbiology (Skill Development course)	H	H	H	H	M	H	H	L	H	L

Mushroom Cultivation (Skill Development course)	H	H	H	H	H	H	H	H	L	H
Herbal Drug Technology (Skill Development course)	H	H	M	H	L	H	H	H	L	M
Research Methodology & Biostatistics-common	M	H	H	M	L	M	H	H	L	L
Medical Biochemistry	H	H	M	H	H	H	H	H	H	L
Physiology	H	M	M	M	M	M	L	M	H	L
Lab I-Medical Biochemistry	M	H	M	H	H	H	H	H	H	L
Lab II- Physiology	H	M	L	M	M	M	L	M	H	L
Nutritional Biochemistry &Metabolism	H	H	M	H	M	M	M	H	H	L
Bioenergetics	M	H		L	H	M	L	H		M
Lab-I- Nutritional Biochemistry &Metabolism	H	H	M	H	M	M	M	H	H	L
Lab II- Bioenergetics	M	H	L		H	M	L			
Dissertation Phase I	H	H	H	H	H	H	H	H		
IPR &Entrepreneurship	M	H	H	H	M	H	M	M	L	L
Scientific writings and communications		H	H		H			H		M
Value Added Course- Clinical Laboratory Techniques	H	H	L	H	M	H			H	
Omics Biology and its Tools	H	H	H	H	H	H	H	H	M	H
Agriculture Technology (Elective)	H	M	M	H	H	H	H	M	M	M
Nanobiology (Elective)	M	H	M	L	H		M			
Bioresource Management (Elective)	H	M	L	M	L	M	M	H	L	L
Dissertation Phase II	H	H	H	H	H	H	H	H	H	H

DETAILED SYLLABUS
THEORY COURSES

BCBM0010: MEDICAL BIOCHEMISTRY (3-0-0)

Course Outcomes

CO 1: Define the different disorders of the body related to carbohydrate metabolism, lipid metabolism, Nitrogen metabolismand digestive disorders (Remembering)
CO 2: Develop an understanding o f how the different metabolism are interconnected (Understanding)
CO 3: Classify disorders of each metabolism (Understanding)
CO 4: Compare all metabolic disorders with their symptoms and etiology (Applying)
CO 5: Examine the normal level of glucose, glycogen, protein, amino acid, nitrogen, diagnostic enzymes (Analysing)
CO 6: Evaluate the genetic relation of each metabolic disorder with corresponding metabolism (Evaluating)
CO 7: Discuss the link between the metabolic disorders and genetic make of patients (Creating)
CO 8: Gain the knowledge on the molecular diagnostic test used in various infectious diseases (Understanding)

Module I (10 Lectures)

a. Disorders of Carbohydrate Metabolism - Diabetes mellitus, glucose and galactose tolerance tests, sugar levels in blood, renal threshold for glucose, factors influencing blood glucose level, glycogen storage diseases, pentosuria, galactosemia.
b. Disorders of Lipids – Plasma lipoproteins, cholesterol, triglycerides and phospholipids in health and disease,hyperlipidemia, hyperlipoproteinemia, Gaucher's disease, Tay-Sach's and Niemann-Pick disease, ketone bodies

Module II (10 Lectures)

a. Abnormalities in Nitrogen Metabolism – Uremia, hyperuricemia, porphyria and factors affecting nitrogen balance.
b. Disorders of liver and kidney – Jaundice, fatty liver, normal and abnormal functions of liver and kidney. Inulin and ureaclearance
c. Inborn Errors of metabolism – Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Lesch-Nyhan syndrome, sickle cell anemia, histidinemia, disorders of blood

Module III (10 Lectures)

a. Digestive diseases – Maldigestion, malabsorption, creatorrhoea, diarrhoea and steatorrhoea.
b. Electrolytes and acid-base balance – Regulation of electrolyte content of body fluids and maintenance of pH, reabsorption of electrolytes.
c. Diagnostic Enzymes – Enzymes in health and diseases. Biochemical diagnosis of diseases by enzyme assays – SGOT, SGPT,CPK, cholinesterase, LDH.

Module IV (15 Lectures)

a. Molecular diagnostics: Basic techniques used in molecular diagnostics, Molecular diagnostics of HIV, Tuberculosis, cholera and pathogenic E. coli
b. Cancer and Ageing –Molecular basis of carcinogenesis, Oncogene and signal transduction, oncogene and G-proteins, oncogene and cell survival, carcinogens and cancer therapy, Cancer pathways, Diagnosis, prevention and treatment of cancer. Ageing: Antioxidants and ageing, DNA repair, Heat shock proteins, role of dopamine receptors in ageing.
c. Disorders of Signal transduction: Disorders of cell surface receptors, Antibodies to receptors, Disorders of Intracellular receptors
d. Oxidative stress related diseases: Role of oxidative stress in various cancers, role of free radicals in diabetic I and diabetic II type of diseases, various inflammatory disorders associated with free radicals, oxidative stress in neurodegenerative diseases; Alzheimer's disease, Parkinson's disease, Huntington's disease. Mitochondrial free radical theory of aging.

Suggested Readings

1. Medical Biochemistry, 7th Edition, Chatterjee MN and Shinde R, 2007, Jaypee Brothers Medical Publishers P (Ltd)
2. Biochemistry, 5th Edition, Jeremy M Berg, John L Tymoczko, and Lubert Stryer, 2002, W.H. Freeman and Co.
3. Text-book of Biochemistry with clinical correlations,7th Edition, Devlin TMJ, 2010, Wiley and Sons.
4. Textbook of Medical Physiology, 12th Edition, Guyton AC and Hall JE, 2012, Elsevier Health Sciences

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	H	H	

CO 2	H	H	H	
CO 3	H	H	H	
CO 4	H	H	H	H
CO 5	H	H	H	H
CO 6	H	H	H	
CO 7	H	H	H	H
CO 8				H

BCPY0011: PHYSIOLOGY (3-0-0)

Course Outcomes

CO 1: Define and have an enhanced knowledge of the fundamentals of physiology by recalling and relating (Remembering).

CO 2: Summarize how the separate systems interact to yield integrated physiological responses (Understanding).

CO 3: Implement the acquired knowledge of the various mechanisms in executing and constructing experiments and apply in their day to day life (Applying).

CO 4: Analyze and report on experiments and observations in physiology (Analysing).

CO 5: Evaluate by presenting and defending opinions by making judgments about the mechanisms and functioning of organs and organ systems (Evaluating).

CO 6: Appreciate, compile and generate new ideas on physiology (Creating).

Part A: Plant Physiology Module I (13 lectures)

a. Electron transport system in plants - Oxidative phosphorylation, mitochondrial respiratory complexes, order and organization of electron carriers, electrochemical gradient, chemiosmotic theory, ATP synthase and mechanism of ATP synthesis.

b. Nitrate assimilation - Structural features of nitrate reductase and nitrite reductase, incorporation of ammonia into organic compounds, regulation of nitrate assimilation.

c. Photosynthesis – Photosynthetic apparatus, pigments of photosynthesis, role of carotenoids, photosystems I and II, their location; Hill reaction, photosynthetic electron transport and generation of NADPH & ATP, cyclic and non-cyclic photo-phosphorylations, complexes associated with thylakoid membranes; light harvesting complexes, path of carbon in photosynthesis – C_3 and C_4 pathway of carbon reduction and its regulation, Photorespiration.

Module II (10 lectures)

a. Special features of secondary plant metabolism - Terpenes (classification, biosynthesis), lignin, tannins, pigments, phytochrome, waxes, alkaloids, biosynthesis of nicotine, functions of alkaloids, cell wall components.

b. Toxins of plant origin – Mycotoxins, phytohemagglutinins, lathyrogens, nitriles, protease inhibitors, protein toxins.

c. Stress metabolism in plants - Environmental stresses, salinity, water stress, heat, chilling, anaerobiosis, pathogenesis, heavymetals, radiations and their impact on plant growth and metabolism, criteria of stress tolerance.

d. Antioxidative defence system in plants – Reactive oxygen species and their generation, enzymic and non-enzymic components of antioxidative defense mechanism.

Part B: Human Physiology Module III (12 lectures)

a. Blood and Circulatory system - Composition and functions of plasma, erythrocytes including Hb, Leucocytes and thrombocytes, plasma proteins. Blood Coagulation – mechanism and regulation. Transfer of blood gases – Oxygen and carbon dioxide, role of 2,3-diphosphoglycerate, Bohr effect and chloride shift.

b. Digestive system – Composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids, proteins, & nucleic acids.

c. Respiratory system– Air passages and lung structure, pulmonary volumes, alveolar surface tension, work of breathing and its regulation.

Module IV (10 lectures)

a. Endocrine system – Secretion and functions of hormones of thyroid, pituitary and gonads. Role of hormones in reproduction.Mechanism of action of hormones.

b. Nervous system-Muscle proteins, molecular mechanisms of muscle contraction (skeletal and smooth), nerve conduction,chemical regulation of synapses, neurotransmitters, neurons, resting membrane potential and action potential.

c. Excretory system – Structure of nephron, glomerular filtration, tubular reabsorption of glucose, water and electrolytes.Tubular secretion. Homeostatic regulation of water and electrolytes, Acid-base balance.

Suggested Readings

1. Harper's Illustrated Biochemistry, 31st Edition, Rodwell VW, Bender DA, Botham KM, Kennely PJ, Weil PA, 2009, MHLMP
2. Textbook of Biochemistry with clinical correlations, 7th Edition, Devlin TM, 2010, WLP

3. Ganong's Review of Medical Physiology, 25th Edition, Barrett KE, Barman SM, Boitano S, Brooks HL, 2017, MHE
4. Textbook of Medical Physiology, 11th Edition, Guyton AC, Hall JE, 2015, EI
5. Principles of Biochemistry, 5th Edition, Voet D, Voet JG, Pratt CW, 2018, WP
6. Lehninger's Principles of Biochemistry, 7th Edition, Nelson DL, Cox MM, 2017, ML
7. Medical Biochemistry, 2nd Edition, Bhagavan N V, 2015, AP
8. Biochemistry, 6th Edition, Garret RH, Grisham CM, 2017, SCP

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	L	L	L	L
CO2	H	M	H	H
CO3	M	M	M	M
CO4	L	H	L	L
CO5	L	M	M	M
CO6			M	M

BCFB0013: FUNDAMENTALS OF BIOCHEMISTRY (4-0-0)

Course Outcomes

CO 1: Relate of the structural and functional aspects of biomolecules (Remembering)
CO 2: Compare and draw the chemical structures of different biomolecules (Understanding)
CO 3: Identify the monomers and polymers of biomolecules (Applying)
CO 4: Analyse the interaction and importance of equilibrium maintenance of different biomolecules for health related issues (Analysing)
CO 5: Estimate the different concentrations of biomolecules for biological applications (Evaluating)
CO 6: Elaborate the biological applications of different biomolecules in drug discovery (Creating)

Module I (6 lectures)

Introduction to Biochemistry, water as biological solvent, weak acids and weak bases, pH and pK, buffers, Henderson-Hasselbalch equation, physiological buffers, fitness of the aqueous environment for living organisms

Module II (14 lectures)

a. Classification, basic chemical structure, general reactions and properties, biological significance of monosaccharide, Sugar derivatives, deoxy sugars, amino sugars, and sugar acids, Mutarotation of sugar, Anomeric effect of sugar (Methylation effect), Inversion (hydrolysis) of cane sugar
b. Polysaccharides - occurrence, structure, isolation, properties and functions of homoglycans - starch, glycogen, cellulose, dextrin, inulin, chitins, xylans, arabinans, galactans
c. Occurrence, structure, properties, and functions of heteroglycans - bacterial cell wall polysaccharides, glycoaminoglycans, agar, alginic acid, pectins, blood group substances and sialic acids, Glycoprotein and their biological applications, Lectins structure and functions

Module III (14 lectures)

a. Definition and Classification - (simple, complex, derived lipids - structure and example). Saturated and unsaturated fatty acids, Nomenclature of fatty acids, General chemical reactions of fatty acids – esterification, hydrogenation and halogenations
b. Phospholipids - classification, structure and functions, Ceramides and Sphingomyelins, Eicosanoids, structure and functions of prostaglandins, thromboxanes, leukotrienes, Types and functions of plasma lipoproteins, Amphipathic lipids - membranes, micelles, emulsions and liposomes.
c. Steroids - cholesterol structure and biological role - bile acids, bile salts.
d. General chemical reactions of fats: Hydrolysis, Saponification number, I_2 number, acetylation, acetyl number, and volatile fatty acid number, Rancidity of fat.

Module IV (4 Hours)

Porphyrins: the porphyrin ring system, chlorophyll, hemoglobin, myoglobin and cytochrome.

Module V (10 lectures)

Watson-Crick Model of DNA structure: A, B and Z – DNA. Chemical Properties: Hydrolysis (acid, alkali), enzymatic hydrolysis of DNA. Cruciform structure in DNA, formation and stability of cruciform, HDNA, palindrome, secondary and tertiary structure of RNA, hnRNA, si RNA, Cot value curve, hypochromic and hyperchromic effect, DNA-protein interactions, Viscosity, Buoyant density, Tm

Module VI (12 lectures)

a. Definition, classification, structure, stereochemistry and reactions of amino acids;
b. Classification of proteins on the basis of solubility and shape, structure, and biological functions. Primary structure - determination of amino acid sequences of proteins, the peptide bond, Ramachandran plot.
c. Secondary structure - weak interactions involved - alpha helix and beta sheet and beta turns structure, Pauling and Corey model for fibrous proteins, Collagen triple helix, and super secondary structures - helix-loop-helix.
d. Tertiary structure - alpha and beta domains. Quaternary structure - structure of haemoglobin, Solid state synthesisof peptides, Protein-Protein interactions, Concept of chaperones.

Suggested Readings

1. Biochemistry, 5th Edition, Jeremy M Berg, John L Tymoczko, and Lubert Stryer, 2002, W.H. Freeman and Co.
2. Fundamentals of Biochemistry, 4th Edition, Voet D, Voet JG and PrattCW,2012, John Wiley and sons NY.
3. Lehninger's Principle of Biochemistry, 7th Edition, David L Nelson and Michael M Cox, 2017, W. H. Freeman and Co.
4. Biochemistry, 4th Edition, Zubey GL, 1998, WCB London.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1		H	H	H	H	H
CO 2		H	H	H	H	H
CO 3		H			H	H
CO 4	H	M	H	H		
CO 5	H	H	H		H	H
CO 6	M	M	M	H		H

BCAT0014: ANALYTICAL TECHNIQUES (4-0-0)

Course Outcome

CO 1: Define the basic principles, concepts and applications of various analytical techniques used in biological sciences (Remembering)
CO 2: Apply the knowledge of centrifugation to separate a constituent from a complex mixture (Applying)
CO 3: Choose a suitable microscopic, electrophoretic, and chromatographic technique to identify and purify a target molecule from a complex mixture (Applying)
CO 4: Select an opposite spectroscopic technique to characterize a sample (Analysing)
CO 5: Ability to appraise the various techniques and formulate an appropriate plan for research studies (Evaluating)

Module I (12 lectures)

Principle of centrifugation, concept of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation

Module II (9 lectures)

Concepts of spectroscopy; Beer-Lambert's law, Principles and applications of colorimetry, Visible and UV spectroscopy, CD, IR and NMR

Module III (11 lectures)

Concepts of chromatography; Principles and applications of paper, thin layer, ion exchange, affinity, gel permeation, adsorption, partition and high-performance liquid chromatography

Module IV (13 lectures)

Principles of electrophoretic separation, types of electrophoresis viz. paper, cellulose, Native PAGE, SDS PAGE, Pulse field gel electrophoresis

Module V (15 lectures)

Basic concepts of microscopy, transmission electron microscopy, scanning electron microscopy, Freeze fracture technique. Principle and applications of Autoradiography

Suggested Readings

1. Instrumental Methods of Analysis. 6th Edition, H. H. Willard, L. L. Merritt Jr. and others1986, CBS Publishers and Distributors.
2. Instrumental Methods of Chemical Analysis, Chatwal G and Anand, S., 1989, Himalaya Publishing House, Mumbai.
3. A Biologist's Guide to Principles and Techniques of Practical Biochemistry Williams, B.L. and Wilson, K., 1975
4. Spectroscopy, Volume 1B. B. Straughan and S. Walker Eds., Chapman and Hall Ltd.

5. Gel Electrophoresis of Proteins - A Practical Approach Hanes,

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	H	H	H	H
CO 2	H				
CO 3			H	H	H
CO 4		H			
CO 5	H	H	H	H	H

BCMB0015: MOLECULAR BIOLOGY (4-0-0)

Course Outcomes

CO 1: Define the principles of DNA replication, transcription and translation (Remembering)

CO 2: Explain the structural and functional properties of biological macromolecules and to understand the role of gene regulation (Understanding)

CO 3: To recognize Central Dogma from replication of DNA till translation of protein (Applying)

CO 4: Distinguish between replication, transcription and translation (Analysing)

CO 5: Execute quantitative analysis to interpret biological data (Evaluating)

CO 6: Design a scientific process,gain insight into the most significant molecular methods to expand our understanding of biology (Creating)

Module I (15 lectures)

Nucleic acid as genetic material: it's proof; Different modes of replication (conservative, semi-conservative and dispersive); DNA replication in prokaryotes, eukaryotes and virus (rolling circle model): General features and enzymology; detailed mechanisms of initiation, elongation and termination; experiments underlying each step and role of individual factors; proofreading and processivity of DNA polymerase; telomerases: mechanism of replication, maintenance of integrity and role in cancer; effect of different inhibitors on replication.

Module II (15 lectures)

Basic concepts of promoter, operator, terminator, enhancer; RNA polymerases and its sub-Modules; different sigma factors and their relation to stress, viral infections etc; initiation, elongation and termination (rho-dependent and independent) mechanism of RNA synthesis; post transcriptional modification of RNA - capping, splicing and poly A tailing; effect of different inhibitors on prokaryotic and eukaryotic transcription.

Module III (20 lectures)

The genetic code and its nature; structure of t-RNA, ribosomal structure; activation of amino acids; initiation, elongation and termination mechanism of polypeptide chain synthesis; role of r-RNA in polypeptide chain synthesis; differences between prokaryotic and eukaryotic translational processes; post-translational modification of peptide, its transportation; non- ribosomal peptide synthesis with special reference to cyclic polypeptide antibiotics synthesis in bacteria; effect of different inhibitors on protein synthesis in both prokaryotes and eukaryotes.

Module IV (10 lectures)

Positive and negative control; catabolite regulation-definition and mechanism; effect of anti-termination and attenuation on the process of gene regulation; various protein motifs involved in DNA-protein interactions during gene regulation. Epigenetics - definition and mechanism.

Suggested Readings

1. Lewin's Genes XII,12 th Edition, Krebs JE, Kilpatrick ST, Goldstein ES, 2017, JB
2. Molecular Biology of the Gene, 7th Edition,Watson JD, Baker TA, Bell SP, Gann A, Levine M, Bell SP, Losick R, Harrison SC, 2020, PP
3. Molecular Biology, 5th Edition, Weaver RF,2011, MGHC.
4. Molecular Biology, 3rd Edition, Clark DP,Pazdernik NJ, 2014, API
5. Molecular Biology, 5th Edition, Freifelder D, 2004, NPHPL.

Mapping of COs to syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	L	L	L	
CO 2		M	M	H
CO 3	H	H	H	
CO 4	M	M	H	

CO 5		L	L	
CO 6				H

BCFI0016: FUNDAMENTALS OF IMMUNOLOGY (4-0-0)

Course Outcomes

CO 1: Course begins with general overview of immunity to get you adjusted to the basics in the field. To demonstrate comprehension of general terms associated with immunological responses and the roles of nearly every cell associated with the immune system. Understand the differentiation of hematopoietic stem cells (HSCs) into lymphoid or myeloid immune cells (Understanding)

CO 2: To understand the immunological defense against intruders Cellular basis for innate immunity against all types of pathogens. To describe different mechanisms exist in body to recognize pathogens nonspecifically (Understanding)

CO 3: To demonstrate comprehension of antibody structure, composition, and classes. Understand antibodies associated with particular immunological responses. Gain insights into the coordination of innate and adaptive immune response (Understanding)

CO 4: Major Histocompatibility Complex (MHC), which determines how individuals display, present, and respond to foreign antigens. To understand the importance of MHC in determining transplant eligibility and autoimmune disease. Understand antigen transport through exogenous or endogenous location and attachment on MHC molecule on the cell surface. (Understanding)

CO 5: Understand how T cells develop, rearrange T-cell receptor. To develop insights into key differences between rearrangements and Differential pathways that a T cell undergoes (Understanding)

Module I (10 lectures)

General overview of Immunity, Introduction to Metaphors, Pathogens and Immunity, Surveying the cells and organs of Immune system- Innate and adaptive cells, Hematopoietic Stem Cell, primary and secondary organs; Innate and Adaptive Immune response

Module II (7 lectures)

Ubiquity of Innate immune response, Anatomic Barriers-Skin, Mucosa and GI defenses; Apoptosis, Inflammation- Extravasation, Lymphocyte Extravasation, Trafficking, and Homing, Inflammatory Mediators, Inflammatory Cytokines and Chemokines, Clinical Considerations, Chronic Inflammatory Response; Innate Targeting of Pathogens-Pathogen Recognition System, PAMPs (Pathogen Associated Molecular Patterns), TLR, Cell Types and Function

Module III (14 lectures)

Introduction to models in immune system, Immunoglobulin Superfamily, Structure of Immunoglobulin Receptors (BCR) and Antibodies, Immunoglobulin Classes, Antigen Binding, Antibody Dependent Cell Mediated Cytotoxicity (ADCC), Monoclonal Antibodies

Complement System: Overview and Terminology of the Complement System, Complement Activation, Classical, Alternative and Lectin pathway, Consequences of Complement Activation

Module IV (14 lectures)

Structure of the MHC Locus, Class I MHC, Class II MHC and Class III MHC, Haplotypes, Recombinant Haplotypes, MHC Protein Structure, Specifics of Peptide Binding, Genetic Expression and Cellular Expression, Non-Classical MHC Genes, MHC and Disease

Antigen Processing and Presentation: T Cell Antigen Recognition, Professional Antigen Presenting Cells (APCs), Self-MHC restriction, Cytosolic Pathway: Class I Processing and Presentation, Transport to the RER, Exogenous Pathway: Class II Processing and Presentation, Variations- Cross presentation, T-cell receptor-Structure and Roles, αβ versus γδ receptors, Common Elements, Functional Differences, T-Cell Receptor Genes, Gene Rearrangement- Alpha Rearrangement-,Beta Rearrangement, Delta Rearrangement

Module V (8 lectures)

Maturation in the Thymus, Double Negative Transitions, Double Positive (DP) Events Completing the Receptor, Displaying Co-Receptors, Beginning Selection; Positive and Negative Selection, CD4+ TH Cells: Types and Functions, Determination of Subclass,Superantigens, TH Cell Activation Pathway

Module VI (2 lectures)

Central and Peripheral Tolerance, Malnutrition, SCID, HIV

Module VII (5 lectures)

Types of hypersensitivity reactions 1,2,3 and 4, Autoimmunity and autoimmune diseases

Suggested Readings

1. Cellular and Molecular Immunology, 7h edition by Abbas, et al. 2012, Elsevier/Saunders.

2. Janeway Immunobiology, Kenneth Murphy, Casey Weaver, 9th edition, Norton & Company
3. Molecular Biology of the Cell, Alberts et al., 5th edition, 2014, W. W. Norton & Company
4. Kuby Immunology, Judy Owen, 6th and 7th editions, W H. Freeman

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module6	Module VII
CO 1	L						
CO 2		M					
CO 3			H				
CO4				M			
CO5					H	L	L

BCHD0017: HERBAL DRUG TECHNOLOGY (1 - 0 - 0)

Course Outcomes

CO 1: To explain steps of herbal drug preparations

CO 2: To perceive the application of herbs in formulation of herbal products

CO 3: To design experiments for preparation various plant-based products

Module I (2 lectures)

Definition of herb, herbal medicine, herbal medicinal product and herbal drug preparation, source of herbs, selection, identification and authentication of herbal materials, processing of herbal raw material

Module II (3 lectures)

Sources and description of raw materials of herbal origin used via, fixed oils, waxes, gums colours, perfumes, protective agents, bleaching agents, antioxidants in products such as skin care, hair care and oral hygiene products.

Module III (3 lectures)

Herbal Excipients – Significance of substances of natural origin as excipients, – colorants, sweeteners, binders, diluents, viscosity builders, dis-integrants, flavors & perfumes.

Module IV (2 lectures)

Stages involved in herbal formulations, Orthodox formulations and methods of delivery of herbal extracts, Novel formulations of herbal extracts

Module V (2 lectures)

General aspects, market, growth, scope and types of products available in the market, Health benefits and role of Nutraceuticals in ailments like Diabetes, CVS diseases, Cancer, Irritable bowel syndrome and various Gastrointestinal diseases.

Module VI (3 lectures)

Collection of herbs, preparation of herbal cosmetics, herbal excipients, formulations, decoctions, and nutrition-based products.

Suggested Readings

1. Herbal Drug Technology Mohan Lal Kori, Santram Lodhi, Tushar A Deshmukh, Rageeb Md. Usman, Vaibhav M Darvheka, NiraliPrakashan Publication
2. Herbal Drug Technology, Paridhavi Agarwal, Universities Press Private Ltd.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO1	H	M	M	M	M	
CO2	M	H	H	H	H	
CO3						H

BCBE0018: BIOENERGETICS (3-0-0)

Course Outcomes

CO 1: Summarise the basic concepts of free energy, standard free energy, redox potential and other thermodynamic concepts about biological systems (Understanding)

CO 2: Use principle of transmembrane transport and its various types with special emphasis to mitochondrial respiratory chain and its carriers (Applying)

Module I (15 lectures)

Concept of free energy, standard free energy, determination of G for a reaction, Relationship between equilibrium constant

and standard free energy change, biological standard state & standard free energy change in coupled reactions. Biological oxidation
- reduction reactions, redox potentials, relation between standard reduction potentials and free energy change (derivations included). High energy phosphate compounds – introduction, phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphates along with reasons for high G. Energy charge.

Module II (15 lectures)
Chemotaxis and chemoreceptors chemo-osmotic theory, ion transport across energy transducing membranes, Influx and efflux mechanisms, Proton circuit and electrochemical gradient, the transport and distribution of actions, anions and ionophores, Uniport, antiport and symport mechanisms, shuttle systems.

Module III (15 lectures)
The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization, The Q cycle and the stoichiometry of proton extrusion and uptake; P/O and H/P ratios, Reversed electron transfer, respiratory controls and oxidative phosphorylation, uncouplers and inhibitors of energy transfer. Fractionation and reconstitution of respiratory chain complexes, ATP- synthetase complex, Microsomal electron transport, partial reduction of oxygen, superoxides.

Suggested Reading
1. Biochemistry, M. Berg, J. L. Tymoczko, L. Stryer, Freeman Publicatio
2. Biochemistry, Voet and Voet, John Wiley and Sons
3. Bioenergetics: A practical approach, paperback Brown and Cooper, Oxford University Press

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO I	H		
CO 2		H	H

BCNM0019: NUTRITIONAL BIOCHEMISTRY & METABOLISM (3-0-0)

Course Outcomes
CO 1: To acquire the knowledge of the dietary requirement of vitamins and minerals in human body (Remembering).
CO 2: To describe the various pathways that describes the metabolism of breakdown and synthesis of carbohydrates, amino acids and lipids in a biological system (Understanding)
CO 3: Interpret the significance of nutritional distribution of the carbohydrates, amino acids, and fats and their disturbancesin the absence of its regulatory enzymes (Applying)
CO 4: Infer the deficiency diseases and abnormalities in response to the dysfunction of enzymes associated with carbohydrates, lipids and amino acids metabolism (Analysing)
CO 5: Compare the linkage of carbohydrate, amino acids and lipid metabolism in in a biological system (Evaluating)

Module I (11 lectures)
Brief account on carbohydrates; Glycolysis; Fates of pyruvate under aerobic and anaerobic conditions; Regulation of glycolysis; Pentose phosphate pathway; Oxidative and Non-oxidative phases of PEP; Citric acid cycle; Production of acetyl CoA, Pyruvate dehydrogenase complex, Regulations of the Citric Acid Cycle; Gluconeogenesis pathway and its regulation; Glycogen biosynthesis and its regulation.

Module II (11 lectures)
Brief account of amino acids; essential and non-essential amino acids; metabolic fates of amino acids; amino acid metabolism: transamination, deamination; amino acid pathway and its degradation; nitrogen excretion and urea cycle; linkage of urea cycle and citric acid cycle

Module III (10 lectures)
Brief account of lipids, Synthesis and storage of triacylglycerol, Transport and mobilization, Essential fatty acids, Fatty acid oxidation, Biosynthesis of cholesterol and steroids.

Module IV (8 lectures)
Importance of carbohydrates, lipids and amino acids in our daily diet; essential and non essential amino acids; dietary input of carbohydrates, lipids and amino acids; deficiency diseases associated with carbohydrates, lipids and amino acids; distribution process of carbohydrates, fats and proteins in the human body once injested.

Module V (5 lectures)
Importance of vitamins in our diet; nutritional significance of minerals and trace elements; dietary sources of vitamins and

minerals; requirements and deficiency diseases associated with Vitamins (fat soluble and water soluble vitamins) and minerals

Suggested Readings

1. Biochemistry, 5th edition, M. Berg, J. L. Tymoczko, L. Stryer, 2002, Freeman Publication.
2. Biochemistry, 4th edition, Voet and Voet, 2002, John Wiley and Sons.
3. Lehninger's Principle of Biochemistry, 7th edition, David L. Nelson and Michael M. Cox, W. H., 2017, Freeman and Co.
4. Text Book of Biochemistry with Clinical Correlation, 6th edition, Thomas M. Devlin, John Wiley- Liss, ed. Hobokhen, 2006, NJ publishers
5. Nutritional biochemistry and metabolism: with clinical applications, 2nd edition, M.C. Linder, 1991.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1					H
CO 2	H	H	H	L	
CO 3				H	
CO 4	M	M	M	H	
CO 5	L	L	L	H	L

BCOB0020: OMICS BIOLOGY AND ITS TOOLS (4-0-0)

Course Outcomes

CO 1: Recall mapping and sequencing of genomes, transcriptome, proteome and metabolome (Remembering)
CO 2: Illustrate the different sequencing techniques (Understanding)
CO 3: Apply the tools of bioinformatics to analyze biological data (Applying)
CO 4: Analyze the data with biostatistics software (Analysing)
CO 5: Decide the type of spectroscopic method for sample analysis (Evaluating)
CO 6: Construct phylogenetic tree after analysis of biological samples (Creating)

Module I (15 Lectures)

a. Mapping and sequencing genomes: Genetic and physical mapping, Sequencing genomes different strategies, High-throughput sequencing, next-generation sequencing technologies, comparative genomics, population genomics, epigenetics.
b. Human genome project, pharmacogenomics, genomic medicine, genome editing, applications of genomics to improve publichealth, drug discovery and agriculture, metagenomics.

Module II (15 Lectures)

a. Transcriptome, analysis of gene expression - ESTs, SAGE, recent developments in RNA sequencing; metatranscriptomics, applications in gene regulation: alternative splicing, non- coding RNA.
b. Introduction to proteomics, techniques to study proteomics such as 1D and 2D PAGE, X- ray crystallography, Mass spectrometry including MALDI-TOF, protein microarrays, protein database analysis, comprehensive analysis of protein-protein interactions in different cell types.

Module III (10 Lectures)

a. Metabolomics, metabolome and metabolite, Structural diversity, number of metabolites in biological system, basic concept of metabolic channeling or metabolons, new approaches to analyze metabolic pathways.
b. Sample preparation, strategy and techniques used for metabolomic studies viz. GC-MS, LC-MS, NMR; data analysis (PDA,PLSDA), Lipidpomics, Glycomics, Phenomics, etc.

Module IV (20 Lectures)

a. Technical writing**:** Preparation of scientific report. Thinking and planning, information, ideas, order of paragraph writing; Presentation of a review; Objective and its importance; design of the experiment; parameters used; data interpretation; compilation of experimental record.
b. Case studies derived from scientific literature (genomics, transcriptomics, proteomics and metabolomics) including comparisons between healthy and diseased tissues.
c. Bioinformatics: Databases, phylogenetic tree, critical analysis of -omics data using advanced tools.
d. Biostatics tools: Data analysis with excel and software (SPSS).

Suggested Readings

1. Principles of Proteomics, 2nd Edition, Twyman RM, 2013, Garland Science
2. Metabolome Analysis: An introduction, 1st Edition, Villas-Boas SG, Roessner U, Hansen MAE, Smedsgaard J, Nielsen J, 2007, Wiley

3. Bioinformatics - From genomes to drugs, 1st Edition, Langauer T, Mannhold R, Kubinyi H, Timmerman H, 2002, Wiley VCH
4. Principles of gene manipulation, 7th Edition, Primrose SB, Twyman RM, 2006, Blackwell Publishing

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	H	H	M
CO 2	H	H	H	M
CO 3	M	M	M	H
CO 4				H
CO 5		H	H	
CO 6				H

BCBM0021: BIORESOURCE MANAGEMENT (2-0-0)

Course Outcomes

CO 1: Define and have an enhanced knowledge of the fundamentals of bioresources by recalling and relating with the surrounding environment (Remembering).

CO 2: Summarize how nature works regarding the climate, biodiversity and the flow of natural resources, and realize the impact of human activity on the environment (Understanding).

CO 3: Implement the acquired knowledge of bioresources through different conservation methods (Applying).

CO 4: Analyze, observe and recognize how their sustainability will safeguard the future of humans and the ecosystem on the planet (Analysing).

CO 5: Evaluate by presenting and defending opinions by making judgments about the human activities and assess the benefits, opportunities, and challenges of bioresources in today's economy (Evaluating)

Module I (12 lectures)

Basics of Bioresources: Concept, kinds, importance, economy- environment nexus. Management, scope and importance of human resource management (HRM) and personnel management; employment and utilization of natural resources; measures of rural poverty and human development; human development index (HDI); sustainable rural development, Community based management of Bioresources

Module II (18 lectures)

Bioresource Management, and their ultilisation: Sustainable agriculture, Climate change and its impact on crop productivity, Bioresource management through land use planning, Post harvest management of agricultural produce, Significance and methods of biodiversity conservation; concepts of hot spots, red data book; traditional knowledge and biodiversity conservation; Earthworm technology: a tool for sustainable agriculture, Integrated farming, Induced breeding , Captive breeding, Sericulture, Integrated pest management, Conservation of biodiversity in seed banks, gene banks and germplasm reserves, Habitat restoration. Application of remote sensing technology for bioresource management, Bio prospecting and bio piracy issues with particular reference to India's biodiversity

Concept and hands on training on formulation of biopesticides, bioinsecticides, bio weedicides, bio manure, bio cosmetics, bioplastics, biofuel generation from natural sources. Field visit and Report Writing: Conservation Centres / small scale industry etc.

Suggested Readings

1. Bioresource Management and climate change, 1st Edition, R. N. Kumar, 2015, OBC
2. Bioresources and their management, 1st Edition, Trivedi SP, Jahageerdar S, Rajendran KV, Kumar D, 2012, AP
3. Bioresources Conservation and Management, 1st Edition, Raju AJS, 2009, TTPP
4. Bioresources of the Eastern Ghats: Their Conservation and Management, 1st edition, Krishnamurthy KV, Murugan R, 2014,NHBS
5. Forest Management, 4th Edition, Davis LS, 2001, MHI
6. Human resource Management, 16th Edition, Dessler G, Varrkey B, 2020, PP
7. Research trends in Bioresource Management, 1st Edition, Maiti R, 2018, APC
8. Biofertilizer and biopesticide, 1st Edition, Lakshman HC, Channabasava A,2014, PP

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II
CO 1	H	
CO 2	M	H

CO 3		M
CO 4		M
CO 5		M
CO 6		M

BCSL0200: SERVICE LEARNING IN BIOSCIENCES (2-0-0)

Course Outcomes

CO 1: To understand the essence of learning through community service
CO 2: To realise and identify the needs of community
CO 3: To apply subject related knowledge for service to the community

Module I (8 lectures)

Service learning: Definitions; Principles of Service Learning; Awareness of Community; Involvement with Community; Commitment to service

Module II (12 hours)

Fermentation and food microbiology; Herbal Drug Technology; Waste Management; Mushroom cultivation; Principles of Floriculture and Horticulture; Health -hygiene and disease awareness

LABORATORY COURSES

BCIM6004: MEDICAL BIOCHEMISTRY LAB

Course Outcomes

CO 1: Practically estimate lipoprotein, bilirubin, blood urea, creatine phosphokinase from a serumsample (Applying)
CO 2: Perform glucose tolerance tests and understand the normal and abnormal constituents of urine (Applying)

List of Experiments

1. Estimation of lipoproteins
2. Glucose tolerance test
3. Estimation of bilirubin
4. Estimation of blood urea
5. Estimation of creatine phosphokinase
6. Normal and abnormal constituents of urine

Suggested Readings

1. Medical Biochemistry, 7^{th} Edition, Chatterjee MN and Shinde R, 2007, Jaypee Brothers Medical Publishers P (Ltd)

Mapping of COs to Syllabus

Course Outcomes	P1	P2	P3	P4	P5	P6
CO 1	H		H	H	H	H
CO 2		H				

***P: Practical**

BCPY6005: PHYSIOLOGY LAB

Course Outcome

CO 1: To be able to understand and master the conceptual and practical physiological functions of systems (Understanding)
CO 2: To acquire basic knowledge and perform experiments in physiology (Applying)
CO 3: To be able to determine, estimate and report on experiments and observations in physiology (Evaluating)
CO 4: To be able to perform an assay, analyse and report on experiments and observations in physiology (Analysing)
CO 5: To equip students with skills and techniques related to physiology to design experiments necessary for careers in research (Creating)

List of Experiments

1. Estimation of urea in serum
2. Estimation of cholesterol in serum.
3. Estimation of calcium in serum.
4. Assay of Serum glutamate oxaloacetate transaminase (SGOT) and serum glutamate pyruvate transaminase (SGPT)
5. Assay of alkaline phosphatase
6. Assay of amylase in serum
7. Estimation of glucose in serum by glucose oxidase-peroxidase method.
8. Assay of LDH activity in serum
9. Separation of plasma proteins by electrophoresis
10. Estimation of glycosylated hemoglobin
11. Counting white blood cells, red blood cells, platelets

Suggested Readings

1. Laboratory Manual for Practical Biochemistry, 2^{nd} Edition, Ganesh MK, Shivaraja SYM, 2013, JB
2. Textbook of Practical Physiology, 5^{th} Edition, Pal GK, Pal P, 2001, UP

Mapping of COs to syllabus

Course Outcomes	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
CO 1	M	M	M	M	M	M	M	M	M	M	M
CO 2	M	M	M	M	M	M	M	M	M	M	M
CO 3	H	H	H	H	H	H	H	H	H	H	H
CO 4	M	M	M	M	M	M	M	M	M	M	M
CO 5	M	M	M	M	M	M	M	M	M	M	M

***P: Practical**

BCBM6006: BIOENERGETICS LAB

Course outcomes

CO 1: Interpret how cells manufacture energy-ATP generation (Evaluating)
CO 2: Illustrate the mechanism of cellular respiration in yeast, plants and mitochrondria (Understanding)

List of Experiments

1. Numerical solving related to determination of free energy, free energy determination from equilibrium constants and standard reduction potentials
2. Demonstration of cellular respiration in yeast
3. Isolation of chloroplast from plant cells
4. Isolation of mitochondria form mouse liver tissue

Suggested Readings

1. Bioenergetics: A Practical Approach Brown, G. C. and Cooper, C. E. Oxford University Press

Mapping of COs to Syllabus

Course Outcomes	P1	P2	P3	P4
CO1	H			
CO2		H	H	H

***P: Practical**

BCDI6007: DISSERTATION PHASE I (0-0-2)

Course Outcomes

CO 1: Develop a scientific mindset with the capacity for analytical and innovative thinking (Creating).
CO 2: Develop writing skill, referencing and citations for effective communication (Applying).
CO 3: Improve communication and creative expression skills to articulate scientific ideas (Creating).
CO 4: Examine the research gap in the related field and formulate strategies to address the same (Analysing).

Syllabus

1. Familiarization with research topic and methodologies by a thorough literature review.
2. Writing of review of literature to brush up already existing knowledge on a given area.
3. Formulate a research hypothesis and a proposed work plan.
4. Presentation of the research topic at department level and submission of literature review.

Suggested Readings

1. Scientific review and research articles published in respective specialized area of research.

Mapping of Course outcomes to Syllabus

Course Outcomes	P1	P2	P3	P4
CO 1	H	H		
CO 2		H	H	
CO 3		H	H	H
CO 4	L	M	L	H

***P: Practical**

BCDI6008: DISSERTATION PHASE II (0-0-16)

Course Outcomes

CO 1: Support the research hypothesis with experiments executed ethically (Evaluating).
CO 2: Develop skill to independently carry out a research in the laboratory (Creating).
CO 3: Examine the methodology, analyse results, and defend the research work (Analysing).

Syllabus

1. Execute a scientific dissertation based on the proposed plan in Phase 1 through bench work.
2. Present and report data at various stages of the research work to the assigned supervisor.
3. Analysing the results, correlating it with different experiment performed during the dissertation.
4. Present the findings in a department level to internal and external examiners, and submission of completed thesis.

Suggested Readings

1. Scientific review and research articles published in respective specialized area of research.

Mapping of COs to Syllabus

Course Outcomes	P1	P2	P3	P4
CO 1	H	L	M	
CO 2	H	M	H	L
CO 3		H	H	H

***P: Practical**

BCFB6009: FUNDAMENTALS OF BIOCHEMISTRY LAB

Course Outcomes

CO 1: Estimate and prepare buffer solutions for different experiments
CO 2: Quantify various biomolecules at different concentrations for future research experiments
CO 3: Apply the technique based on spectrophotometer for analysis of various biomolecules

List of Experiments

1. Preparation of buffers
2. Determination of pKa and pI of acidic, basic, and neutral amino acids
3. Estimation of amino acids by Ninhydrin method
4. Estimation of DNA by DPA method
5. Estimation of RNA by Orcinol method
6. Estimation of proteins by Bradford method
7. Estimation of proteins by Lowry method
8. Isolation and estimation of lipids from seeds
9. TLC of plant pigments
10. TLC of lipids

Suggested Readings

1. The Protein Protocols Handbook, 3rd Edition, Walker, JH, 2009,HumanaPress
2. Biochemical methods, 2nd Edition, SadasivamandManickam,2004, New Age International(P) Limited Publishers, New Delhi.

Mapping of COs to Syllabus

Course Outcomes	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
CO 1	H	H	H							
CO 2			H	H	H	H	H	H	H	H
CO 3			H	H	H	H	H			

***P: Practical**

BCAT6010: ANALYTICAL TECHNIQUES LAB

Course Outcome

CO 1: Recall and perform the laboratory analysis in accordance with Good Laboratory Practices, in conditions of hygiene and safety (Remembering)
CO 2: Describe the principles and the theoretical concepts of the instruments (Understanding)
CO 3: Choose an appropriate separation technique for analysis of the samples (Applying)
CO 4: Ability to undergo a comparative analysis of different identification and purification protocols that can best suit a particular experiment (Analysing)
CO 5: To evaluate the spectrophotometric parameter for understanding the nature of the biological sample (Evaluating)
CO 6: Design an analytical work flow to characterize a biological sample (Creating)

List of Experiments

1. Study of UV absorption spectra of biological macromolecules-proteins, nucleic acids
2. Separation of bacterial lipids/amino acids/sugars/organic acids by TLC
3. Separation of bacterial lipids/amino acids/sugars/organic acids by Paper Chromatography
4. Study of nucleic acids using Agarose gel electrophoresis.
5. Study of serum proteins by vertical gel electrophoresis
6. Separation of haemoglobin or blue dextran by gel filtration
7. Quantitative estimation of hydrocarbons/pesticides/organic solvents/methane by gas chromatography
8. Demonstration of PCR and its application

Suggested Readings

1. The Protein Protocols Handbook, Walker,J.H.(Ed.) Humana Press
2. Principles and Techniques of Biochemistry and Molecular Biology Wilson, K. and Walker,J., Cambridge University Press

Mapping of COs to Syllabus

Course Outcomes	P1	P2	P3	P4	P5	P6	P7	P8
CO 1	H	H	H	H	H	H	M	M
CO 2	H	H	H	H	H	H	H	H
CO 3		H	H	H	H			
CO 4	M	M	M			H	H	
CO 5	H							
CO 6	H	H	H	H	H	H	H	H

***P: Practical**

BCRT6012: REMEDIAL TEACHING & NET COACHING

BCNM6013: NUTRITIONAL BIOCHEMISTRY & METABOLISM LAB

Course Outcomes

CO 1: To discuss the effect of pH and temperature on enzyme activity (Understanding).
CO 2: To analyze the saponification value (Analysing)
CO 3: To measure the content of vitamins in food sample (Evaluating)
CO 4: To estimate the acidity in milk and evaluate its causes (Evaluating)
CO 5: Design a protocol to study how pH and temperature effects the regulation of enzymes (Creating)

List of Experiments

1. Determination of saponification value of fats/oils
2. Estimation of acidity in milk
3. Estimation of vitamin C from biological sources
4. Effect of pH on amylase activity.
5. Effect of temperature on amylase activity

Suggested Readings

1. Fundamentals of Biochemistry, 5th edition, Voet, D., Voet, J. G., & Pratt, C. W., 2007. John Wiley.
2. Biochemistry, 4th Edition, Zubey, G. L., 1998, WCB London.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1				H	H
CO 2	H				
CO 3			H		
CO 4		H			
CO 5				H	H

BCMB6013: MOLECULAR BIOLOGY LAB

Course Outcomes

CO 1: Define the principles for isolation of DNA from bacteria, plant and animal (Remembering)
CO 2: Demonstrate the knowledge of laboratory practices in molecular biology and conduct independent work in laboratory (Understanding)
CO 3: Apply practical knowledge to perform isolation of genomic and chromosomal DNA from bacteria (Applying)
CO 4: Test for DNA amplification by PCR and observe the amplicons of gel electrophoresis (Analysing)
CO 5: Execute quantitative analysis to interpret clear and concise communication of biological data and evaluate student progress with guided enquires (Evaluating)
CO 6: Design a scientific process, think critically and employ the scientific method in the formal practices of observation and experimentation (Creating)

List of Experiments

1. Isolation of genomic DNA from bacteria/plant/animal
2. Isolation of chromosomal DNA from bacteria.

3. DNA amplification by PCR and visualization of DNA by gel electrophoresis
4. Restriction digestion of DNA

Suggested Reading

1. Molecular Biology Techniques, A Classroom Laboratory Manual, 4th Edition, Carson S, Heath M, Melissa S, Witherow DS, 2019, AP

Mapping of COs to syllabus

Course Outcomes	P1	P2	P3	P4
CO 1	M	M		
CO 2	H	H	H	H
CO 3	H	H		
CO 4			H	H
CO 5			H	
CO 6	M	M		

***P: Practical**

BCFI6014: FUNDAMENTALS OF IMMUNOLOGY LAB

Course Outcomes

CO 1: Visualize the types of cells present in the blood and understand their normal and abnormal percentage as a sign of infection
CO 2: Analyze the basic difference between serum and blood plasma
CO 3: Determine antigen antibody interaction
CO 4: Determine immunodiagnostic application
CO 5: Understand the type and detection of antibodies present in body secretions
CO 6: Understand the principles for isolation of various blood cell types

List of Experiments

1. Microscopic examination of blood cells
2. Isolation of serum and plasma from blood
3. Antibody capture ELISA
4. Antigen capture ELISA
5. Blood grouping through agglutination
6. Antibody IgG purification
7. Detection of secretory IgA from saliva
8. Apoptosis determination using standard kits
9. Separation of peripheral blood mononuclear cells by Ficoll-Hypaque

Mapping of COs to syllabus

Course Outcomes	P 1	P2	P3	P4	P5	P6	P7	P8	P9
CO 1	H								
CO 2		H							
CO 3			H						
CO4				H	H				
CO5						H	H	H	
CO6									H

***P: Practical**

BCRT6015: REMEDIAL TEACHING & NET COACHING

BCSC6017: SCIENTIFIC WRITINGS AND COMMUNICATIONS (0-0-1)

Course Outcomes

CO 1: Assess published data, critically read, interpret, and present it (Analysing)
CO 2: Compare the strengths and weaknesses of publications (Evaluating)
CO 3: Develop skills in interpreting and evaluating scientific data (Creating)
CO 4: Demonstrate ethics in research and related good laboratory practices (Understanding)
CO 5: Relate the relevance of personality for boosting overall confidence (Understanding)

CO 6: Design paper writing based on advanced fields of research (Creating)

Activities-Lecture/Talk by students/Faculty/Outsourcing

1. Introduction to Good Laboratory practices
2. Development of personality skills and refinement of communication skills for scientific presentation and interviews
3. Presentation of research articles/classical papers by 3rd Semester
4. Problem solving and critical thinking session by giving the research problem and allow them to present strategy
5. Scientific communication and its ethics
6. Invited Talk

Mapping of COs to Syllabus

Course Outcomes	P1	P2	P 3	P4	P5	P6
CO1	H	M	M			
CO2	H	M	M			
CO3	H	M	M			
CO4	M	M	M	H		
CO5	M	M	M		H	
CO6	M	M	M			H

PROGRAMME: MASTER OF SCIENCE (MSC) BIOTECHNOLOGY

PROGRAMME OUTCOMES

PO 1: **Skill Development**: Master academic, technical, managerial and crucial soft skills to qualify for careers in research, industry, education, administration and management or for higher studies where a holistic understanding of applied biosciences is required.

PO 2: **Research:** Develop a scientific mindset with the capacity for analytical and innovative thinking and practical knowhow to formulate, design and ethically implement scientific research in frontier areas of Biochemistry, Biotechnology and Microbiology

PO 3: **Communication:** Acquire effective communication and creative expression skills in the form of writing, design, presentation and networking to convincingly articulate scientific ideas in biosciences and related fields

PO 4: **Employment and Entrepreneurship:** Acquire the necessary knowledge and proficiencies to become employable or get self- employed and thereby create job opportunities through entrepreneurship in heath, agriculture, industry, environment and allied areas of applied biosciences and thereby affirmatively contribute to scientific social responsibility.

PROGRAMME SPECIFIC OUTCOMES

PSO 1: **PSO1: Confidence:** Demonstrate a comprehensive understanding of chemical and biological structure, principles, techniques, andapplications

PSO 2: **PSO2: Knowledge based Skill**: To develop better understanding and improve skills that would enable them to begin a career in research laboratories, industries as well as to generate self-employability

PSO 3: **PSO3: Scientific Social Responsibility:** To develop linkages between scientific community and society to build trust, partnershipand responsibility of science towards achieving social goals

PSO 4: **PSO4: Cell culture handling and transgenic technology:** The programme will help in gaining knowledge on *in vitro* culture techniques for plant and animal cells which contributes in the development of transgenic plants and animals.

PSO 5: **PSO5: Grasp of industrial and environmental aspects of Biotechnology:** The programme will help in the understanding the application and working of pharmaceutical, and fermentation industry for healthcare and food products. It will also emphasise on environment protection and its long-term sustainability

PSO 6: **PSO6: Scale-up and connect to advanced and modern concepts**: The programme will update students about the most recent developments in the fields of OMICS, genome editing, systems biology, nano-biotechnology and nano-materials to stimulate scaling up to advanced learning.

MAPPING OF COURSES WITH POS/PSOS

Courses	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
Thermodynamics and Enzymology	H	H	L	M	H	M	L	M		
Cell Biology and Genetics	H	H	H	M	H	M	L	M	L	L
Fundamentals of Biochemistry	H	M	H	H	H	H	L	H	M	L
Analytical Techniques	H	H	M	H	H	H	M	H	L	L
Lab I- Fundamentals of Biochemistry	H	H	M	M	H	H	L	H	M	L
Lab II- Thermodynamics and Enzymology	H	H	M	M	H	M		M		
Lab III- Cell Biology and Genetics	H	H	H	M	H	H	L	H	M	L
Lab IV- Analytical Techniques	H	H	M	H	H	H	M	H	L	L
Industrial/ Laboratory visit	H	H		H	M	H		H	M	H
Genetic Engineering	H	H	L	M	M	H	M	M		L
Computer Applications and Bioinformatics	H	H	M	M	M	H	L	M		H
Basic Microbiology	L	H	L	L		H		L		
Molecular Biology	H	M	M	M	M	H	L	M	L	L
Fundamentals of Immunology	H	H	H	H	M	H	H	M	L	L
Lab I- Genetic Engineering	H	H	M	M	M	H	M	M		M
Lab II- Computer Applications and Bioinformatics	H	L	M	M		H		H		H
Lab III- Basic Microbiology	H	H	H	H		H		L		
Lab IV- Molecular Biology	H	H	M	M	M	H	L	H	L	L

Lab V- Fundamentals of Immunology	H	H	H	H	M	H	L	M	L	L
Waste Management (Skill Development course)	H	H	M	H	M	H	H	H	L	M
Fermentation and Food Micorbiology (Skill Development course)	H	H	H	H	M	H	H	L	H	L
Mushroom Cultivation (Skill Development course)	H	H	H	H	H	H	H	H	L	H
Herbal Drug Technology (Skill Development course)	H	H	M	H	L	H	H	H	L	M
Research Methodology & Biostatistics-common	M	H	H	M	L	M	H	H	L	L
Bioprocess Engineering	H	H	H	H	H	H	M	H	L	
Plant Biotechnology	H	H		H	M	H		H	M	
Animal Biotechnology	H	H	L	M	M	H		H	M	
Pharmaceutical &Environmental Biotechnology	H	H	M	H	M	H	M	L	H	L
Lab I- Animal Biotechnology	H	H	M	M	M	H		H		
Lab II- Bioprocess Engineering	H	H	H	H	H	H	M	M	H	L
Lab III- Plant Biotechnology	H	H		H	M	H		H		
Lab IV-Pharmaceutical & Environmental Biotechnology		H	M	H	M	H	M	L	H	L
Dissertation Phase I	H	H	H	M	M	H	H	H	H	M
IPR &Entrepreneurship	M	H	H	H	M	H	M	L	M	L
Scientific Writings and Communications		H	H		H					H
Value Added Course- Clinical Laboratory Techniques	H	H	L	H	M	H			H	
Trends in Biotechnology	H	H	H	H	H	H	M	M	M	H
Agriculture Technology (Elective)	H	M	M	H	H	H	H	M	M	M
Nanobiology (Elective)	M	H	M	L	H		M			
Bioresource Management (Elective)	H	M	L	M	L	M	M	H	L	L
Dissertation Phase II	H	H	H	H	H	H	H	H	H	H

BTRM0003: RESEARCH METHODOLOGY AND BIOSTATISTICS (4-0-0)

Course Outcomes

CO 1: Recall and classify the different forms of research – basic, applied, interdisciplinary, etc. Scientific literatures (Remembering)

CO 2: Summarize an understanding of various kinds of research, objectives of doing research, research process, research design and sampling, scientific problems (Understanding)

CO 3: Apply statistical methods of data analysis and interpretation. (Applying)

CO 4: Explain ethical conduct of research and its communication. (Analysing)

CO 5: Recommend adequate knowledge of hypothesis testing procedures, measurement, scaling techniques and quantitative data analysis (Evaluating)

CO 6: Produce a manuscript by conducting research work on original ideas, formulating research synopsis, research report, data analysis and meaningful interpretation of data (Creating)

Module I (15 lectures)

a. Scientific research- Definition, types: basic and applied research, interdisciplinary research, Steps involved in scientific research

b. Scientific literature primary and secondary literature, biological abstract, current content, review, monograph, peer-reviewed journals, e-resources; research and review articles; scientific communication- scientific paper, scientific posters

c. Scientific problems: What is scientific problem? Methods and techniques, research conditions, data types, techniques, repeatability, reproducibility and reliability, validity, effect measure and choice of statistical test, experimental protocol, experimental routine

d. Research design: Meaning, need for research design, features of a good design, Types of research design

Module II (5 lectures)
Brief introduction to ethics, scientific conduct and misconduct-plagiarism, authorship issues, investigation and punishment of scientific misconduct, ethics of animal and human research

Module III (15 lectures)
a. Introduction to Biostatistics: definition and applications of biostatistics;
b. Data-types and presentation: types of biological data, accuracy and significant figures;
c. Population and samples: populations, samples from populations, random sampling, variables and attributes, statistical errors.
d. Frequency distributions
e. Graphical representation of data: line diagram, bar diagram, pie chart, histogram
f. Measures of central tendency: the arithmetic mean, median and mode
g. Measures of dispersion: range, mean deviation, variance, standard deviation, standard error of mean, standard score

Module IV (6 lectures)
a. Permutations and combinations, sets
b. Probability: Introduction, counting possible outcomes, probability of an event, adding and multiplying probabilities
c. Probability distributions: Binomial, Poisson and Normal distribution

Module V (19 lectures)
a. Testing of hypothesis and goodness of fit: Null hypothesis, level of significance, errors of influence, Student's t-test,paired t-test, Fischer's test, Chi-square test, linear correlation and linear regression
b. Analysis of variance: variances of samples and their means, F distribution, partitioning of the total sum of squaresand degrees of freedom, models and types of ANOVA

Suggested Readings

1. Educational Research Planning, conducting and evaluating quantitative and qualitative research, 6th Edition, Creswell JW,2019, PP
2. Research Methodology in the medical and biological sciences, 1st Edition, Laake P, Benestad HB and Olsen BR. 2007,Academic Press, EP.
3. Research Methodology: Methods and technique, 2nd Edition, Kothari CR, 2008, NAIP
4. Research Methodology for Biological sciences. 5th t Edition, 2011, Gurumani N, MJPP
5. Introduction to Biostatistics, 5th Edition, Banerjee PK, 2014, SCCL
6. Biometry: The principles and practices of statistics in biological research, 3rd Edition, Sokal RR and Rohlf FJ, 1995, SFWHF
7. Biostatistical Analysis, 5th Edition, Zar JH, 2010, PPH.
8. Statistical Methods in Biology, 2nd Edition, Bailey NTJ, 1980, HP

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H				M
CO 2	H	M			M
CO 3			H	H	M
CO 4	M	H			H
CO 5			H	H	H
CO 6	L		M	M	M

BTGE0005: GENETIC ENGINEERING (3-0-1)

Course Outcomes
1. To understand the properties and function of different enzymes used in genetic engineering (Understanding)
2. To compare the different types of cloning and expression vector used in genetic engineering and its limitations(Analysing)
3. To understand the concepts regarding different hybridization techniques and applications (Understanding)
4. To acquire theoretical knowledge in the techniques, tools, and application of genetic engineering (Remembering)
5. To develop an ability to design and conduct genetic engineering experiments, as well as to analyse and interpret data (Applying)

Module I (10 lectures)
Restriction nucleases: Exo and Endonucleases: History, Restriction endonuclease nomenclature, classification of restriction endonuclease–typeI, typeII, and typeIII, cleavage patterns– sticky ends, blunt ends, applications; Modifying enzymes–ligases, kinases, RNAse, polymerases, phosphatases and methylases, RNA dependent DNA polymerase, Terminal Deoxynucleotidyl transferase

Module II (13 lectures)
Cloning vectors: Plasmids and plasmid vectors, phagemids, cosmids, artificial chromosome vectors, (YAC, BAC), E. Coli plasmid vectors– pBR322, pUC18, pET21, Bacterio-phage vectors–λ and M13, Cosmids, phagemids and Phasmids, Shuttle vectors-Yeast vectors, Baculo virus vector. Intein-based vectors; Inclusion bodies; Plant based vectors, Ti and Ri as vectors, Yeast vectors, Insertion and Replacement vectors, Expression vectors; Strategies for production of foreign proteins in E.coli, Yeast,animalcell,pMal;GST;pET-basedvectors;Proteinpurification;His-tag;GST-tag;MBP-tag

Module III (12 lectures)
Isolation of genomic and plasmid DNA, DNA cloning; Strategies forc onstruction of genomic and cDNA libraries, chromosome walking; screening of ibraries; Oligonucleotide, cDNA and antibody probes; The Southern, Northern, Western, North-Western, Zoo blots, Southwestern, Farwestern blotting and Colony hybridization, yeast-two hybrid system, c-DNA synthesis and cloning: mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis; Cloning interacting genes two-hybrid systems, cloning differentially expressed genes. Site directed mutagenesis and protein engineering

Module IV (10 lectures)
Maxam and Gilbert method and Sanger's method, Next generation sequencing, Applications of genetic engineering: Transgenic animals and plants, production of recombinant pharmaceuticals, gene therapy, disease diagnosis, Transgenic and gene knockout technologies: Vector engineering, strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing

Suggested Readings
1. Principles of Gene Manipulation and Genomics, 7th Edition, Primrose SB and Twyman R, 2006, Wiley-Blackwell
2. Genomes 4,4th Edition, Brown TA,2017, Garland Science
3. Molecular Cloning: A Laboratory Manual,3rd Edition, Sambrook J and Russell DW, 2001, Cold Spring Harbor Laboratory Press

Mapping of COs to Syllabus

Course outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		
CO 3			H	
CO 4				H
CO 5	M	M	L	

BTBE0007: BIOPROCESS ENGINEERING (3-0-1)

Course Outcomes
1. Outline the principles of fermentation, design and operation of bioreactors for production of biomass and products (Understanding)
2. Compare strategies of bioprocess development for industrial production of bioproducts and specialized applications (Analysing)
3. Relate fermentation and related bioprocess development in food, industry and environment(Understanding)
4. Estimate the contribution and prospect of bioprocess engineering in commercial biotechnology (Evaluating)

Module I (8 lectures)
Introduction to bioprocess engineering; Isolation, preservation and maintenance of industrial microorganisms, strain improvement strategies media formulation for industrial fermentation, air and media sterilization; kinetics of microbial growth, Fermenter/bioreactor- types and classes, Designing of a fermenter/Bioreactor.

Module II (10 lectures)
Kinetics of operation of bioreactors -batch, fed batch and continuous bioreactor; Measurement and control of bioprocess parameters in a bioreactor – heat and mass transfer, aeration and agitation, scale up ans scale down; Biotransformation, Mixed microbial cultures, immobilized cells, Specialized bioreactors (pulsed, fluidized, photo bioreactors); Advanced and non-conventional bioprocesses (animal and plant cell culture, genetic engineering, tissue engineering)

Module III (12 lectures)
Downstream processing: Product recovery and purification, removal of microbial cells and solid matters, precipitation, filtration, centrifugation, cell disruption, extraction and purification-, chromatography, drying and crystallization, ; Industrial production of chemicals using biological aid: alcohols, acids (citric, acetic and gluconic), solvents (glycerol, acetone, butanol), antibiotics (penicillin, streptomycin, tetracycline) amino acids (lysine, glutamic acid), biotransformation of steroids and non-steroid compounds.

Module IV (15 lectures)

Food: Bakery and dairy products, wine, beer and other alcoholic beverages and formulated bio-products, Conventional and molecular breeding of plants for food production; Mushroom production; Single cell proteins; Probiotics; Food spoilage and preservation process
Environment: Techniques of bioremediation of industrial and medical effluent disposal; Phyto- remediation and myco-remediation; Bioremediation of heavy metals, oil spills, dyes and plastics.

Suggested Readings

1. Principles of Fermentation Technology. 2ns Edition, Stanbury PF, Whitaker A, Hall SJ., 1995, Butterwoth Heinemann.
2. Bioprocess Engineering: Basic Concepts. 2nd Edition, Shuler, ML and Kargi, F., 2002, Prentice Hall, PTR.
3. Industrial Microbiology, 1st Edition, Casida LE., 2007, John Wiley and Sons.
4. Microbial Biotechnology, 2nd Edition, Glazer AN and Nikaldo H., 2007, WH Freeman & Co.
5. Prescott and Dunn's Industrial Microbiology. 4th Edition, Reed, G., 2004, CBS Publishers, New Delhi

Mapping of COs to Syllabus

Course outcomes	Module I	Module II	Module III	Module IV
CO 1	H	H	M	
CO 2	M	H	H	
CO 3	M	M	H	H
CO 4	H	H	H	H

BTTE0009: THERMODYNAMICS AND ENZYMOLOGY (3-0-1)

Course Outcomes

1. To relate the entropy to law of thermodynamics and Free energy and its relation to chemical equilibria (Evaluating)
2. To understand the fundamentals of enzyme structure, properties and function (Understanding)
3. To compare the different types of methods for protein purification (Analysing)
5. To understand the rate of reactions and order of reactions, and inhibitions and their kinetics (Understanding)
6. To describe the structure, functions and the mechanism of different enzymes (Evaluating)
7. To understand the application of enzymes (Understanding)

Module I (5 lectures)

Laws of thermodynamics, reversible and irreversible processes, entropy, enthalpy, internal energy, free energy and equilibrium constant, Gibbs free energy equation, determination of free energy change of under standard and non-standard conditions, high energy compounds, coupled reactions, determination of feasibility of reactions.

Module II (5 lectures)

Classification, nomenclature and general properties like effects of pH, substrate and temperature on enzyme catalyzed reactions. Isolation and purification of enzymes, Salting out of protiens, Isoelectric point, Electrophoresis of protein.

Module III (7 lectures)

Kinetics of enzyme catalyzed reaction: Single substrate reactions, bi-substrate reactions, concept of Michaelis-Menten, Determination and significance of kinetic constants, Limitations of Michaelis-Menten Kinetics, Briggs Haldane relationship

Module IV (10 lectures)

Activation energy and Arrhenius concept, Binding energy, Enzyme catalysis: enzyme specificity and the concept of active site, determination of active site. Stereospecificity of enzymes, Mechanism of catalysis: Proximity and orientation effects, general acid-base catalysis, concerted acid – base catalysis, nucleophilic and electrophilic attacks, catalysis by distortion, metal ion catalysis. Theories on mechanism of catalysis, Inhibition of enzyme activity: Competitive-cite: succinate on Malonate dehydrogenase as example, non-competitive -cite: Iodoacetamide on triose phosphate dehydrogenase and EDTA as example: Suicide inactivation-action of penicillin on bacterial cell wall biosynthesis as an example.

Module V (9 lectures)

Mechanism of enzymes action: mechanism of action of lysozyme, chymotrypsin, carboxypeptidase and DNA polymerase. Multienzymes system, Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complex. Coenzyme action.

Module VI (9 lectures)

Enzyme regulation: Allosteric enzymes, Feedback Regulation, Sigmoidal kinetics and their physiological significance, Symmetric and sequential modes for action of Allosteric enzymes. Reversible and irreversible covalent modification of enzymes, cascade systems, Immobilised enzymes and their industrial applications, Ribozyme (catalytic RNA) and Abzyme (use of antibody as enzyme) - definition only.

Suggested Readings

1. Lehninger Principles of Biochemistry, 6th Edition, Nelson DL and Cox MM,2013, W. H. Freeman
2. Physical Chemistry, Rakshit P C,2014, Sarat Book House
3. Biochemistry (Biochemistry (Berg)), 6th Edition, Berg JM,Tymoczko JL and Stryer L ,2006, W. H. Freeman
4. Fundamentals of Biochemistry: Life at the Molecular Level,4th Edition, Voet D,2012, John Wiley & Sons Inc
5. Textbook of Biochemistry with Clinical Correlations, 7th Edition, Devlin TM,2010, Wiley-Liss

Mapping of COs to Syllabus

Course outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H					
CO 2	M	H				
CO 3		H				
CO 4			H	H		
CO 5					H	H
CO6						M

BTCA0010: COMPUTER APPLICATIONS AND BIOINFORMATICS (3-0-2)

Course Outcomes

1. To recall the basics of operation of computer and its related softwares, languages (Remembering)
2. To utilize concepts of C- programming language for preparing application based programs.(Applying)
3. To demonstrate the working principle of the World Wide Web and the internet protocols involved (Understanding)
4. To inspect the role of the biological resources in sequence alignment, methods of gene prediction, phylo-genetic tree construction and other tools (analysing)
5. To perceive the importance of methodologies involved in protein structure prediction, structure analysis tools and drug designing (evaluating)

Module I (10 lectures)

Basic computer organization, Processor and memory, secondary storage devices, Input-Output devices, Computer software, Computer language; Basic Ideas in Programming in C: Variables, data types, Constants, Keywords, Input/output, Control Statements, Functions, Structures; Operating system–Basic commands in Linux.

Module II (5 lectures)

Introduction to Spreadsheet, presentation software, document and word processing. WorldWideWeb, Client-server organization; Internet Protocols-FTP, HTTP, Telnet; Search engines- search concepts

Module III (12 lectures)

Concept of databases: Biological Databases-Primary, secondary, composite databases; Databases for Literature, Sequence and structure; Searching and their retrieval. DNA and Protein sequence alignments- Pairwise alignment, dot plot, global and local alignment algorithms-Needleman and Wunsch algorithm, Smith-Waterman algorithm; Multiple sequence alignment – progressivealignment and alterative alignment algorithms; PAM and Blosum scoring matrices; Multiple sequence alignment-based database searching– PSI-Blast

Module IV (9 lectures)

Gene prediction approaches in prokaryotic and eukaryotic genomes, Methods of gene prediction, Introduction to gene prediction tools, Regulatory sequence analysis, Oligo design and analysis tool. Bioinformatics for phylogenetic analysis. Character based and distance based phylogenetics tree, interpretation of phylogenetic tree, Construction of phylogenetic tree from distance matrix Human genome project; concept of microarray and principles of microarray data analysis

Module V (9 lectures)

Structural biology and Protein structure prediction, Methods of protein structure prediction: Homology modeling, Threading and Ab initio methods, Molecular visualization tools- Rasmol, Pymol and Swiss pdb viewer. Structure analysis tools -VAST and DALI. Stages of Drug development , Definition of drug, target and its properties Steps in Drug Designing, Lead identification, Types of drug designing, ADME along with concept of Lipinski rule of five and drug likeliness, Molecular docking, QSAR

Suggested Readings

1. Bioinformatics: Sequence and Genome analysis, Mount D, Cold Spring Harbor Laboratory Press.
2. Essential Bioinformatics. Xiong J, Cambridge University Press
3. Introduction to Bioinformatics, Attwood TK and Parry-Smith DJ, Pearson Education
4. C- Programming made easy. Rajaram R. Universities Press.
5. Bioinformatics Principles and Applications, Ghosh Z and Mallick B. Oxford University Press
6. Bioinformatics-Students Companion. Kalbulla Syed Abrahin, Guruswami Gurusubrmanian, Zothansanga, Ravi Prakash

Yadav, Nachimuthu Senthil Kumar, Shunmugiah karutha Pandian, Probodh Borah, Surendra Mohan, Springer

Mapping of COs to Syllabus

Course outcomes	Module I	Module II	Module III	Module IV	Module V
CO1	H	M			
CO2	H	M			
CO3	M	H			
CO4			H	H	M
CO5			M	M	H

BTPB0011: PLANT BIOTECHNOLOGY (3-0-2)

Course Outcome

1. To inspect the relevance of plant tissue culture and their application in *in vitro* propagation of indigenous as well genetically manipulated plants (Analysing)
2. To perceive the techniques of gene transfer by biological and non- biological methods in developing transgenic plants (Evaluating)
3. To examine the role of transgenic plants in developing plants carrying desirable traits and its related advanced techniques (Analysing)

Module I (15 lectures)

Definition, brief history, principle and significance of tissue culture; Cellular totipotency: Cytodifferentiation: Organogenic Differentiation: induction, factors affecting shoot bud differentiation; Cell suspension Culture, Callus Culture, Embryo Culture, Haploid Culture: microspore and macrospore culture. Triploid culture: Endosperm Culture, Protoplast: isolation, Culture and Fusion; Somatic hybridization and cybridization; Somatic Embryogenesis and Synthetic Seed Production; Androgenesis and its applications in genetics and plant breeding; Germplasm conservation and c ryopreservation.

Module II (15 lectures)

Introduction to transgenic plants, methods of gene transfer – Agrobacterium tumefaciens mediated, Agrobacterium rhizogenes mediated; Direct gene transfer methods – Chemical, Physical and alternative methods. Selectable markers, reporter gene and promoter in plant vectors

Module III (15 lectures)

Transgenic plants, characterization of transgenics; chloroplast transformation; marker-free methodologies; advanced methodologies- cisgenesis, intragenesis and genome editing .Strategies for Introducing genes of biotic and abiotic stress resistance in plants (Herbicide resistance; drought, Salinity, thermal stress, flooding and submergence tolerance, insect resistance, virus resistance) longer shelf life (including strategies for suppression of endogenous genes), male sterility, enhanced nutrition (golden rice), edible vaccines molecular pharming - concept of plants as biofactories, production for industrial enzymes and pharmaceutically important compounds.

Suggested Readings

1. Plant tissue and Organ culture fundamental methods. Gamburg OL, Philips GC., Narosa publications
2. Text book of BiotechnologySingh BD., Kalyani publishers

Mapping of COs to Syllabus

Course outcomes	Module I	Module II	Module III
CO I	H		
CO 2		H	M
CO 3	M	M	H

BTAB0012: ANIMAL BIOTECHNOLOGY (3-0-1)

Course Outcomes

1. Have a basic understanding on different types of media composition, different cell culture and its characteristics (Understanding)
2. Applications of various techniques involved in improvement of animal (Applying)
3. Application of Genetic engineering methods for production of important compounds and treating diseases (Applying)

Module I (10 lectures)

General considerations of cell culture: Aseptic condition, Media, Balanced salt solution, Carbon dioxide incubator, feeder layer, serum, growth factors; Types of culture media (defined and undefined media), culture media composition; role of different media. Types of cell culture –organ, Organotypic, single cell, Histotypic/3D, primary cells, cell lines, adherent, suspension cell cultures, stem cell culture, embryonic stem cell culture; Characteristics of cells in culture; measurement of cell viability, apoptosis, senescence; Scaling up of animal cell culture.

Module II (8 lectures)
Embryology: Collection and preservation of embryos; culturing of embryos; micromanipulation technology and fertilization in animals; Equipment used in micromanipulation; Sperm sorting; Enrichment of semen for x (female) or y (male) sperm; Biotechnology Techniques in Animal Breeding: Artificial Insemination, In Vitro Fertilization and embryo transfer.

Module III (12 lectures)
Transgenic animal: methods of production and application; transgenic animals as models for human diseases; transgenic animals in livestock improvement; industry, biomedicine chimera mice production; Gene knockouts, production of human antibodies in animals; gene therapy for animal diseases; Animal cloning and ethical issues.

Suggested Readings
1. Animal Biotechnology, 2nd Edition, Ranga MM,2018, Agrobios India Limited
2. Culture of Animal Cells: A Manual of Basic Technique, 5th Edition, Freshney IR, 2005, Wiley
3. Plant tissue and Organ culture fundamental methods, Gamburg OL, Philips GC, 2005, Narosa publications
4. Text book of Biotechnology,5th Edition, Singh BD, 2016, Kalyani publishers

Mapping of COs to Syllabus

Course outcomes	Module I	Module II	Module III
CO 1	H		
CO 2		H	M
CO 3			H

BTFF0013: FERMENTATION AND FOOD MICROBIOLOGY (1-0-0)

Course Outcomes
1. Demonstrate the understanding of the principles of fermentation and food microbiology in skill development (Understanding)
2. Construct experimental platforms with fermentation systems to learn the making of commercial food products (Applying)
3. Analyze experimental data interpret results to arrive at credible conclusions (Analysing)

Module I (2 lectures)
Production of wine from fruit juice (Monitoring of sugar reduction during wine production; Estimation of alcohol concentration in wine)

Module II (2 lectures)
Production of traditional rice beer of ethnic communities of NE region (microbial isolation; growth monitoring, alcohol concentration)

Module III (1 lecture)
Estimation of vicinal diketone in beer

Module IV (1 lecture)
Microbial production of curd (assay milk quality by MBRT test; Isolation and identification of *Lactobacillus* from fermented dairy products; lactic acid estimation

Module V (2 lectures)
Making of bread and other bakery products by fermentation

Module VI (1 lecture)
Pickled products: Making of traditional pickles of India (NE region); production of Sauerkraut; fermented fish and other products

Module VII (2 lectures)
Fermentation in flavour and fragrance (tea processing; essential oil)

Module VIII (2 lectures)
Microbial enzyme production *via* liquid and solid-state fermentation

Module IX (1 lecture)
Sterility testing in food products (microbial examination of food)

Suggested Readings

1. Principles of Fermentation Technology. 2nd Edition, Stanbury PF, Whitaker A, Hall SJ. 1995, Butterwoth Heinemann
2. Industrial Microbiology, 1st Edition, Casida LE., 2007, John Wiley and Sons.
3. Prescott and Dunn's Industrial Microbiology. 4th Edition, Reed, G. 2004, CBS Publishers, New Delhi

Mapping of COs to Syllabus

Course outcomes	Module1	Module2	Module3	Module4	Module5	Module6	Module7	Module VIII	Module9
CO 1	H	H	H	H	H	H	H	H	H
CO 2	H	H		H	H	H	H		H
CO 3	H	H	H	H	H	H	H	H	H

BTIE0014: IPR AND ENTREPRENEURSHIP (1-0-0)

Course Outcomes

1. Interpret different IPR, laws governing IPR and their management in biosciences (Understanding)
2. Relate the fundamentals of business and entrepreneurship to biosciences (Understanding)
3. Apply the understanding of IPR and entrepreneurship in innovation management and start-up (Applying)

Module I (9 lectures)

Concept of Intellectual Property; Introduction to intellectual property rights and its types: patents, trademarks, copyright and related rights, industrial design, geographical indications, Protection of new varieties of plants and plant breeder's rights; World Intellectual Property Organization (WIPO) and its role, PCT; Indian Patent Act 1970 Rules and amendments thereof; Drafting and filing patent applications; management and practical use of IP rights, including licensing, enforcement and ethics.

Module II (6 lectures)

Entrepreneurship essentials: opportunities, ideas and Innovation; feasibility and market research; business plan; Building a business: business models, teams, pitching and investment, finance; Start-up ecosystem; Technology and bio-entrepreneurship – case studies.

Suggested Readings

1. Biotechnology and Intellectual Property Rights: Legal and Social Implications, 1st Edition, Singh, KK., 2015, Springer, India.
2. IPR, Biosafety and Bioethics, 1st Edition, Goel D, Parashar S, 2013, Pearson Publishers.
3. Fundamentals of Entrepreneurship. 3rd Edition, Nandan H, 2007, Phi Learning, New Delhi,.
4. Entrepreneurship and Small Business Management, 2nd Edition, Mariotti S and Glackin C, 2016, Pearson Publishers.

Mapping of COs to Syllabus

Course outcomes	Module I	Module II
CO 1	H	
CO 2		H
CO 3	M	M

BTPE0015: PHARMACEUTICAL & ENVIRONMENTAL BIOTECHNOLOGY (3-0-0)

Course Outcomes

1. Choose suitable methods to distinguish the sources, types and composition of waste with methods of handling and sampling strategies (Remembering)
2. Demonstrate the concepts of environment, regulation of population and associated factors (Understanding)
3. Explain the basic concepts of pharmacology used in drug formulation (Understanding)
4. Inspect the working structure of pharmaceutical industries and role of regulatory bodies (Analysing)
5. Plan the management of the environmental pollution load with respect to its physical properties and associated critical considerations in view of emerging technologies (Applying)
6. Appraise the various steps involved in clinical trials and various approaches for toxicity studies (Evaluating)
7. Interpret and infer the relationships among the different constituents of the environment (Analysing)

Module I (9 lectures)

Pharmacology – history, nature and source of drug, classification of drugs, Dosage forms, Routes of drug administration, site of action of drug, Factors modifying drug action. Concept of Pharmacodynamics, Mechanism of action of drug, drug Interaction, adverse drug reaction, Pharmacogenetics, Principles of pharmacokinetic, models of pharmacokinetics, Transmembrane transport of drug, Drug absorption pathway, Bio-availability of drug, Drug metabolizing enzyme, Excretion of drug. Biological half-life of the drug, Bioassay and therapeutic drug monitoring

Module II (7 lectures)
Hit to lead optimization by Preclinal studies and clinical trials, Approaches to screen lead molecules, source of lead molecules, Clinical trials- Ethical considerations, regulatory requirements of clinical trials and phases of clinical trials. Preclinical Toxicology- Acute, subacute and chronic toxicity, Anima tests, prodrug, Formulation and drug delivery systems.

Module III (7 lectures)
Regulatory Authorities and regulatory application- Overview, policies and Procedure. Role of various regulatory organization- USFDA, WHO, CSDA. ICMR guidelines for drug discovery. Drug and Cosmetic Act, India.Good manufacturing Practices, Structure of Pharmaceutical Industry, Manufacturing small molecule APIs and large molecule APIs, Pharmacogenomics -the scope of personalized medicine

Module IV (10 lectures)
Basic concepts of environment viz. atmosphere, hydrosphere, lithosphere; biotic environment; biotic and abiotic interactions; energy flow and nutrient cycling (C,N,P); Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement; Population-environment relationship modules *viz*. Characteristics of a population; Survivorship graph curves; population dynamics; population density curves; population regulation strategies (r and K selection); meta population; age structured population.

Module V Environmental monitoring and pollution treatment (12 lectures)
Pollution types and monitoring approaches: Environmental pollution; sources (air, water, soil); pollutants and its types; standard criteria of pollution monitoring; biotechnological approaches of environmental monitoring viz. plant based, animal based, cell biology based, molecular biology-based approaches; pollution management.
Pollution treatment methodologies: sewage/waste water treatment; primary, secondary and tertiary methods of treatment; sources and characteristics of solid waste; Solid waste stabilization (aerobic and anaerobic treatment); Bioremediation strategies (in-situ and ex situ bioremediation); role of microorganisms in bioremediation; Significance of genetic engineering in degradation of toxic compounds

Suggested Readings
1. Microbial Ecology, 2nd edition, Campbell, R., 1983, Blackwell.
2. Microorganisms Function, Form and Environment, 2nd Edition, Hawker, L. E. and Linton, A. H., 1989, Edward Arnold.
3. Environmental Microbiology, 2nd edition, Mitchell, R., 1992, John Wiley & Sons.
4. Rang & Dale's Pharmacology 9th Edition James Ritter Rod Flower Graeme Henderson Yoon Kong Loke David MacEwan Humphrey Rang. Elsevier Publishing, 2019
5. Essentials of Medical Pharmacology, 8th Edition, KD Triparthi. Jaypee Brothers Medical Publisher
6. Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs. 2nd Edition, Rodney J Y Ho., Wiley Publishers, 2013

Mapping of COs to Syllabus

Course outcomes	Module I	Module II	Module III	Module IV	Module V
CO1				H	M
CO2				H	H
CO3	H	M	M		
CO4	M	M	H		
CO5				M	H
CO6		H	L		
CO7				H	H

BTTB0016: TRENDS IN BIOTECHNOLOGY (4-0-0)

Course Outcomes
1. Recall the fundamentals of biotechnology, biochemistry, molecular biology to better comprehend the recent topics in biotechnology (Remembering)
2. Relate with developments in Omic, particularly Genomics, Transcriptomics, Proteomics, Metabolomics and other emerging fields of study (Understanding)
3. Assess the global and Indian scenario of innovation and commercial biotechnology and their impact on human life and environment (Evaluating)
4. Examine the new and emerging frontiers in biotechnology at an interdisciplinary level (Analysing)

Module I (30 lectures)
Genomics: Genome sequencing, History of sequencing, Next Generation Sequencing (NGS), whole genome sequencing, model organisms, genome projects, microarrays; epigenomics, pharmacogenomics, comparative genomics, metagenomics, and their

applications
Transcriptomics ESTs, SAGE, NGS(RNASeq); metatranscriptomics, alternative splicing, non- coding RNA
Proteomics: 2D PAGE, X-ray crystallography, Mass spectrometry including MALDI-TOF, protein microarrays, recent developments in secretomics, interactomics; applications of proteomics in drug discovery
Metabolomics: Metabolome diversity; Metabolite profiling; High throughput analytical techniques for metabolome analysis (GC-MS, LC-MS, NMR), applications
Other emerging Omics – Lipidpomics, Glycomics, Phenomics, etc.
Bioinformatics and statistical analysis in Omics (PCA, HCA, PLSDA, Heatmap and other tools of analysis and data representation)

Module II (10 lectures)
Genome editing, synthetic biology, molecular evolution, nanobiotechnology and advanced biomaterials, structural and computational biology, gene ontology, systems biology

Module III (10 lectures)
Global and Indian biotech sector, Segments of biotech market, Bioprospecting in biotechnology, ethical concerns; Commercial production of industrial bio-molecules; bio-products from both natural and synthetic source and their commercialization, vaccines and therapeutics, diagnostics; commercial plant tissue culture including automation, strategies for environment cleanup and their commercialization.

Module IV (10 lectures)
New colors of biotechnology: Blue (aquatic and marine life); Yellow (food and nutrition), White (gene-based bio-industry) Gold (bioinformatics and nanobiotechnology), Brown (extreme environments), Violet (bioethics and laws) Purple (Inventions and IPR), Dark (bio-terrorism, bio-weapons)

Suggested Readings
1. Principles of Gene Manipulation and Genomics, 7th Edition, Primrose, S.B. and Twyman, R., 2006, Wiley – Blackwell Publishers.
2. Genome, Trascriptome and Proteome Analysis. 1st Edition, 2001, Bernot, A., John Wiley & Sons Ltd.
3. Omics: Biomedical Perspectives and Applications. 1st Edition, Barh, D, Blum, K and Madigan, MA, 2012, Taylor & Francis Group.
4. Industrial Biotechnology: Products and Processes, 1st Edition, Wittman, C and Liao, JC, 2016, Wiley Publishers

Mapping of COs to Syllabus

Course outcomes	Module I	Module II	Module III	Module IV
CO 1	H	H	H	H
CO 2	H	M		
CO 3	M		H	
CO 4		H		H

BTAT0017: AGRICULTURE TECHNOLOGY (2-0-0)

Course Outcomes
1. Relate with agriculture as a multidisciplinary field of scientific study (Understanding)
2. Analyze the concepts of farming and agricultural technology and their impact on agriculture. (Analysing)
3. Apply principles of agriculture in farm and agribusiness management (Applying)

Module I (9 lectures)
Scope of agriculture and agro-economy of India, History of Indian agriculture, Green Revolution, Food security, Agencies involved in agricultural development (India and Global)
Introduction to disciplines of agricultural sciences: Agronomy, Horticulture, Plant Breeding and Genetics, Agricultural Biotechnology, Biochemistry and Microbiology, Physiology, Plant Pathology, Entomology, Soil Science, Water technology, Agricultural extension, Agricultural engineering, Agricultural economics and statistics, Meteorology, Seed technology, Plantation crops, Animal husbandry and Fishery

Module II (14 lectures)
Nature of soil, Soil chemistry, biology and biochemistry, Soil fertility and nutrient management, Soil analysis techniques, bio-fertiliser, organic farming, soil conservation
Principles of irrigation and water management, Water analysis techniques, Water stress, Dryland agriculture and watershed management; Flood stress, Salinity stress
Nutrition, Food testing, Crop varietal improvement, Crop breeding techniques, Seed technology, Crop production and protection techniques including biotech, post-harvest management, Farm machinery and equipment; Innovation in agriculture

Module III (7 lectures)

Farm management principles, integrated farming systems, agricultural market, agro-based industry, agribusiness and local farm economy, Government schemes, Credit, Crop insurance, Soil health cards.

Suggested Readings

1. Handbook of Agriculture, 6th Edition, ICAR, 2016, Indian Council of Agriculture and Research, New Delhi.
2. Fundamentals of Agriculture, 1st Edition, Singh KP, 2014, Kalyani Publishers, New Delhi.
3. Agricultural Microbiology, 2nd Edition, Rangaswami, G., Bagyaraj, D.J. 2005, Prentice Hall India Learning Private Limited, NewDelhi.
4. Textbook of Agricultural Biotechnology, 1st Edition, Nag, A., 2008, Prentice Hall India Learning Private Limited, New Delhi.

Mapping of COs to Syllabus

Course outcomes	Module I	Module II	Module III
CO 1	H	H	H
CO 2	H	H	
CO 3		M	H

LABORATORY COURSES

BTAP6003: ANIMAL BIOTECHNOLOGY LAB

Course Outcomes
1. To understand the principle of the techniques (Understanding)
2. To prepare culture media and cell cultures (Analysis)
3. Analysis of the data (Analysis)
4. To develop research aptitude (Applying)
5. To develop writing skill (Applying)
6. To develop technical skills (Applying)

List of Experiments
1. Isolation of lymphocytes
2. Cell viability by using tryphan blue.
3. Isolation of genomic DNA from animal cells
4. Preparation of animal cell culture media and Filter sterilization
5. Preparation of single cell suspension from spleen/liver/thymus
6. Quantitation of animals cells using hemocytometer

Suggested Readings
1. John R W Masters Animal Cell Culture: A Practical Approach, Fifth Ediction
2. Hirenkumar Sherathiya (Author), 2012, Practical manual for Plant Tissue Culture, Munich, GRIN Verlag,

Mapping of COs to Syllabus

Course outcomes	P1	P2	P3	P4	P5	P6
CO 1	H	H	H	H	H	H
CO 2				H		
CO 3	L	H	M			H
CO 4	L	L	L	L	L	L
CO 5	L	L	L	L	L	L
CO 6	H	M	H	H	H	H

***P: Practical**

BTGE6004: GENETIC ENGINEERING LAB

Course Outcomes
1. To understand the different types of techniques used in genetic engineering experiments(Understanding)
2. To develop technical skills (Applying)
3. To interpret experimental datas (Evaluating)
4. To develop research aptitude (Applying)
5. To develop writing skill (Applying)

List of Experiments
1. Transformation
2. Cloning in plasmid/ Phagemid vectors
3. Gene expression in *E. coli* and analysis of gene product
4. Silver staining of gels (protein)
5. RFLP (Restriction fragment length polymorphisms)
6. RAPD (Random Amplification of Polymorphic DNA)

Suggested Readings
Molecular Cloning: A Laboratory Manual,3rd Edition, Sambrook J and Russell DW, 2001, Cold Spring Harbor LaboratoryPress

Mapping of COs to Syllabus

Course outcomes	P1	P2	P3	P4	P5	P6
CO 1	H	H	H	H	H	H
CO 2	H	H	H	H	H	H
CO 3	M	M	H	M	H	H
CO 4	M	M	M	M	M	M

CO 5	L	L	L	L	L	L

***P: Practical**

BTBE6006: BIOPROCESS ENGINEERING LAB

Course Outcomes
1. Recall the theoretical topics in bioprocess engineering (Remembering)
2. Experiment with fermentation systems for estimation of biomass and product formation (Applying)
3. Analysing data from the scientific experiments and interpret results (Analysing)

Syllabus
1. Parts and design of fermenter
2. Media for Industrial Fermentation
3. Isolation, preservation and maintenance of industrial microorganisms
4. Solid state fermentation
5. Submerged fermentation
6. Production and estimation of protease
7. Production and estimation of amylase
8. Growth kinetics for batch culture
9. Production and quantification of alcohol using yeast
10. Lactic acid fermentation process

Suggested Readings
1. Principles of Fermentation Technology. 2ns Edition, Stanbury PF, Whitaker A, Hall SJ., 1995, Butterwoth Heinemann.
2. Bioprocess Engineering: Basic Concepts. 2nd Edition, Shuler, ML and Kargi, F., 2002, Prentice Hall, PTR.
3. Industrial Microbiology, 1st Edition, Casida LE., 2007, John Wiley and Sons.
4. Microbial Biotechnology, 2nd Edition, Glazer AN and Nikaldo H., 2007, WH Freeman & Co.
5. Prescott and Dunn's Industrial Microbiology. 4th Edition, Reed, G., 2004, CBS Publishers, New Delhi

Mapping of COs to Syllabus

Course outcomes	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
CO 1	H	H	H	H	H	H	H	H	H	H
CO 2			H	H	H	H	H	H	H	H
CO 3				M	M	H	H	H	H	H

***P: Practical**

BTDI6007: DISSERTATION PHASE I (0-0-2)

Course Outcomes
1. Develop a scientific mindset with the capacity for analytical and innovative thinking (Creating).
2. Develop writing skill, referencing and citations for effective communication (Applying).
3. Improve communication and creative expression skills to articulate scientific ideas (Creating).
4. Examine the research gap in the related field and formulate strategies to address the same (Analysing).

Syllabus
1. Familiarization with research topic and methodologies by a thorough literature review.
2. Writing of review of literature to brush up already existing knowledge on a given area.
3. Formulate a research hypothesis and a proposed workplan.
4. Presentation of the research topic at department level and submission of literature review.

Suggested Readings
Scientific review and research articles published in respective specialized area of research.

Mapping of Course outcomes to Syllabus

Course outcomes	P1	P2	P3	P4
CO 1	H	H		
CO 2		H	H	
CO 3		H	H	H
CO 4	L	M	L	H

***P: Practical**

BTDI6008: DISSERTATION PHASE II (0-0-16)

Course Outcomes

1. Support the research hypothesis with experiments executed ethically (Evaluating).
2. Develop skill to independently carry out a research in the laboratory (Creating).
3. Examine the methodology, analyse results, and defend the research work (Analysing).

Syllabus

1. Execute a scientific dissertation based on the proposed plan in Phase 1 through bench work.
2. Present and report data at various stages of the research work to the assigned supervisor.
3. Analysing the results, correlating it with different experiment performed during the dissertation.
4. Present the findings in a department level to internal and external examiners, and submission of completed thesis.

Suggested Readings

Scientific review and research articles published in respective specialized area of research.

Mapping of COs to Syllabus

Course outcomes	P1	P2	P3	P4
CO 1	H	L	M	
CO 2	H	M	H	L
CO 3		H	H	H

***P: Practical**

BTTE6009: THERMODYNAMICS AND ENZYMOLOGY LAB

Course Outcomes

1. To understand the principle of the experiments on enzyme activity (Understanding)
2. To conduct an experiment on enzyme activity (Applying)
3. To analyse the effect of different physicochemical condition on enzyme activity (Analysing)
4. To interpret experimental datas (Evaluating)
5. To develop research aptitude (Applying)
6. To develop writing skill (Applying)

Syllabus

1. Effect of pH on amylase enzyme activity
2. Effect of temperature on amylase enzyme activity
3. Determination of Km and V_{max} of salivary amylase enzyme
4. Assessment of inhibitor on enzyme activity.
5. Assessment of activatoron enzyme activity.

Suggested Readings

1. Introductory Practical Biochemistry, Sawhney SK and Singh R, 2001, Narosa Publishing
2. An Introduction to Practical Biochemistry,3rd Edition, Plummer D, 2017, McGraw Hill Education

Mapping of COs to Syllabus

Course outcomes	P 1	P 2	P 3	P 4	P 5
CO 1	H	H	H	H	H
CO 2	H	H	H	H	H
CO 3	H	H	H	M	M
CO 4	H	H	H	H	H
CO 5	M	M	M	M	M
CO 6	L	L	L	L	L

***P: Practical**

BTCA6010: COMPUTER APPLICATIONS AND BIOINFORMATICS LAB

Course Outcomes

1. To construct various application program by using the concepts of C programming (Applying)
2. To demonstrate the usage of basic commands for operation in LINUX systems (Understanding)
3. To execute sequence alignment, primer designing, gene prediction phylogenetic tree construction by utilizing thevarious

biological database and tools (Evaluating)
4. To build the 3D protein structures by homology modeling methods, visualize it to subject to molecular docking experiments (Creating)

Syllabus
1. Programs of C language
2. Introduction to basic commands used in LINUX operating systems
3. Introduction to various databases available, their usage in sequence searching, retrieval available in databases
4. Sequence alignment
5. Introduction to Gene prediction tools
6. Primer designing and analysis
7. Phylogenetic Analysis based on sequence alignment data and RAPD/ protein profile data
8. Visualization of structures of protein, ligands in databases and their molecular docking
9. Homology modeling

Suggested Readings
Bioinformatics. A Practical Approach. Shui Qing Ye, Chapman and Hall/CRC

Mapping of COs to Syllabus

Course outcomes	P1	P2	P 3	P 4	P5	P 6	P 7	P 8	P 9
CO1	H								
CO2		H							
CO3			M	H	H	H	H		
CO4			M					H	H

***P: Practical**

BTIV6011: INDUSTRIAL/LABORATORY VISIT

BTBP6011: PLANT BIOTECHNOLOGY LAB

Course Outcome
1. To design the composition of plant media and solution (Creating)
2. To develop various techniques of plant tissue culture. (Applying)
3. To determine the application of the various techniques used in plant tissue culture (Analysing)

Syllabus
1. Preparation of Plant tissue culture media and Stock solutions
2. Callus induction, Shoot/ Root induction – organogenesis
3. Cell suspension culture
4. Haploid production – Anther and ovule culture
5. Artificial seed production
6. Protoplast fusion by PEG

Suggested Readings
Hiren Kumar Sherathiya Practical manual for Plant Tissue Culture, Munich, GRIN Verlag.

Mapping of COs to Syllabus

Course outcomes	P1	P2	P3	P4	P5	P6
CO 1	H	M	M	M	M	M
CO 2	M	H	H	H		
CO 3					H	H

***P: Practical**

BTPE6012: PHARMACEUTICAL & ENVIRONMENTAL BIOTECHNOLOGY LAB

Course Outcomes
1. Experiment with handling animals and the routes of injections (Applying).
2. Determine the techniques of evaluation of sterility of pharmaceutical products(Evaluating)
3. Design experiments for testing cyto-toxicity of pharmaceutical products (Creating)
4. Test for the physical properties of wastewater and solid waste (Analysing)
5. Design protocol to estimate the level of pollution in water and solid (Creating)

6. Determine an appropriate method for waste management (Evaluating).

Syllabus

- Demonstration of method of injecting drugs by various routes.
- Sterility testing methods for pharmaceutical products
- Assessment of cyto-toxicity of drug by mitotic index
- Assay of vitaminB_{12} in commercially available capsules/tablets.
- Determination of pH and conductivity of wastewater.
- Determination of pH and conductivity of solid waste.
- Determination of BOD of wastewater samples.
- Determination of COD of wastewater samples.

Suggested Readings

1. Chandrakant Kokare. Pharmaceutical Biotechnology Experiments and Techniques, Nirali Prakashan, Fifth Edition
2. Microorganisms Function, Form and Environment, 2nd Edition, Hawker, L. E. and Linton, A. H., 1989, Edward Arnold.
3. Environmental Microbiology, 2nd edition, Mitchell, R., 1992, John Wiley & Sons.

Mapping of COs to Syllabus

Course outcomes	P1	P2	P3	P4	P5	P6	P7	P8
CO1	H							
CO2		H	M					
CO3		M	H	M				
CO4					H	H		
CO5							H	H
CO6					M	H	M	M

***P: Practical**

BTCL6014: CLINICAL LABORATORY TECHNIQUES (0-0-1)

Course Outcome

1. Perform the experiments necessary for careers in research and diagnostic laboratories. (Applying)
2. Detect Inflammation which could help them in diagnoses of underlying health condition (Analyzing)
3. These diagnostic tests will help learner to analyze the presence of pathogenic agents and guide them for further screening (Analyzing)
4. Analyze and correlate hemoglobin with different health conditions and can guide the patient for further diagnostic test (Analyzing)
5. Developing methods of identification of clinically important microorganisms and study response to antibiotics (Applying).

Syllabus

1. Good Laboratory practices
2. Determination of blood groups (A, B, O and Rh system)
3. Determination of total erythrocyte count, total leucocyte count and determination of platelet count
4. Estimation of sugar by DNS Assay
5. CRP estimation in blood
6. Antigen and antibody detection ELISA
7. Haemoglobin estimation in blood
8. Preparation of microbiological media
9. Isolation of microorganisms from a clinical sample.
10. Staining techniques and microscopic examination of microbial cells.
11. Antibiotic susceptibility testing

Suggested Readings

1. Laboratory Manual for Practical Biochemistry, 2nd Edition, Ganesh MK, Shivaraja SYM, 2013, JB
2. Textbook of Practical Physiology, 5th Edition, Pal GK, Pal P, 2001, UP
3. Practical Microbiology, Maheshwari DK, 3rd Edition, 2002, SCP

Mapping of COs to syllabus

Course outcomes	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
CO 1	H	H	H	H							
CO 2					H						
CO 3						H					

CO 4							H				
CO 5								H	H	H	H

***P: Practical**

BTBB6015: BASIC BIOINFORMATICS (0-0-1)

Course Outcome

1. To recognize the importance of various types of biological databases (Remembering)
2. To apply the bioinformatics tools for performing the different types of sequence alignments (applying)
3. To construct the phylogenetic tree by using various strategies (Creating)

Module I

Definition of Bioinformatics and introduction to Biological databases, classification, Concept of nucleotide sequence, protein sequence and sequence alignments, types

Module II

Features of Phylogenetic tree, types of trees, interpretation of tree.

Module III

Nucleic acid databases, Protein databases, Small molecules/ Ligand databases and literature databases, Searching of sequences and retrieval of sequences, Pairwise sequence alignment and multiple sequence alignment using BLAST, Introduction to MEGA sequence alignment tool

Module IV

Sequence based phylogenetic tree construction using BLAST, Phylogenetic tree construction from chromatogram of sequencing results using MEGA & BIOEDIT tool and tree construction from RFLP profile and protein profile using DendroUPGMA

Suggested Readings

1. Introduction to Bioinformatics, Attwood T K and Parry-Smith DJ, Pearson Education.
2. Bioinformatics-Students Companion. Kalbulla Syed Abrahin, Guruswami Gurusubrmanian, Zothansanga, Ravi Prakash Yadav, Nachimuthu Senthil Kumar, Shunmugiah karutha Pandian, Probodh Borah, Surendra Mohan, Springer

Mapping of COs to syllabus

Course outcomes	M1	M2	M3	M4
CO1	H	M	H	M
CO2	H	M	H	M
CO3	M	H	M	H

PROGRAMME: MASTER OF SCIENCE (MSC) MICROBIOLOGY

PROGRAMME OUTCOMES

PO 1: **Skill Development**: Master academic, technical, managerial and crucial soft skills to qualify for careers in research, industry, education, administration and management or for higher studies where a holistic understanding of applied biosciences is required.

PO 2: **Research:** Develop a scientific mindset with the capacity for analytical and innovative thinking and practical knowhow to formulate, design and ethically implement scientific research in frontier areas of Biochemistry, Biotechnology and Microbiology

PO 3: **Communication:** Acquire effective communication and creative expression skills in the form of writing, design, presentation and networking to convincingly articulate scientific ideas in biosciences and related fields

PO 4: **Employment and Entrepreneurship:** Acquire the necessary knowledge and proficiencies to become employable or get self- employed and thereby create job opportunities through entrepreneurship in heath, agriculture, industry, environment and allied areas of applied biosciences and thereby affirmatively contribute to scientific social responsibility.

PROGRAMME SPECIFIC OUTCOMES

PSO 1: **Confidence:** Demonstrate a comprehensive understanding of chemical and biological structure, principles, techniques, andapplications

PSO 2: **Knowledge based Skill**: To develop better understanding and improve skills that would enable them to begin a career in research laboratories, industries as well as to generate self-employability

PSO 3: **Scientific Social Responsibility:** To develop linkages between scientificcommunity and society to build trust, partnershipand responsibility of science towards achieving social goals

PSO 4: **Research and analysis**: Realize the impact of science in society and plan to pursue research, and learn to work as a teamas well as independently to retrieve information, carry out research investigations and result interpretations

PSO 5: **Diagnostic skills**: Attain a remarkable understanding of biochemical principles of bioenergetics,metabolism, physiologyand disorders through diagnostic laboratory procedures.

PSO 6: **Technical and analytical skills:**Acquire a thorough knowledge on omics biology, high-throughput omics approaches to analyse biological samples such as genomics, transcriptomics, proteomics, metabolomics and comprehensive analysis approach.

MAPPING OF COURSES WITH POS/PSOS

Courses	PO 1	PO 2	PO 3	PO 4	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
Thermodynamics and Enzymology	H	H	L	M	H	M	L	M		
Cell Biology and Genetics	H	H	H	M	H	M	L	M	L	L
Fundamentals of Biochemistry	H	M	H	H	H	H	L	H	M	L
Analytical Techniques	H	H	M	H	H	H	M	H	L	L
Lab I- Fundamentals of Biochemistry	H	H	M	M	H	H	L	H	M	L
Lab II- Thermodynamics and Enzymology	H	H	M	M	H	M		M		
Lab III- Cell Biology and Genetics	H	H	H	M	H	H	L	H	M	L
Lab IV- Analytical Techniques	H	H	M	H	H	H	M	H	L	L
Industrial/ Laboratory visit	H	H		H	M	H		H	M	H
Genetic Engineering	H	H	L	M	M	H	M	M		L
Computer Applications and Bioinformatics	H	H	M	M	M	H	L	M		H
Basic Microbiology	L	H	L	L		H		L		
Molecular Biology	H	M	M	M	M	H	L	M	L	L
Fundamentals of Immunology	H	H	H	H	M	H	H	M	L	L
Lab I- Genetic Engineering	H	H	M	M	M	H	M	M		M
Lab II- Computer Applications and Bioinformatics	H	L	M	M		H		H		H
Lab III- Basic Microbiology	H	H	H	H		H		L		
Lab IV- Molecular Biology	H	H	M	M	M	H	L	H	L	L
Lab V- Fundamentals of Immunology	H	H	H	H	M	H	L	M	L	L
Waste Management (Skill Development course)	H	H	M	H	M	H	H	H	L	M
Fermentation and Food Micorbiology (Skill Development course)	H	H	H	H	M	H	H	L	H	L

Mushroom Cultivation (Skill Development course)	H	H	H	H	H	H	H	H	L	H
Herbal Drug Technology (Skill Development course)	H	H	M	H	L	H	H	H	L	M
Research Methodology & Biostatistics-common	M	H	H	M	L	M	H	H	L	L
Virology & Mycology	H	H	H	H	H	H	H	M	H	L
Environment Microbiology	M	H	H	M		M	M	H		M
Medical Microbiology	M	H	H	M		H	M	L	H	
Infection and Molecular Diagnostics	H	H	H	H	H	H	H	M	H	L
Lab I- Virology & Mycology	H	H	L	H	H	H	H	M	L	L
Lab II- Environment Microbiology	H	H	H	L	L	H		H		M
Lab III- Medical Microbiology	H	H	H	L	L	H			H	
Lab IV- Infection and Molecular Diagnostics	H	H	H	H	H	H	H	M	H	L
Dissertation Phase I	H	H	H	M	M	H	H	H	H	M
IPR &Entrepreneurship	M	H	H	H	M	H	M	L	M	L
Scientific writings and Communications		H	H		H					H
Value Added Course- Clinical Laboratory Techniques	H	H	L	H	M	H			H	
Industrial & Food Microbiology	L	M	H	H		H	L	L		H
Agriculture Technology (Elective)	H	M	M	H	H	H	H	M	M	M
Nanobiology (Elective)	M	H	M	L	H		M			
Bioresource Management (Elective)	H	M	L	M	L	M	M	H	L	L
Dissertation Phase II	H	H	H	H	H	H	H	H	H	H

MBVM0003: VIROLOGY AND MYCOLOGY (3-0-1)

Course Outcomes

1. To develop a comprehensive understanding about viruses in general
2. To gain insights on the infection pattern of viruses and to detect viral infection in vitro
3. Understand the in vitro models of viral infection (Understanding)
4. To gain deep insights into various types of viruses on the basis of its genetic material
5. To understand detail mechanism on different types of viral diseases prevalent across the globe
6. To understand about bactriophages and how they play important role in the treatment of infections (understanding)
7. To understand basic principle behind how vaccine works and trace the history of vaccines
8. Understand diseases successfully recovered due to vaccination (Understanding)
9. Understand the risk and benefits of vaccination and develop vaccine schedule
10. To understand general overview and characteristics of fungi
11. To differentiate fungi on the basis of nutritional types and how fungi are important in plant growth (Understanding)
12. Fungi as a model to understand some of the human diseases
13. Understand how biotechnology helped in the exploitation of fungi industrially
14. Develop knowledge on various aspects of fungi from medicine to food security
15. Gain insights into the drug targets and antifungal agents (Analysing)

Module I (10 lectures)

Introduction to virology: Virus history, Diversity, shapes, sizes and components of genomes, Baltimore classification of Viruses Infectious cycle: Attachment and entry into the cells, entry of non-enveloped virions, Assay of virus infectivity, modes of transmission of viral diseases

Isolation and purification of viruses: animal cell culture, multiplicity of Infection, virus preservation

Module II (20 lectures)

Animal Viruses: + Stranded RNA viruses: Picornaviruses, Flaviviruses- West Nile virus and Dengue virus, Coronaviruses- SARS pathogenesis

–ve strand RNA viruses: Paramyxoviruses, Orthomyxoviruses: Influenza pathogenesis and Bird flu, Rhabdoviruses: Rabies pathogenesis

Retroviruses: structure, classification, life cycle; reverse transcription. Retroviruses: HIV, viral pathogenesis and AIDS Bacteriophages: Phage basics, Infectious cycle: Lytic and lysogenic, regulation of switch between lytic and lysogenic cycle, assay of bacteriophages, Phage therapy

Module III (5 lectures)

Basic principles, Small pox and polio vaccine, subunit vaccine, Flu vaccination, how toxic are vaccines, Vaccine schedule

Module IV (10 lectures)

Introduction: Overview of fungi**,** general characteristics of fungi, fungal structure, Fungal Cell wall – architecture and biosynthesis,

reproduction in fungi-vegetative, asexual and sexual, homothallism and heterothallism
Nutrition classification of fungi: fungi, saprophytic, parasitic, obligatory and facultative, biotrophic
Fungal-plant interactions: symbiotic and antagonistic interactions, ecto-mycorrhizae, endomycorrhizae and vesicular arbuscularmycorrhizae, Yeast as model for human diseases

Module V (5 lectures)
Importance of Fungi in biotechnology, industrially important enzymes from fungi, Fungal metabolites and their economic significance - mycotoxins, medicinal uses of fungi (antibiotics), Antifungal agents and their mode of actions, drug targets, Fungi as food - mushrooms, mushroom poisoning

Suggested Readings
1. Human Virology, 5th edition, Leslie Collier, John Oxford, and Paul Kellam,2016, Oxford university press
2. Medical Mycology, 1st edition, Christopher C et.al, 2017, OUP Oxford
3. Clinical Virology manual,5th edition, Michael Loeffelholz, Richard L. Hodinka, Benjamin Pinsky, Stephen Young,2016, Wiley
4. The Mushroom Cultivator, 1st edition, Paul Stamets and J.S. Chilton, 1985, Richmond Publishing Co Ltd
5. Radical Mycology, 1st edition, Peter McCoy's, 2016, Chthaeus Press
6. Fantistic fungi,1st edition, Paul Stamets and Schwartzberg, 2019, Earth Aware Editions

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	M				
CO 2		M			
CO 3			M		
CO4				M	
CO5					M

MBEM0009: ENVIRONMENT MICROBIOLOGY (3-0-1)

Course Outcomes
1. Outline the traditional and modern approaches of microbial biodiversity analysis (Understanding).
2. Relate the role of a habitat in natural selection of diverse microbial forms (Remembering).
3. Classify the different modes of microbial interaction in a micro- and macro-habitat (Understanding).
4. Apply the properties of microbes in agriculture and in wastewater remediation (Applying).

Module I (10 lectures)
a. Taxonomy: classical and modern - polyphasic approach, molecular chronometers, chemotaxonomy, genetic methods.
b. Biodiversity: structure and function of a microbial community, estimates of total number of species, measures, and indices of diversity (diversity, dominance, and species richness indices), culture dependent and culture independent methods, microbial biodiversity analysis and documentation.

Module II (10 lectures)
a. Ecology: Microbial ecology vs. macroecology, concept of habitat and niche, fundamental and realized niche, resource partitioning and character displacement, characteristics of microbial population growth curves, microbial population regulation, r and K selected strategies, microbial community succession.
b. Extremophiles: Molecular and physiological adaptation of acidophiles, alkalophiles, halophiles, thermophiles and hyperthermophiles, psychrophiles and barophiles.

Module III (15 lectures)
a. Microbial interaction: Brief account of the interactions - rhizosphere, phyllosphere, microbial interactions within community - mycorhizza, epiphytic and endophytic microorganisms and their functional capability, microbial biofilm: definition, development, and importance.
b. Biogeochemical cycles: microbial role in biogeochemical cycles (C, N, P, S), primary production and decomposition.
Application of bacteria in agriculture: nitrogen fixing organisms – nitrogenase system and nif genes. Bio fertilizers – Bacterial, Azotobacter and vermiform compost

Module IV (10 lectures)
Waste treatment: Types of waste – solid and liquid waste characterization, bioremediation - several sustainable approaches for remediation of xenobiotic compounds and hydrocarbons, Physical, chemical and biological treatment methods, wastewater remediation – trickling, activated sludge, oxidation pond. Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN tests, tests for faecal coliforms (b) Membrane filter technique.

Suggested Readings

1. A Textbook on Microbiology, 4th Edition, Dubey RC, Maheshwari DK, 2013, S Chand Publishing.
2. General Microbiology, 7th Edition, Schlegel HG, 1993, Cambridge University Press.
3. Applied Microbiology (Agriculture, Environmental, Food and Industrial Microbiology), 1st Edition, Reddy SM, Girisham S, Narendra Babu G, 2017, Scientific Publishers.

Mapping of Course outcomes to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H	L	
CO 3		L	H	
CO 4			M	H

MBMM0010: MEDICAL MICROBIOLOGY (3-0-1)

Course Outcomes

1. Define the role of microflora in human body and its mode of transmission (Remembering).
2. Explain the mode of microbial pathogenesis in disease causation (Understanding).
3. Illustrate the differences in bacterial and fungal diseases (Understanding).
4. Examining different diagnostics methods and treatment options for microbial infections (Analysing).

Module I (5 lectures)

a. Human Microflora: Normal microbiota in human body, role of resident microbial flora.
b. Transmission: Routes of transmission, community and nosocomial infections, opportunistic infections
c. Detection strategies and protocol: Collection, transportation and processing of clinical samples, Quality control of a medicalmicrobiology laboratory

Module II (15 lectures)

a. Toxigenesis: Account of several virulence factors – pili, fimbriae, flagella, lipopolysaccharide, exo-enzymes, adhesins, capsules and toxins; classification and action of endo-toxins and exo-toxins.
b. Mechanisms of pathogenesis: adhesion, colonization and invasion of host tissue – mucous membrane of respiratory, enteric and urogenital tracts; role of aggressins, depolymerizing enzymes, organotropisms, pathogenecity islands, cytoskeletal modulation of host cell.

Module III (15 lectures)

a. Bacterial diseases: Clinical features, transmission, characteristics of causative organism, pathogenesis, laboratory diagnosis, prevention and control of bacterial diseases and clinical syndromes – typhoid fever, cholera, diphtheria, tetanus, meningitis, septic arthritis, conjunctivitis, otis media, pneumonia, gastroenteritis, urinary tract infections, wound infections, skin and soft tissue infections.
b. Fungal diseases: Clinical features, transmission, characteristics of causative organism, pathogenesis, laboratory diagnosis, prevention and control of bacterial diseases and clinical syndromes – Cutaneous mycoses: Tinea pedis (Athlete's foot) Systemic mycoses: Histoplasmosis, Opportunistic mycoses: Candidiasis.

Module IV (10 lectures)

a. Antibiotic therapy: antibiotic sensitivity assays - Stokes method, Agar dilution method, Broth dilution method, E-strip method, efficacy; pharmacokinetics and side-effects, prophylaxis.
b. Microbial drug resistance: emergence and evolution of antibiotic resistance, current issues of MDR/XDR microbial strains, resistance tests – phenotypic and molecular, combination therapy.

Suggested Readings

a. Essentials of Medical Microbiology, 3rd Edition, Sastry AS, Bhat S, 2020, Jaypee Brothers Medical Publishers (P) Ltd.
b. Review of Medical Microbiology, 27th Edition, Jawitz, Melnick and Adelberg, 2015, Mc Graw Hill education.

Mapping of Cos to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2	L	H		
CO 3		M	H	
CO 4			H	H

MBCG0011: CELL BIOLOGY AND GENETICS (4-0-1)

Course Outcomes

1. Recall the fundamental concepts of cell biology and genetics (Remembering)
2. Relate cellular structure to function, physiology and communication (Understanding)
3. Examine the principles of genetics, mutation and recombination (Analysing)
4. Compare concepts in cell, developmental biology and genetics (Evaluating)

Module I (9 lectures)

Cell and its organelles: Structure of prokaryotic and eukaryotic cell and their organelle; Cell wall, nucleus mitochondria, chloroplast, ribosome, Golgi bodies, endoplasmic reticulum, lysosome; Plasma membrane: structure, transport across membrane, cell junction, Cytoskeleton and its role in topography, motility. Major cellular processes: protein synthesis, sorting and secretion, respiration and photosynthesis.

Module II (12 lectures)

Organization of genes and chromosomes: Structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin; Concept of gene, operons, gene families; Cell division and cell cycle and its regulation, Uncontrolled cell growth – cell cycle in cancer; oncogenes, tumor suppressor genes; Programmed cell death,; Basic concepts of development: stages and mechanisms of early and late development; differentiation, Stem cells.

Module III (15 lectures)

Cellular communication: General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation. Cell signaling: Hormones and their receptors, cell surface receptor, signal transduction pathways, second messengers and their roles in signal transduction, regulation of signaling pathways.

Module IV (15 lectures)

Mendelian principles: Mendel's laws, concept of allele, multiple alleles, pseudoallele, codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance, expressivity.

Linkage and crossing over, sex linkage, sex limited and sex influenced characters. Extra chromosomal inheritance: Inheritance of mitochondrial and chloroplast genes, maternal inheritance; Genetic disorders, Pedigree analysis; Gene Mapping- linkage maps, molecular markers; Basic principles of population and evolutionary genetics, Quantitative genetics- polygenic inheritance and biostatistics.

Module V (9 lectures)

Fine structure of a gene: Cistron, muton and recon; Basic genome organization (prokaryotic and eukaryotic); Bacterial genetics (transformation, transduction, conjugation)

Mutation: Types, causes and detection, mutant types– lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Transposable genetic elements;

Recombination: Homologous and non-homologous recombination, including transposition, site-specific recombination.

Suggested Readings

1. Cell Biology, Genetics, Molecular Biology, Evolution & Ecology, 1st Multicolor Edition, Verma,PS and Agarwal, VK,2005,S. Chand& Co.
2. Cell and Molecular Biology,8th Edition, deRobertis,EDPanddeRobertis,EMF,2017, Wolters Kluwer Publishing
3. Principles of Genetics.8th Edition, Gardner, J., Snustad, D. P., Simmons, M. J., 2005, Wiley, India
4. Cell-A Molecular Approach. 6th Edition, Cooper, GM. and Hausman, RE, 2015, SinauerAssociatesInc.US.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	H	H	H	H
CO 2	H	H	H		
CO 3				H	H
CO 4	M	M	M	M	M

MBWM0012: WASTE MANAGEMENT (1-0-0)

Course Outcomes

1. Understand the waste management systems with respect to its physical properties and associated critical considerations in view of emerging technology (Remembering)
2. To prepare an outline with methods of sample handling, storage and disposal of various waste(Understanding)
3. To apply the concepts of zero waste (Applying)
4. To select an appropriate method for disposal of hazardous solid waste (Analysing)

5. To choose an appropriate method to recycle waste (Evaluate)
6. To synthesize the recycling approaches towards economic growth (Creating)

Module1 (4 lectures)
Overview of waste management: Basic concepts and principle of waste management; sources of waste; waste management hierarchy; management strategies; challenges and opportunities; contribution to economic growth.

Module II (2 lectures)
Training on sustainable approaches to solid waste management

Module III (3 lectures)
Training on Waste water processing treatment

Module IV (2 lectures)
Training on Reuse and Recycling Techniques to convert thrash to thrive

Module V (2 lectures)
Field visits to explore waste management processing.

Module VI (2 lectures)
Waste management awareness program

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H	M	M		H	
CO 2	H	H	M			H
CO 3	M	H	M	H		
CO 4	H	L	M			
CO 5	M	H	H	H		

MBMC0013: MUSHROOM CULTIVATION (1-0-0)

Course Outcomes
1. To develop comprehensive understanding basics of mushroom and their importance to humans and environment (Remembering)
2. To develop skills on techniques of mushroom cultivation and understand global market and demand of mushrooms (Understanding)
3. To develop skills on preservation techniques for mushrooms, risk and benefits associated(Analysing)

Module I (5 lectures)
Definition of a Mushroom, Mushroom Hunting, Ecological Classification of Mushrooms, Food Supply through Mushroom, Enhance Human Health through Mushroom Derivatives, Benefit the Environment through Mushroom Mycelia

Module II (7 lectures)
Mushroom Cultivation: Both a Science and an Art, World Mushroom Production, Differences in Mushroom Production Patterns, World Mushroom Market, Nutritive value of mushrooms, Poisonous Mushrooms
Phases of Mushroom Cultivation: Sterilization : Knowledge of General Safety, health and hygiene, Optimum growing condition Substrate: Preparation of beds for cultivation of various mushrooms and its maintenance, Problems in mushroom cultivation & its remedies Cultivation of selected mushrooms: Oyster Mushroom Cultivation, Milky Mushroom Cultivation, Button Mushroom cultivation, Shiitake Mushroom cultivation
Practical aspects: Sterilization process practice, morphological and microscopic identification of mushroom mycelium, Molecular identification of mushrooms, Spore printing technique, Growing and Identification of viable Spawn, microbial analysis of substrate and optimization,

Module III (3 lectures)
Economics of Mushroom cultivation, Post Harvesting care and processing, Packaging and storage
Practical aspects: Visits and trainings to research laboratories and Mushroom farms, mushroom trainings to community people

Suggested Readings

1. Paul Stamets. Growing Gourmet and Medicinal Mushrooms The Mushroom Cultivator by, 2000, Ten Speed Press
2. Paul Stamets and J.Chilton. A Practical Guide for Growing Mushrooms at Home, by,1985, Richmond Publishing Co Ltd

Mapping of Course outcomes

Course Outcomes	Module I	Module II	Module III

CO 1	M		
CO 2		H	
CO 3			H

MBBM0014: BASIC MICROBIOLOGY (2-0-1)

Course Outcomes

1. Differentiate and classify a significant number of common bacteria by their salient properties (Understanding).
2. Compare the nutritional needs of bacteria for growth and their metabolism (Understanding).
3. Identify key factors of the microbial growth curve and growth kinetics (Applying).
4. Define the physical and chemical methods of microbial growth control (Remembering).

Module I (5 lectures)

a. Historical perspective: Discovery of microbial world, Landmark discoveries relevant to the field of microbiology, controversy over spontaneous generation
b. Microbial taxonomy and diversity: Basis of microbial classification, Haeckel's 3 Kingdom concept, Whittaker's 5 Kingdom Concept, three Domain of Carl Woese, Archael taxonomy.
c. Staining techniques: Basic and acidic dyes, simple and differential staining, negative and positive staining, Grams' staining,acid fast staining, flagella and spore staining

Module II (10 lectures)

a. Nutritional classification: nutritional groups of bacteria - photoautotroph, photoorganotroph, chemolithotroph (ammonia, nitrite, sulfur, hydrogen, iron oxidizing bacteria), chemoorganotroph; classification based on - oxygen requirement, temperature, pH and salinity - and tolerance.
b. Microbial growth: Definition of growth and bacterial reproduction, microbial growth curve, mathematical expression of exponential growth phase, measurement of growth and growth yields - spectrophotometric method, microscopic counting, serial dilution and viable cell count, most probable number, synchronous and continuous culture
c. Microbial cultures: Concept of pure culture, methods of pure culture isolation, enrichment culturing techniques, single cell isolation, and pure culture development.
d. Culture media: chemically defined, complex, differential, and special selective media.
e. Transport of nutrients: Microbial nutrient uptake – diffusion, active transport (periplasmic binding protein and ABC transporters), group translocation and protein export system

Module III (10 lectures)

a. Photosynthesis: characteristics and metabolism of autotrophs, an-oxygenic photosynthetic bacteria and cyanobacteria, CO2fixation and mechanism of photosynthesis
b. Metabolism: An overview of metabolism, Glycolysis, Pentose-phosphate pathway, Entner- Doudoroff pathway, Citric acid cycle; electron transport system, aerobic and anaerobic respiration.
c. Endospore – Structure, properties, and germination.

Module IV (5 lectures)

a. Sterilization: physical and chemical control of bacteria.
b. Antimicrobials: General characteristics of antimicrobial drugs – antibiotics, antifungals and antivirals, classification and mode of action, antibiotic susceptibility testing - Kirby-Bauer's disc diffusion method; antiseptics and disinfectants

Suggested Readings

1. A Textbook on Microbiology, 4th Edition, Dubey RC, Maheshwari DK, 2013, S Chand Publishing.
2. General Microbiology, 7th Edition, Schlegel HG, 1993, Cambridge University Press.

Mapping of COs to syllabus:

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	H		
CO 2		H	H	
CO 3			H	L
CO 4			L	H

MBIM0015: INFECTION AND MOLECULAR DIAGNOSTICS (3-0-0)

Course Outcomes

1. Develop understanding on basic terminology associated with infection and diseases
2. Understand how far vaccines are effective in reducing the burden of infectious diseases
3. To understand various challenges faced in the developing world to reduce the burden of infectious disease (Analysing)
4. To gain knowledge on various types of infectious agents as a means of infection
5. To understand different mechanism for the transmission, pathology and control of infectious diseases (Understanding)
6. To understand changing paradigm of global health and strategies towards their control
7. To understand novel emerging infectious diseases which are constant threat to public health
8. To understand the problem multidrug resistance and solutions
9. Gain insights into the role of IPC in control of infections
10. To develop an understanding on how human-induced environmental changes, such as global warming, deforestation and land-use conversion, urbanization, international commerce, and human migration, are altering the ecology of infectious disease transmission (Evaluating)
11. To gain knowledge on antigen antibody based immunodiagnostic test as a primary screening for detection of infection
12. To understand the mechanisms and advancement in the techniques for screening of infectious diseases(Understanding)
13. To understand problems associated with traditional approaches for detection and how advancement in nucleic acid-based detection method decreased time and increased specificity
14. To understand the currently available molecular diagnostic approaches for detection of infectious diseases (Understanding)

Module I (10 lectures)

a. Acute infections, chronic infections, outbreak, epidemic and pandemic, epidemiology, endemicity, reproductive number, Age dependent pattern of infection, herd immunity
b. Vaccines-Impact, questions, safety and challenges, disease eradication, Nutrition and infection in developing world

Module II (10 lectures)

a. Principles of the transmission of the infectious agents (viruses, bacteria, rickettsiae, mycoplasma, fungi, and protozoan), The role of vectors, reservoirs, and environmental factors
b. Epidemiology of diarrheal diseases, TB, Hepatitis B,A, C and E, epidemiology and control of Malaria, meningococcal diseases: global problem and solutions, bioterrorism

Module III (15 lectures)

Nipah virus, SARS, COVID-19, Ebola, Plague, Diptheria, Acute encephalitis syndrome (AES), Hantavirus Pulmonary Syndrome - causes, spread and control; Case studies, endemic, pandemic and epidemic diseases, Zoonotic diseases, Combating emerging infections, Viral mediated cancers, current issues of MDR/XDR microbial strains, concept of DOTS, emergence of antibiotic resistance, gut microbiota in health and disease, Role of Infection prevention and control (IPC)

Module IV (10 lectures)

Immunoelectrophoresis, agglutination, ELISA, immunofluorescence, Immunohistochemistry; Fluorescent Activated Cell Sorter (FACS); Single and double immunodiffusion, Immunofluorescence, RIA, ELISA, Western blot, FACS

Module V (10 lectures)

Non nucleic acid-based methods: Biotyping, Antimicrobial susceptibility testing, serotyping, bacteriophage typing, Nucleic acid-based methods - Agarose gel electrophoresis, RFLP, PFGE, PCR

Suggested Readings

1. Infectious Diseases, 4th Edition, Jonathan Cohen, William Powderly and Steven Opa,2016, Elsevier
2. Oxford handbook of infectious diseases and microbiology, 2nd Edition, Estee Torok , Ed Moran and Fiona Cooke,2010,Oxford University Press
3. Molecular diagnosis of infectious diseases, 2nd Eition, Jochen Decker and Udo reischl,2004, Springer
4. Clinical Immunodiagnostics,1st Edition, Ian C Clift,2020, Jones & Bartlett Learning
5. The elements of Immunology,1st Edition, Fahim Halim Khan,2009, Pearson Education India

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	M				
CO 2		M			
CO 3			M		
CO4				M	
CO5					M

MBNB0016: NANOBIOLOGY (2-0-0)

Course Outcomes

1. To understand the history and concept of nanotechnology (Understanding)
2. To explain the different types of nanomaterials (Applying)
3. To compare the different types of methods involved in the synthesis of nanoparticles (Evaluating)
4. To analyse the properties of nanoparticles by using different instruments (Analysing)
5. Application of nanotechnology in different fields (Applying)

Module I (5 lectures)

Introduction to nanobiotechnology; History of nanotechnology; Types of nanomaterials- Quantam dots, Carbon based, Metal based, Dendrimer, Composite; Properties of nanomaterials

Module II (13 lectures)

Synthesis of Nanomaterials- Physical, Chemical, Biological (Bacteria, Fungus, Plants); Characterization of nanomaterials- UV-Vis Spectroscopy, Electron microscope- Energy Dispersive X-ray Spectroscopy, Mass Spectroscopy-Types-Nuclear Magnetic Resonance (NMR) Spectroscopy, FT-IR Spectroscopy- X-Ray Diffraction (XRD)

Module III (12 lectures)

Application of Nanotechnology- Drug delivery system; Disease treatment; Agriculture; Food industry; Detection system; Nanotechnology - Environmental and health effects

Suggested Readings

1. Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials, 1st Edition, Varghese T and Balakrishna KM, 2012, Atlantic
2. A Textbook of Nanoscience and Nanotechnology, Varghese PI and Pradeep T, 2003, Tata McGraw-Hill Education
3. Designing Hybrid Nanoparticles, Maria Benelmekki, 2015, Morgan & Claypool Publishers
4. A Textbook of Nanoscience and Nanotechnology, Bhattacharya SA, 2013, Wisdom Press
5. Textbook of Nanoscience and Nanotechnology, Murty BS, Shankar P, Raj B, Rath BB and Murday J,2013,Springer

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H		
CO 2	H		
CO 3		H	
CO 4		H	
CO 5			H

MBIF0018: INDUSTRIAL AND FOOD MICROBIOLOGY (4-0-0)

Course Outcomes

1. Recall methods of isolation and screening methods for industrially important microorganisms (Remembering).
2. Illustrate techniques for scaling of microbial fermentation for food and product formation (Understanding)
3. Develop methods for production of economically important products and its preservation (Applying).
4. Categorize important preservation and safety measures for food production in North-east India (Analysing)
5. Compare the diverse fermented food products and its mode of preparation in tribal population of North-East India (Understanding)

Module I (15 hours)

a. Microbes: Isolation and Screening of industrially important microorganisms, improvement of microbial strains, qualities of anindustrially important microbe, preservation and maintenance of industrial strains.
b. Fermentation basics: Fermentation medium and sterility, types of fermentation process - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (e.g. baker’s yeast) and continuous fermentations, fermentationkinetics.
c. Industrial design: Bioreactor – design and components, bioreactor types - Laboratory, pilot- scale and production fermenters,constantly stirred tank and air-lift fermenters, fermentation process control. Post production techniques and down-stream processing.

Module II (15 hours)

a. Production: Microbial production of industrial products, micro-organisms involved, media formulation, fermentation conditions, upstream and downstream processing and uses - Citric acid, ethanol, penicillin, streptomycin, glutamic acid, Vitamin B12, Enzymes (amylase, protease, lipase), wine, beer.

b. Biofuel: Production of gaseous fuel – biohydrogen and biomethane; liquid fuel – bioethanol, biodiesel and biobutanol.
c. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes(glucose isomerase and penicillin acylase).

Module III (15 hours)

a. Food preservation: Food as a substrate for microbes, microbial growth in food, characteristics of micro-organisms in food, food preservation – physical methods (dehydration, freeze drying, heat and irradiation), chemical methods (chemical preservatives and additives), canning.
b. Food Spoilage: characterization of contamination and spoilage of cereals, sugar products, vegetables, fruits, meat and meat products, milk and milk products, fish and sea foods, poultry, beer and wines; Spoilage of fermented foods and canned foods. Laboratory testing protocols and biosensors in food industry.

Module IV (15 hours)

a. Food safety: Microbiological quality standards of food, Food control agencies and their regulations – FDA, EPA, CDC and ISI. ISO and Hazard analysis and Critical Control point (HACCP) system, Food Safety Act and Trade Regulations.
b. Fermented food: Cultures for food fermentation, fermented foods and their production – bread, cheese, fermented vegetables, dairy products –acidophilus milk, yoghurt, single cell proteins, pickles, oriental foods and beverages, locally fermented alcoholic beverages, probiotics, prebiotics and symbiotic.

Suggested Readings

a. An Introduction of Industrial Microbiology, 1st Edition, Sivakumaar PK, Joe MM, Sukesh K, 2010, S Chand Publishing.
b. Food Microbiology, 5th Edition, Frazier WC, Westhoff DC, Vanitha NM, 2014, McGraw Hill Education.
c. Biotechnology, 1st Edition, Satyanarayana U, Chakrapani U, 2020, Books & Allied Ltd.

Mapping of COs to Syllabus

Course Outcomes	1	2	3	4
CO 1	H			
CO 2	H	H		
CO 3		H	L	L
CO 4			H	H

LABORATORY COURSES

MBCB6011: CELL BIOLOGY AND GENETICS LAB

Course Outcomes
1. Recall the theoretical topics in cell biology and genetics (Remembering)
2. Apply the fundamental concepts of cell biology and genetics in laboratory (Applying)
3. Analyze data and numerical problems from experiments and interpret results (Analysing)

Syllabus
1. Method s of cell lysis and staining
2. Cell imaging and documentation
3. Study of mitosis and meiosis in plants/cultured cells
4. Isolation of DNA from animal and plant sources
5. Agarose gel electrophoresis of isolated genomic DNA
6. Determination of Tmof DNA
7. Isolation of auxotrophic mutants by replica plating
8. Numerical problems in genetics(Mendelian, population and bacterial genetics, mutation, recombination, etc.

Suggested Readings
1. Cell Biology, Genetics, Molecular Biology, Evolution & Ecology, 1st Multicolor Edition, Verma, PS and Agarwal,VK,2 0 0 5 , S. Chand & Co.
2. Cell and Molecular Biology, 8th Edition, deRobertis, EDPanddeRobertis, EMF, 2017, Wolters Kluwer Publishing
3. Principles of Genetics.8th Edition, Gardner, J., Snustad, D. P., Simmons, M. J., 2005, Wiley, India
4. Cell-A Molecular Approach. 6th Edition, Cooper, GM. and Hausman, RE, 2015, Sinauer Associates Inc. US.

Mapping of COs to Syllabus

Course Outcomes	P1	P2	P3	P4	P5	P6	P7	P8
CO 1	H	H	H	H	H	H	H	H
CO 2	H	H	H	H	H	H	H	H
CO 3					H	H	H	H

***P: Practical**

MBBM6012: BASIC MICROBIOLOGY LAB

Course Outcomes
1. Experiment with different microbial isolation techniques (Applying)
2. Examine cell structure through microscopy and microbial colonies for identification (Analysing).
3. Determine the factors that affect microbial growth (Evaluating).

Syllabus
1. Preparation of various routine laboratory media - differential, selective and enriched.
2. Isolation of microorganisms by serial dilution method
3. Isolation of pure cultures by streak plate method
4. Staining techniques and microscopic examination of bacteria – Gram's staining, negative staining, capsule staining, spore staining, acid fast staining of bacteria
5. Staining techniques and microscopic examination of fungi – Lactophenol cotton blue
6. Measurement of microbial growth curve by direct cell count method/turbidity method
7. Measurement of fungal growth by colony diameter method/biomass method
8. Preservation of bacterial cells by various techniques
9. Antibiotic susceptibility testing (disc diffusion/broth microdilution)

Suggested Readings
1. Practical Microbiology, 3rdEdition, Maheshwari DK, 2002, S Chand Publishing
2. Experiments in Microbiology, Plant pathology, tissue culture and Microbial Biotechnology, 5thEdition, Aneja KR, 2017, NewAge International Publishers.

Mapping of COsto syllabus:

Course Outcomes	P1	P2	P3	P4	P5	P6	P7	P8	P9
CO 1	H	H	H						
CO 2			M	H	H				

CO 3						H	H	H	H

***P: Practical**

MBVM6008: VIROLOGY AND MYCOLOGY LAB

Course Outcomes

1. Apply the knowledge on bacteriophages to isolate and quantify (Applying)
2. Learn the technical skills to isolate DNA from phages (Analysing)
3. Apply the knowledge on fungi to isolate, and identify (Applying)
4. Learn the technical skills to isolate DNA from fungi (Analysing)
5. Analyse different nutrients in macro fungi (Analysing)

Syllabus

1. Isolation of bacteriophage from natural sources
2. Cultivation and quantification of phages
3. Isolation of DNA from bacteriophage
4. Phage identification by PCR
5. Isolation of fungi from soil
6. Staining of fungus
7. Nucleic acid isolation of fungi
8. Spore printing of fungi
9. Detection of protein, minerals and vitamins in fungi

Suggested Readings

1. General Virology, 3rd edition, S. E. Luria, J. E. Darnell, 1978, John Wiley & Sons
2. Textbook of Virology ,2nd edition, A.J. Rhodes and C.E. Van Rooyen,1953,The Williams & Wilkins Company
3. Virus-insect-plant Interactions, 1st edition, Kerry F. Harris, Oney P. Smith, James E,2001 Duffus, Academic Press Inc
4. Principles of Virology: Molecular Biology, Pathogenesis, and Control, 1st edition, S. J. Flint, Lynn W. Enquist, Robert M. Krug,Vincent R. Racaniello, 2000, American Society for Microbiology
5. Introductory Mycology, 4th edition, Constantine J. Alexopoulos, Charles W. Mims, Meredith M. Blackwell,1996, Wiley

Mapping of outcomes:

Course Outcomes	P 1	P2	P3	P4	P5	P6	P7	P8	P9
CO 1	H								
CO 2		H							
CO 3			H			H		H	
CO4				H			H		
CO5					H				H

***P: Practical**

MBEM6009: ENVIRONMENT MICROBIOLOGY LAB

Course Outcomes

1. Experiment with different protocols for isolation of microbes from natural habitats (Applying)
2. Examine microbial interactions in soil, water, and plant systems (Analysing)
3. Evaluate the roles of microbes for its medicinal, plant growth promoting, and degradation properties (Evaluating).

Syllabus

1. Isolation of microbes (bacteria & fungi) from soil (28ºC&45ºC)
2. Isolation of Cyanobacteria from natural sample
3. Isolation of antibiotic producing microbes from soil sample.
4. Determination of antimicrobial spectrum of isolate
5. Isolation of anaerobic microorganisms
6. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane
7. Isolation of protease secreting bacteria from soil
8. Isolation of xenobiotic compound degrading bacteria by enrichment culture technique
9. Assessment of microbiological quality of water
10. Microbial biofilm detection
11. Isolation and identification of symbiotic bacteroids of Rhizobium sp. from root nodules of leguminous plants
12. Isolation of phosphate solubilizing bacteria from soil and quantitative measurement of the phosphate solubilisation

Suggested Readings

1. Practical Microbiology, 3rd Edition, Maheshwari DK, 2002, S Chand Publishing
2. Experiments in Microbiology, Plant pathology, tissue culture and Microbial Biotechnology, 5th Edition, Aneja KR, 2017, NewAge International Publishers.

Mapping of COs to Syllabus

Course Outcomes	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CO 1	H	H	H	H	H	H	H	H	H	H	H	H
CO 2	M	L	H		H	H			L	H	H	H
CO 3			H	H			H	H			H	H

***P: Practical**

MBMM6010: MEDICAL MICROBIOLOGY LAB

Course Outcomes

1. Developing methods of identification of clinically important microorganisms (Applying).
2. Categorize microbes based on their physiology to develop methods for diagnosis (Analysing).
3. Assess the response of bacteria to antibiotics by *in vitro* assays (Evaluating).

Syllabus

1. Biochemical tests – IMViC tests – of enteric bacteria
2. Isolation and biochemical characterization of pathogenic bacteria from any clinical sample
3. Isolation and biochemical characterization of normal micro flora of skin, throat or oral cavity
4. Isolation and identification of fungal pathogens from clinical specimens
5. Isolation of hemolytic bacteria using blood agar media.
6. Minimum inhibitory concentration (MIC) determination of antimicrobial compound against microorganism
7. Isolation and screening of bacterial and fungal cultures for enzyme production – amylase or gelatinase
8. Determination of presence of catalase and oxidase activity in bacteria
9. Determination of the ability of bacteria to utilize sugars by oxidative or fermentative mode
10. Demonstration of sugar fermentation – sucrose, lactose and glucose

Suggested Readings

1. Practical Microbiology, 3rd Edition, Maheshwari DK, 2002, S Chand Publishing
2. Experiments in Microbiology, Plant pathology, tissue culture and Microbial Biotechnology, 5th Edition, Aneja KR, 2017, New Age International Publishers.

Mapping of COs to Syllabus

Course Outcomes	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
CO 1	H	H	H	H	L		H	H	H	H
CO 2	H	H		M	H		H	H	H	H
CO 3					L	H				

***P: Practical**

MBIM6015: INFECTION AND MOLECULAR DIAGNOSTICS LAB

Course Outcomes:

1. Analyse antibodies by different types of ELISA generated due to microbial infection (Analysing)
2. Standardization of Indirect Immunoflourescence assay (Evaluating)
3. Demonstrate practical knowledge on Single radial immune diffusion (Analysing)
4. Demonstrate practical knowledge on Double immune diffusion method (Analysing)
5. Demonstrate practical knowledge on Immunoelectrophoresis (Analysing)
6. Standardize antimicrobial susceptibility test and learn analysing its result (Evaluating)

Syllabus

1. Detection of antimicrobial antibodies by ELISA
2. Indirect Imunoflourescence assay
3. Single radial immune diffusion
4. Double diffusion method of Ouchterlony
5. Immunoelectrophoresis
6. Rocket electrophoresis
7. DOT ELISA for the presence of specific antigen.

8. Antimicrobial susceptibility testing

Suggested Readings
1. Practical Immunology,4th edition, Drank C.Hay,2002, Wiley-Blackwell
2. Handbook of Practical and Clinical Immunology, 2nd edition, G.P. Talwar and S.K.Gupta,2017, CBS
3. Current diagnosis and treatment in infectious diseases, 2nd edition, Walter R. Wilson and Merle A. Sande, 2013, McGraw-Hill Education

Mapping of Course outcomes:

Course Outcomes	P 1	P2	P3	P4	P5	P6	P7	P8
CO 1	H						H	
CO 2		H						
CO 3			H					
CO4				H				
CO5					H	H		
CO6								H

***P: Practical**

MBDI6006: DISSERTATION PHASE I (0-0-2)

Course Outcomes
1. Develop a scientific mindset with the capacity for analytical and innovative thinking (Creating).
2. Develop writing skill, referencing and citations for effective communication (Applying).
3. Improve communication and creative expression skills to articulate scientific ideas (Creating).
4. Examine the research gap in the related field and formulate strategies to address the same (Analysing).

Syllabus
1. Familiarization with research topic and methodologies by a thorough literature review.
2. Writing of review of literature to brush up already existing knowledge on a given area.
3. Formulate a research hypothesis and a proposed workplan.
4. Presentation of the research topic at department level and submission of literature review.

Suggested Readings
1. Scientific review and research articles published in respective specialized area of research.

Mapping of Course outcomes to Syllabus

Course Outcomes	P1	P2	P3	P4
CO 1	H	H		
CO 2		H	H	
CO 3		H	H	H
CO 4	L	M	L	H

***P: Practical**

MBDI6007: DISSERTATION PHASE II (0-0-16)

Course Outcomes
1. Support the research hypothesis with experiments executed ethically (Evaluating).
2. Develop skill to independently carry out a research in the laboratory (Creating).
3. Examine the methodology, analyse results, and defend the research work (Analysing).

Syllabus
1. Execute a scientific dissertation based on the proposed plan in Phase 1 through bench work.
2. Present and report data at various stages of the research work to the assigned supervisor.
3. Analysing the results, correlating it with different experiment performed during the dissertation.
4. Present the findings in a department level to internal and external examiners, and submission of completed thesis.

Suggested Readings
Scientific review and research articles published in respective specialized area of research.

Mapping of COs to Syllabus

Course Outcomes	P1	P2	P3	P4

CO 1	H	L	M	
CO 2	H	M	H	L
CO 3		H	H	H

***P: Practical**

DEPARTMENT OF BOTANY

Vision:

To motivate and encourage the students in effective ways to utilize the knowledge of 'Plant Sciences' in order to solve the future needs of Food, Fuel, Energy and Environment for the betterment of mankind and society.

Mission:

The department endeavours to make substantial contribution in the field of 'Plant Sciences' by new research innovations and producing competent students who are not only well versed with the subject but are also better adjusted socially, emotionally and intellectually.

MSC PROGRAM OUTCOMES

PO 1: Critical Thinking: Inculcate critical thinking to carry out scientific investigation objectively. Formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. Critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.

PO 2: Knowledge Skill: Equip the student with skills to analyse problems, formulate a hypothesis, evaluate and validate results, and draw reasonable conclusions thereof. Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge.

PO 3: Scientific Communication Skills: Imbibe effective scientific and/or technical communication in both oral and writing. Ability to show the importance of the subject as precursor to various scientific developments since the beginning of the civilization.

PO 4: Ethics: Continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in the subject concerned. Ability to identify unethical behavior such as fabrication, falsification or misrepresentation of data and adoptive objective, unbiased and truthful actions in all aspects.

PO 5: Enlightened Citizenship: Create awareness to become an enlightened citizen with commitment to deliver one's responsibilities within the scope of bestowed rights and privileges.

PO 6: Analytical Reasoning: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyse and synthesise data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.

PO 7: Multicultural Competence: Development of a set of competencies in order to enhance and promote the growth of multicultural sensitivity within universities. Integrating multicultural awareness such as race, gender, physical ability, age, income and other social variables, and by creating an environment that is, "welcoming for all students".

PO 8: Lifelong Learning: Ability to think, acquire knowledge and skills through logical reasoning and to inculcate the habit of self-learning throughout life, through self- paced and self- directed learning aimed at personal development, and adapting to changing academic demands of work place through knowledge/ skill development/ reskilling.

PO 9: Leadership Qualities: Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination in a smooth and efficient way.

PO 10: Research Skills: Prepare students for pursuing research or careers in industry in concerned subject and allied fields. Capability to use appropriate software to solve various problems and to apply programming concepts of C++ and Mathematica/Matlab to various scientific investigations, problem solving and interpretation.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO1: Acquire basic as well as in-depth knowledge on plant science in addition to understanding interdisciplinary fields such as molecular biology, cell culture, bioprocess engineering, computational biology, recombinant DNA technology, statistics etc, and their applications in healthcare, agriculture, environment, and industry.

PSO2: Acquire sound practical knowledge on plant science, molecular biology, microbiology, plant tissue culture, etc, and become well-trained for employment or self-employment.

PSO3: The students would be equipped and well-trained on applied sciences and also empowered to independently develop basic research projects on multidisciplinary fields.

PSO4: The students would be well-prepared for competitive examinations conducted by national and international organisations.

Courses offered in MSC BOTANY

Course Code	**Course Name**
BOMP0021	Mycology and Phycology
BOBP0022	Bryophytes, Pteridophytes and Gymnosperms
BOAN0023	Angiosperms
BOMP6026	Mycology and Phycology Lab
BOBA6027	Bryophytes, Pteridophytes and Gymnosperms and Angiosperms Lab
VAC	Bio-Fertilizer Technology
VAC	Biomass Conversion, Biorefinery & Circular Bioeconomy
BOSL0100	Service Learning on Ethno Botanical Practices
BOCM0024	Cell and Molecular Biology
BOPB0025	Plant Physiology and Biochemistry
BOPP0026	Plant Microbiology and Plant Pathology
BOCB6028	Cell and Molecular Biology and Plant Physiology and Biochemistry Lab
BOPP6029	Plant Microbiology and Plant Pathology Lab
BOSL0100	Service Learning on Ethno botanical Practices
BOCP0027	Cytogenetics and Plant Breeding
BOPE0028	Plant Ecology and Phytogeography
BOBB0029	Biochemicals, Molecular Techniques and Bioinformatics
BOTC0030	Plant Cell and Tissue Culture
BOPE6030	Plant Ecology Lab
BOCT6031	Cytogenetics, Molecular Techniques and Tissue Culture Lab
VAC	Herbal Medicine
VAC	Forest Inventory and Mensuration
BODI6032	Dissertation Phase I
BOER0031	Environmental Management, Research Methodology and Biostatistics
BOER6033	Environmental Management, Research Methodology and Biostatistics Lab
BOFP0032	Fundamentals of Plant Biotechnology
BOAB0033	Advances in Plant Biotechnology
BOGT0034	Genetics, Plant Breeding and Transformation
BOMB0035	Molecular Genetics and Bioinformatics
BOTS0038	Taxonomy of Angiosperms and Biosystematics
BOBE0039	Economic Botany and Ethnobotany
BOEG0040	Ecology, Environment and Global concerns
BORG0042	Restoration Ecology and Geoinformatics
BOPY0043	Plant Pathology
BOMA0044	Microbial Genetics and Applied Microbiology
BOPP0045	Advanced Plant Physiology
BOBM0046	Plant Biochemistry and Metabolism
BOBB0047	Biomass, Biorefinery and Circular Bioeconomy
BOPD0048	Bioprospecting of Plant Diversity and Automation
BOSL0100	Service Learning on Ethno Botanical Practices
BODI6034	Dissertation Phase II

Mapping of Courses to POs and PSOs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BOMP0021	M	H	L	L	L	L	M	M	L	H	H	H	H	H
BOBP0022	H	H	M				L	H		H	H	M	H	H
BOAN0023	H	H	H	M	M	M	M	H	H	H	H	M	H	L
BOMP6026	M	L	L	L	L	H	L	H	M	M	H	H	H	H
BOBA6027	H	H	M				L	H		H	H	M	H	H
VAC	L	H	M					M		M	M		M	L
VAC	H	H	H	M	M	M	M	H	H	H	H	M	H	L
BOCM0024	H	M									H		H	H
BOPP0026	M	H	L	L	L	L	M	M	L	H	H	H	H	H
BOER0031	H	M				M					H		H	L

BOPB0025	H	H	H	H	H	H		H	M	H	H	H	H	H
BOCB6028	H	H	H	H	H	H		H	M	H	H	H	H	H
BOPP6029	M	L	L	L	L	H	L	H	M	M	H	H	H	H
BOER6033	H	M		L			L		M		H		H	L
BOCP0027	H	H						M		M	H	M	M	M
BOPE0028	H	H	M	L	L	M	M	H	M	H	H	M	H	H
BOBB0029	H	H	H	M	M	H	L	M	M	H	H	H	H	H
BOTC0030	H	H	H	H	H	H	H	H	M	H	H	H	H	H
BOPE6030	H	H	M	L	L	M	M	H	M	H	H	M	H	H
BOCT6031	H	H	H	L	M	H	L	M	M	M	H	H	H	H
VAC	H	H	M	L		L	M	H	M	H	H	M	H	H
BOFP0032	H	H	H	H	H	H	H	H	M	H	H	H	H	H
BOAB0033	H	H	H	H	H	H	H	H	M	H	H	H	H	H
BOGT0034	H	M									H	H	H	L
BOMB0035	H	M									H	H	H	L
BOTS0038	H	M	M								M		M	L
BOBE0039	M	M	M									M	M	L
BOEG0040	H	H	M	L		M	M	H	M	H	H	M	H	H
BORE0041	H	H	M	L		M	M	H	M	H	H	M	H	H
NEW (4.09)	M	H	H	H				M		M	M	H	H	M
NEW (4.10)	H	H	H	M				M		H	M	H	M	M
NEW (4.11)	H	H	H	H	H	H		H	M	H	H	H	H	H
NEW (4.12)	H	H	H	H	H	H		H	M	H	H	H	H	H
NEW (4.13)	H	H	H	M	M	M	M	H	H	H	H	M	H	L
NEW (4.14)	H	H	H	M	H	H	L	H	H	H	H	H	H	H

THEORY COURSES

BOMP0021: MYCOLOGY AND PHYCOLOGY

(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course outcomes

At the end of this course, student will be able to:

1. Understand general characteristics, classification and economic importance of fungi and algae (Remembering) \
2. Able to compare the vegetative and reproduction structures among groups of fungi and algae (Understanding)
3. Able to tell the importance of algae in environment and agriculture (Evaluating)
4. Develop scientific skill sets in and implement in agriculture (Applying)

Module I: Introduction (4 Hours)

Introduction, history, general features and economic importance of fungi

Module II: Classification of fungi (20 Hours)

Myxomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina- important features; thallus organizations; modes of reproduction

Module III: Role of Fungi in agriculture and environment (4 Hours)

Mycorrhizal associations and Lichens-their importance to agriculture and environment; Fungi as bio-fertilizers

Module IV: Introduction to algae (4 Hours)

History; general description; systems of classification and economic importance of algae

Module V: Classification of algae (20 Hours)

Classification (*Cyanophyta, Chlorophyta, Phaeophyta, Rhodophyta, Xanthophyta, Chrysophyta, Bacillariophyta, Pyrrophyta, Euglenophyta, Eustigmatophyta, Prasinophyta* and *Prochlorophyta*); cell structure; thallus organization and mode of reproduction in algae

Module VI: Role of algae in agriculture and environment (4 Hours)

Algal blooms - its importance; Algae as feed; bio-fertilizers; pollution indicators

Module VII: Research on Fungi and algae (4 Hours)

Current and future research; Future prospects/scopes in these areas

Suggested Readings

1. Alexopoulos CJ, Mims CW, Blackwell M. Introductory Mycology, Willey.
2. Dube HC. An Introduction to Fungi, Scientific Publishers.
3. Aneja KR. Mehrotra RS. Introduction to Mycology, New Age International Publisher.
4. Peterson JH. The Kingdom of Fungi, Princeton University Press.
5. Smith AL. Lichens, Wentworth Press.
6. Sharma, O.P. Algae, McGraw-Hill Education.
7. Van Den Hoek, C., Mann, D. G. and Jahns, H.M. Algae: An Introduction to Phycology, Cambridge University Press.
8. Bilgrami, K.S. and Saha, L.C. A textbook of Algae, CBS.
9. Lee, R.E. Phycology, Cambridge University Press.
10. Bellinger, E.G. and Sigee, D.C. Freshwater Algae: Identification, Enumeration and use as Bioindicator, Willey Blackwell.
11. Dutta, T.C. and Dutta, A. C. A Class-Book of Botany. Oxford University Press

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI	Module VII
CO1	H	M		H	M		L
CO2	L	H		L	H		L
CO3		M	H		M	H	L
CO4	L	M	H	L	M	H	H

BOBP0022: BRYOPHYTES, PTERIDOPHYTES AND GYMNOSPERMS

(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course Outcomes

At the end of this course, student will be able to:

1. Summarize the general characteristics, morphological and reproductive diversity among different groups of Bryophytes

(Understanding)
2. Compare the general characteristics, morphological and reproductive diversity among different groups of Pteridophytes (Understanding)
3. Interpret the general characteristics, morphological and reproductive diversity among different groups of Gymnosperms (Understanding)
4. Identify the different economic importance of the Bryophytes, Pteridophytes and Gymnosperms (Applying)
5. Infer fossils and fossilization (Understanding)

Module I: Bryophytes (20 Hours)
General introduction, Classification of Bryophytes; evolutionary history and phylogenetic characterization of bryophytes; comparative account of gametophyte and sporophyte structure of *Hepaticopsida, Bryopsida* and *Anthocerotopsida*; Peristome structure and its significance in the classification of Mosses; Economic importance of Bryophytes

Module II: Pteridophytes (20 Hours)
General introduction, Classification and range of thallus of Pteridophytes; evolutionary history and phylogenetic characterization of pteridophytes; early vascular plants; a brief account of the following classes of Pteridophytes: *Psilotopsida, Lycopsida, Sphenopsida, Pteropsida*; Telome concept, apogamy and apospory, heterospory and seed habit; Economic importance of Pteridophytes

Module III: Gymnosperms (15 Hours)
General introduction, Classification of Gymnosperms; Comparative study of *Cycadales, Ginkgoales, Coniferales, Ephedrales, Welwitschiales* and *Gnetales*; Economic importance of Gymnosperms

Module IV: Paleo-botany (5 Hours)
Introduction, Fossils, Kinds of fossils and process of fossilization; Geological time scale; Importance of fossils

Suggested Readings
1. Alam, A. Textbook of Bryophyta, I K International Publishing House Pvt Ltd.
2. Johri, R.M, Lata, S, Tyagi, K. A Textbook of Bryophyta, Dominant Publishers and Distributors (Cornell University).
3. Vashishta, P.C., Sinha, A.K. and Kumar, A. Botany for Degree Students-Pteridophyta, S. Chand.
4. Mitra, J.N, Mitra, D. and Chowdhury, S.K. Studies in Botany (Vol I & Vol II), Moulik Library.
5. Sharma, O.P. Pteridophyta, McMillan India Limited.
6. Rashid, A. An Introduction to Pteridophyta, South Asia Books.
7. Verma, H.K.A Textbook of Pteridophyta. Random Pub.
8. Bhatnagar, S.P. Gymnosperms, New Age International Publishers

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H			
CO2		H		
CO3			H	
CO4	M	M	M	
CO5				H

BOAN0023: ANGIOSPERMS
(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course Outcomes
At the end of this course, student will be able to:
1. Understand the concepts of plant identification, classification, nomenclature (Understanding)
2. Understand the general morphology and distinguishing characteristics of different angiosperm families(Understanding)
3. Identification of dicotyledons and monocotyledons plants with reference to specific key characters (Applying)
4. Understand the internal organization of the tissue and cell structure of both vegetative and floral parts of angiosperm plants (Understanding)
5. Understand the development of gametophytes, fertilization, endosperm, embryo, apomixis and parthenocarpy in angiospermic families (Understanding)
6. Application of anatomy and embryology in taxonomy (Applying)

Module I: Taxonomy (12 Hours)
History of plant taxonomy; Methods of Plant identification; Taxonomic Keys: Single access and Multi-access; Field inventory; Collection; Herbaria: Functions of Herbarium, Preparation of Herbarium; Major systems of classification: Cronquist(1981); Takhtajan'sSystem (1997), APG IV (2016) (merits and demerits). Principles and rules of Botanical Nomenclature

Module II: Morphology (8 Hours)
Vegetative Characters: Modified Roots and Stems; Leaf Phyllotaxy, Venation; Trichomes. Reproductive Characters: Floral parts, Arrangements of flowers on the floral axis, Unisexual and Bisexual Flowers, Variation in fruit surface, Placentation, Variation in seed coats

Module III: Angiospermic Families (15 Hours)
Dicotyledons: *Magnoliaceae, Annonaceae, Tiliaceae, Sterculiaceae, Rutaceae, Meliaceae, Vitaceae, Sapindaceae, Anacardiaceae, Fabaceae, Caesalpinaceae, Mimosaceae, Oleaceae, Apocynaceae, Asclepidaceae, Boraginaceae, Scrophulariceae, Bignoniaceae, Acanthaceae, Euphorbiaceae, Moraceae*. Monocotyledons: *Orchidaceae, Musaceae, Araceae, Commelinaceaee, Zingiberaceae, Cyperaceae, Poaceae*

Module IV: Anatomy(10 Hours)
Meristem, Classification of meristems; Permanent tissue; Theory of shoot apical meristem and root apical meristem; Origin, structure and function of cambium; Primary and secondary structure of root and stem, Anomalous secondary growth in roots and stems. Cork cambium and its derivatives, function of cork and abscission layers. General structure of plants; cell wall, stomata and secretary structure; Anatomy of floral organs; Anatomy in relation to taxonomy

Module V: Embryology (15 Hours)
Structure of microsporangium, microsporogenesis and development of male gametophyte; Structure of ovule, megasporogenesis and development of female gametophyte; Pollen-Pistil interaction; Fertilization and its control; Endosperm types, structure and functions; Dicot and monocot embryo; Embryo endosperm relationship; Polyembryony and its induction, Apomixis, causes and significance; Parthenocarpy; Embryology in relation to taxonomy

Suggested Readings
1. Pandey, B.P. A textbook of Botany: Angiosperms S. Chand.
2. Sharma, O.P. Plant Taxonomy McGraw-Hill Education
3. Nair, R. Taxonomy of Angiosperms APH Publishing Corporation
4. Singh, G. Plant Systematics: An Integrated Approach. CRC Press.
5. Lawrence, G.H.M. Taxonomy of Vascular Plants Scientific Publisher.
6. Subramanyam, N.S. Modern Plant Taxonomy. Vikas Publishing House Pvt. Ltd. New Delhi.
7. Sambamurty, A.V.S.S. Taxonomy of Angiosperms. I. K. International Publishing House Pvt. Ltd., New Delhi.
8. Verma, B.K. Introduction to Taxonomy of Angiosperms. PHI Learning Private Limited, New Delhi.
9. Pandey, B.P. Plant anatomy, S. Chand & Co., New Delhi
10. Esau, Anatomy of Seed Plants. John Wiley & Sons, New York.
11. Grewal, Plant anatomy. Campus Books International, New Delhi.
12. Maheshwari, An Introduction to Embryology of Angiosperms. Tata McGraw Hill Publising Co., New Delhi.
13. Bhojwani, S.S., Bhatnagar, S.P. and Dantu, P.K. The Embryology Angiosperms, Vikas Publishing

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO1	H				
CO2		H			
CO3			H		
CO4				H	
CO5					H
CO6				M	M

BOCM0024: CELL AND MOLECULAR BIOLOGY
(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course Outcomes
At the end of this course, student will be able to:
1. Memorize the key concepts of cell and its structural organization (Remembering)
2. Analyse the process of DNA replication and compare various repair mechanism (Analysing)
3. Gain better understanding of gene cloning and DNA libraries (Understanding)
4. Understand the basics of gene cloning and importance of genome evolution (Understanding)

Module I: Basics of Cell (4 Hours)
Cell: Concept, structural organization of plant cell.

Module II: Cellular Organelles: Their Organizations and Functions (15 Hours)
Mitochondria: structure, genome organization, protein import and mitochondrial assembly. Chloroplast: structure, genome

organization, import and sorting of chloroplast proteins. Endoplasmic reticulum: structure, translocation of secretory proteins across ER membrane, insertion of protein into ER membrane, protein folding and processing. Golgi apparatus: organization, protein glycosylation, protein sorting and export from Golgi, the vesicular transport mechanism. Nucleus: nuclear envelope, nuclear pore complex, trafficking between nucleus and cytoplasm.

Module III: Gene and Genome (6 Hours)
Gene and genome: fine structure of gene, genome organization

Module IV: Enzymes for Gene Manipulations (7 Hours)
DNA/gene manipulating enzymes, restriction enzymes: endonuclease, exonuclease, types of endonucleases, recognition sequences, ligase, polymerase, phosphatase, transcriptase, transferase, topoisomerase

Module V: DNA Replication (7 Hours)
Various models, enzymes for replication, structure of DNA polymerase, speed of replication, collaboration of proteins, process and termination of replication

Module VI: DNA Damage and Repair Mechanism (6 Hours)
Basic concept, types of DNA damage thymine dimer, 6- 4 photoproducts, photo-reactivation, excision repair

Module VII: Transposons and Genetic Recombination (8 Hours)
Mobile genetic elements: Insertion elements, transposons. Genetic recombination: Holliday, Potter & Dressler, Meselson and Radding and Szostak model of genetic recombination

Module VIII: Basics of Gene Cloning (7 Hours)
Gene cloning: cloning vectors (types and characteristics), molecular cloning and construction of DNA libraries

Suggested Readings

1. Lewin. Genes. Published by Pearson Prentice Hall
2. Albert. Molecular Biology of Cell
3. Singh, B. D. Fundamentals of Genetics Kalyani Publications
4. Brown TA. Gene Cloning and DNA Analysis: An Introduction. Blackwell Publishing
5. Watson J. Molecular Biology of Gene

Mapping of COs to Syllabus

Course Outcomes	**Module I**	**Module II**	**Module III**	**Module IV**	**Module V**	**Module VI**	**Module VII**	**Module VIII**
CO1	**H**	**H**	**L**	**L**	**L**		**H**	**L**
CO2		**L**			**H**	**H**		
CO3	**L**					**M**	**L**	**H**
CO4		**L**	**H**	**M**				**M**

BOPB0025: PLANT PHYSIOLOGY AND BIOCHEMISTRY

(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course outcomes
At the end of this course, student will be able to:
CO1: Explain the concepts of plant water relation, transpiration, mineral nutrition, uptake and translocation of nutrients (Understanding)
CO2: Understand the process of photosynthesis and respiration (Understanding)
CO3: Analyze the role of photoreceptors, growth regulators in different physiological process and plants respond towards abiotic stress (Analyzing)
CO4: Explain the concepts of thermodynamics, enzyme kinetics and biomolecule metabolism (Understanding)

Module I: Plant water relations, Absorption and Transport Mechanism (8 Hours)
Concept of water potential; Absorption and transport of water; Ascent of sap; Transpiration, mechanism of stomatal movement; Mineral nutrition: physiological roles and deficiency symptoms; Nutrient uptake; Translocation in phloem.

Module II: Photosynthesis (8 Hours)
Photosynthetic pigments, Photosystems I and II, Electron transport chain and photophosphorylation, Mechanism of ATP synthesis; Pathways of CO_2 fixation: C3, C4 and CAM, Photorespiration, Factors affecting photosynthesis.

Module III: Respiration (8 hours)
Overview of plant respiration, Glycolysis, TCA cycle, Mitochondrial electron transport, Oxidative and substrate level phosphorylation, Mechanism of ATP synthesis, Pentosphosphate pathway, Mechanism of anaerobic respiration.

Module IV: Sensory photobiology, Plant growth regulators and stress physiology (16 Hours)
Photoperiodism and Vernalization, Discovery of phytochromes and cryptochromes and their photochemical and biochemical properties; Bioassay, biosynthesis, physiological roles and mechanism of action of plant growth regulators; Physiological responses of plants to abiotic stress: water, temperature and salt.

Module V: Thermodynamics and Bioenergetics (4 Hours)
Laws of thermodynamics; Gibbs Free Energy; enthalpy, entropy, energy change in coupled reactions, energy rich phosphate compounds, ATP as universal currency of energy, energetics of metabolic processes.

Module VI: Properties of Water and Enzyme Kinetics (6 Hours)
Dissociation of water, ion product of water, pH, ionization of weak bases, biological buffers Henderson-Haselbach Equation. General aspects of enzymes, prosthetic groups and co-enzyme, allosteric mechanism, regulatory enzyme, active sites, isozyme, ribozyme, mechanism of catalysis, kinetics, Michaelis-Menten Equation, enzyme inhibition.

Module VII: Metabolism of Biomolecules (10 Hours)
Structures and functions of amino acids, peptides and proteins; Carbohydrate: classification**,** structures, functions, biosynthesis and metabolism; lipid: synthesis of saturated and unsaturated fatty acids, oxidations of fatty acid. dd

Suggested Reading

1. Davies PJ. Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.
2. Nelson DL. and Cox MM. Lehninger Principles of Biochemistry, 4th Edition, W.H. Freeman and Company, New York, USA.
3. Hopkins, W.G. and Huner, A. (2008) Introduction to Plant Physiology, 4th edition, John Wiley and Sons, USA
4. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A. (2015) Plant Physiology and Development, 6th edition, Sinauer Associates Inc., USA
5. Harborne, J.B. (1973) Phytochemical Methods, John Wiley & Sons, New York

Mapping of COs to Syllabus

Cos	Module I	Module II	Module III	Module IV	Module V	Module VI	Module VII
CO1	3						
CO2		3	3				
CO3				3			
CO4					3	3	3

BOPP0026: PLANT MICROBIOLOGY AND PLANT PATHOLOGY

(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course Outcomes
At the end of this course, student will be able to:

1. Classify various microorganisms and their reproduction and isolation methods (Understanding)
2. Analyze the roles of microorganisms in environment (Analyzing)
3. Identify and detect microbial plant diseases and decide control strategies (Applying)
4. Asses and apply post-harvest controls measures and techniques (Evaluating)

Module I: Introduction to microbial world and microscopy (6 Hours)
A brief history of microbiology and its evolution; Microscopy-principle, types and applications

Module II: Microbial diversity and applications (10 Hours)
Bacteria & Archaebacteria: properties, classification, nutritional types; Viruses- properties and classification, prions and bacteriophages; Role of microorganisms in the environment

Module III: Isolation and cultivation of bacteria and viruses (10 Hours)
Types of nutritional media (Liquid & solid), types of bacterial cultures- batch, continuous and synchronous, growth curve and pure culture of microorganism; Isolation methods of bacteria, virus and phages

Module IV: Microbial Genetics and its life cycle (8 Hours)
Genome organization in microorganism (DNA, RNA, Plasmids); mechanisms of transformation, conjugation and transduction in bacteria; Life cycle of viruses and bacteriophages

Module V: An insight into Plant Pathology (8 Hours)
Historical and developmental aspects of plant pathology, mode of infection and role of enzymes and toxins in plant disease, defense mechanisms of plants against infection

Module VI: Plant diseases & control measures (12 Hours)
Study of plant diseases caused by fungi, bacteria, viruses, nematodes and mycoplasma; approaches for plant disease control-cultural, chemical, biological, bio pesticides, breeding for resistant varieties, plant quarantine, integrated pest management; molecular and transgenic approach for crop protection

Module VII: Post-harvest Management (6 Hours)
Post-harvest pathology: Fungal deterioration of food commodities, mycotoxins and health hazards, control measures; overview of integrated pest management

Suggested Reading

1. Pelczar MJ. Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
2. Prescott L, Harley JP, Klein DA. Microbiology, McGraw Hill, India. 6th edition.
3. Campbell NA, Reece JB, Urry .A., Cain L, Wasserman SA, Minorsky PV, Jackson
4. Mehrotra RS, Aggarwal A. Plant Pathology, 2nd Edition, Tata McGraw-Hill Publishing Company Ltd.
5. Singh RP. Plant Pathology, 2nd Edition, Kalyani Publishers.
6. Mehrotra RS, Aggarwal A. Fundamentals of Plant Pathology, Tata McGraw-Hill Publishing Company Ltd.
7. Sambamurty AVSS. A textbook of Plant Pathology, Dreamtech Press, Wiley.
8. Gour HN. Physiological and Molecular Plant Pathology, Scientific Publishers India.
9. Dickinson M. Molecular Plant Pathology, Garland Science

Mapping of COs to syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI	Module VII
CO1	M	M	H		L	M	
CO2	L	H			M	M	M
CO3			M	L	M	H	
CO4				M	M	M	H

BOCP0027: CYTOGENETICS AND PLANT BREEDING

(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course Outcomes
At the end of this course, student will be able to:
1. Infer eukaryotic genome organization structure of nucleosome, its assembly and deassembly (Understanding)
2. Summarize the cytogenetics of haploids and their uses in plant breeding (Understanding)
3. Compare euploids with aneuploids and explain chromosomal banding patterns (Understanding)
4. Illustrate the role of plant breeding and transgenic research in crop improvement (Understanding)
5. Outline the various methods of gene transfer (Understanding)
6. Compare the different types of DNA and also interpret gene mapping (Understanding)

Module I: Overview of Gene and Genome Organization (10 Hours)
Organization of eukaryotic genetic material, Chromatin organization and replication: Chemical constituents-DNA and histones, nucleosome and higher order organization, DNA packaging and genetic activity, nucleosome assembly and deassembly, DNA content and adaptability, nuclear DNA and C-value paradox

Module II: Cytogenetics of Haploids (8 Hours)
Haploidy/monoploidy, meiosis and breeding behaviour of haploids, uses of haploids in plant breeding and genetic studies

Module III: Euploidy and Aneuploidy (10 Hours)
Induction and characterization of monosomics, trisomics and nullisomics, aneupolid gene mapping, inheritance pattern in autopolyploids, status of allopolyploids in plant evolution

Module IV: Chromosomal banding (6 Hours)
Chromosome banding patterns: Linear differentiation of chromosome segments, types of chromosome banding, uses of chromosome banding in cytogenetics

Module V: Plant Breeding and Crop Improvement (10 Hours)
Objectives and scope of plant breeding, hybridization in self- and cross-pollinated crops, genetic basis of inbreeding depression and heterosis, breeding for disease and insect resistance, transgenes and transgenic plants, bio-safety concerns & regulation of transgenic crops in India

Module VI: Gene Transfer Technology (6 Hours)
Alien gene transfer through chromosome: Transfer of gene through individual chromosome, characterization and utility of alien addition and substitution lines

Module VII: Types of DNA and Gene Mapping (10 Hours)
Repetitive DNA, split genes, overlapping genes, physical and genetic mapping using molecular markers

Suggested Reading

1. Allard RW. Principles of Plant Breeding (2nd Edition), John Wiley and Sons
2. Hartwell LH, Hood L, Goldberg ML, Reynolds AE, Silver LM, Veres RC. Genetics –From Genes to Genomes, 3rd edition, McGraw Hill.
3. Acquaah G. Principles of Plant Genetics and Breeding, Blackwell Publishing Ltd. USA.
4. Hartl DL and Jones EW. Genetics – Analysis of Genes and Genomes, 7th edition, Jones and Barlett publishers.
5. Lewin B. Genes IX, Jones and Barlett Publishers.
6. Strickberger MW. Genetics, 3rd Edition, Pearson (Prentice Hall).

Mapping of COs to Syllabus

COs	Module I	Module II	Module III	Module IV	Module V	Module VI	Module VII
CO1	H						
CO2		H					
CO3			H	H			
CO4					H		
CO5						H	
CO6							H

BOPE0028: PLANT ECOLOGY AND PHYTOGEOGRAPHY

(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course Outcomes
At the end of this course, student will be able to:
1. Understand the concepts and scope of ecology (Remembering).
2. Understand about the fundamental structural and functional aspect of ecosystem (Understanding)
3. Analyze the characteristic feature of plant population, dynamics and interrelationships (Analysis)
4. Understand the concept of community, concept of climax, ecological succession (Understanding).
5. Understanding the concept of ecological stability and perturbations (Understanding)
6. Acquire detail knowledge on plant diversity, its status and threats, strategies for conservation (Remembering)
7. Understanding the concept of phytogeography and phyto-geographical division of India (Understanding)

Module I: Introduction to Ecology and Ecological Organization (12 Hours)
Introduction to ecology, scope of ecology, Ecosystem: concept, components and organization, structure and functions of ecosystem, energy dynamics (trophic organization, energy flow pathways, ecological efficiencies), eco-physiology, ecosystem nutrient cycles, ecological niche, ecosystem types, major ecosystems of the world

Module II: Population Ecology (14 Hours)
Population Ecology: Characteristics of population, population growth curves, population size and density, spatial distribution, Age structure, natality, mortality, biotic potential; life history strategies (r and k selection), population dynamics, competition and coexistence, population interaction, Intra-specific interactions, interspecific interactions, Mutualism and commensalism, Prey-predator interactions, Scramble and contest competition.

Module III: Community Ecology and Ecological Succession (12 Hours)
Concepts of community, species diversity and pattern diversity in community, Ecological succession: Trends of succession, Types and general process of succession, models and mechanisms of ecological succession, concept of climax, community evolution

Module IV: Ecosystem Stability (10 Hours)

Concept (resistance and resilience); ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems; ecology of plant invasion

Module V: Biodiversity and Phytogeography (12 Hours)
Plant diversity: Concept, status in India, utilization and concerns, Loss of diversity and causes, Indigenous medicinal systems, Strategies for conservation - in situ conservation and ex situ conservation: general account of the activities of Botanical Survey of India (BSI), Sustainable development, Phytogeography - Principles and importance of plant geography, phyto-geographic regions of world and India, biomes: Classification and components, Willis - Age and Area hypothesis. Continuous range, cosmopolitan circum polar, circum boreal and circum austral, Discontinues distribution - Wagener theory - continental drift hypothesis, endemism

Suggested Readings

1. Kormondy EJ. Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition
2. Odum EP. Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
3. Singh JS, Singh SP, Gupta S. Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
4. Wilkinson DM. Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
5. Sharma PD. Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
6. Ambasht, R.S. (1988). A text books of plant ecology. Students, Friends & Co., Varanasi
7. Kumar, H.D. (1997). General ecology, Vikas Publication company, New Delhi
8. Pandey, K. and Shukla, J.P. (2009). Elements of toxicology, Wisdom press, New Delhi

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO1	H				L
CO2	H				
CO3		H			
CO4		L	H		
CO5				H	
CO6					H
CO7					H

BOBB0029: BIOCHEMICALS, MOLECULAR TECHNIQUES & BIOINFORMATICS

(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course Outcomes

At the end of this course, student will be able to:

CO1: Interpret different molecular biology techniques (Understanding)

CO2: Compare various blotting techniques, summarize spectrometry and spectroscopy (Understanding)

CO3: Interpret RNAi (Understanding)

CO4: Demonstrate various chromatographic and microscopic techniques (Understanding)

CO5: Utilize the knowledge on bioinformatics to use various biological databases and software (Applying)

Module I: An introduction to Molecular Biology: methods & techniques (15 Hours)

Isolation and purification: Genomic and plasmid DNA; RNA; proteins. Electrophoresis: Polyacrylamide gel electrophoresis (PAGE), agarose gel electrophoresis, native PAGE, SDS-PAGE, 2D electrophoresis. DNA amplification and genome mapping: PCR, RT-PCR, RFLPs, RAPD, AFLP, SSR, ISSR, SNP, Isoelectric focusing (IEF): Principles, kinds of pH gradients used in IEF- free carrier ampholytes, immobilized pH gradients, genome expression analysis: Microarray, EST, SAGE. DNA sequencing: Various methods of DNA sequencing, protein and whole genome sequencing strategies. Isolation, separation and analysis of carbohydrate and lipid molecules, Bar-coding with references to plants

Module II: Immunotechniques & Biophysical methods (10 Hours)

Blotting: Principles, types of blotting, immunoblotting- Southern, Northern, Western and Dot blots, FISH, GISH, Mass spectrometry: GC-MS, LC-MS, Spectroscopy: basic concept, NMR & ESR spectroscopy

Module III: Basic principle of Gene silencing (5 Hours)

Gene silencing: RNA interference (RNAi)

Module IV: Chromatographic techniques (10 Hours)

Chromatography: Gel filtration, ion exchange & affinity chromatography, paper chromatography,TLC, HPLC, GC- basic concept

Module V: Microscopic techniques (10 Hours)

Resolving powers of different microscopes, Microscopy: Phase contrast, confocal, fluorescence, scanning & transmission electron microscopy

Module VI: Bioinformatics (10 Hours)

Basic concepts of computer hardware; Operating systems-Windows, Unix and Linux; use of common application software in biology: word processing, spread sheets, graphics and database; introduction to web browsing software and search engines with special reference to online bioscience resources; database, sequence analysis, phylogenetic inference package, sites and centres, Primer designing using various softwares, BLAST

Suggested ReadingS

1. Hofmann A. Wilson and Walkers Principles and Techniques of Biochemistry and Molecular Biology, 8th South Asia Edition, Cambridge University Press.
2. Carson S, Miller HB, Witherow DS. Molecular Biology Techniques: A Classroom Laboratory Manual, 4th Edition, Elsevier.

3. Agrawal and Suraksha. Techniques in Molecular Biology, 2008 Edition, IBDC Publishers.
4. Bajpai PK. Biological Instrumentation & Methodology, S. Chand.
5. Lesk AM. Introduction to bioinformatics, 4th Edition, Oxford Attwood TK, Parry-Smith DJ. Introduction to Bioinformatics, Pearson India

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO1	H					
CO2		H				
CO3			H			
CO4				H	H	
CO5						H

BOTC0030: Plant Cell and Tissue Culture (4 CREDITS-60 HOURS) (L-T-P: 4-0-0)

Course Outcomes:
At the end of this course, student will be able to:
CO1: Understand the concepts of tissue culture techniques (Understanding)
CO2: Enable students to learn the importance of applied tissue culture techniques (Understanding)
CO3: Evaluate various methods of preservation of endangered germplasm (Analyzing)
CO4: Gain knowledge on industrial implementation of tissue culture techniques (Creation)

Module I: Introduction to Plant Tissue Culture (4 Hours)
Principles of plant tissue culture: historical perspective, organization of laboratory, media composition and preparation, aseptic manipulation.

Module II: Cellular Totipotency and Clonal Propagation (8 Hours)
Concepts of cellular totipotency and differentiation, process and mechanism, cell culture and cell cloning, clonal propagation, stages and steps of clonal propagation.

Module III: Organogenesis and Embryogenesis (10 Hours)
Process and types of organogenesis: direct and indirect organogenesis, factors effecting organogenesis; Somatic embryogenesis: induction, basic requirement and factors effecting somatic embryogenesis.

Module IV: Somatic Hybridization (10 Hours)
Somatic Hybridization: isolation, culture and fusion of protoplasts, regeneration of hybrids and cybrids, applications, advantages and disadvantages of hybrids and cybrids.

Module V: Production of Haploids, Somaclonal and Gametoclonal variation (8 Hours)
Haploids: androgenic and gynogenic; application of haploids, advantages and disadvantages; somaclonal and gametoclonal variation and their selection and promises.

Module VI: Industrial application and Germplasm storage (8 Hours)
Suspension culture, hairy root culture and bioreactors, production of secondary metabolites, synthetic seed technology, cryopreservation and germplasm storage.

Module VII: Transgenics (12 Hours)
Basic concepts, transgenic plants, method of transformation, selection, identification, molecular analysis for confirmation and application.

Suggested Readings:
1. Pierik RLM, In Vitro Culture of Higher Plants. Kluwer Academic Publishers.
2. George EF, Hall MA, Geert-Jan De Klerk, Plant Propagation by Tissue Culture (3rd Edition), Springer, Netherlands.
3. Herman EB. Media and Techniques for Growth, Regeneration and Storage Agritech Publications, New York, USA.
4. Brown TA. Gene Cloning and DNA Analysis: An Introduction, Blackwell Publishing
5. Watson J. Molecular Biology of Gene.
6. Bhojwani, S.S. and Razdan, M.K. *Plant Tissue Culture: Theory and Practice*. The
7. Netherlands: Elsevier Science Amsterdam, 1996. Print.

Mapping of COs to Syllabus

Cos	Module I	Module II	Module III	Module IV	Module V	Module VI	Module VII
CO1	3	3	3				
CO2				3	3		2

CO3						3	
CO4						3	3

BOER0031: ENVIRONMENTAL MANAGEMENT, RESEARCH METHODOLOGY & BIOSTATISTICS
(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course Outcomes

At the end of this course, student will be able to:

1. Acquire the concepts of Environmental Management and Environmental Impact assessment (Understanding)
2. Understand the salient features of EIA and safety norms (Understanding)
3. Identify and argue the complex issues inherent in selecting a research problem, selecting an appropriate researchdesign and implementing a research project (Applying)
4. Understand the principal concepts in biostatistics (Understanding)
5. Analyze the concepts of scientific research problems and its solutions (Analyzing)

Module I: Basics of Environmental Management & Impact Assessment (10 Hours)

Introduction and scope of environmental management; basic concepts of sustainable development; Environmental impact assessment (EIA); general guidelines for the preparation of environmental impact statement; scope and types of environmental audit; energy audit; cost benefit analysis

Module II: Environmental Management Plans and Safety Norms (10 Hours)

Environmental management plan; ISO 14000 standards and certification; environmental risk management and environmental safety norms; International summits and treaties related with environment

Module III: Introduction to Research Methodology (10 Hours)

Definition; basic and applied research; interdisciplinary research; Discriminative reading; reading and reviewing scientific literature; biological abstract; review; monograph; peer-reviewed journals; e-resources; research and review articles

Module IV: Introduction to Research Problems, Communication and Ethics (10 Hours)

Definition of scientific problems; scientific papers and posters; Introduction to ethics, scientific conducts and misconduct; plagiarism; authorship issues; ethics of animal and human research

Module V: Introduction to Biostatistics (5 Hours)

General concepts and terminology; measures of location; scale and shape; mean, median, mode, standard deviation, standard error and coefficient of variance; Binomial, Poisson and Normal distribution

Module VI: Hypothesis Tests, Multivariate Analysisand Sampling Design(15 Hours)

Contingency tables and chi-square test; comparison of means: t-test, multiple range tests, F-test, Run test, sign test, Karl Pearson coefficient of correlation, Kruskal-Wallis H test and Mann-Whitney U-test, Analysis of variance; Correlation and regression analysis; Introduction to multivariate methods; Sampling methods; Simple experimental design

Suggested Readings

1. Gupta SC, Kapoor, V.K. Fundamentals of Mathematical Statistics, 11th Edition, Sultan Chand & Sons
2. Krishnan V. Statistics for Beginners, Atlantic Publishers & Distributors Pvt. Ltd.
3. Fuller WA. Sampling Statistics, Wiley.
4. Easterling RG. Fundamentals of Statistical Experimental Design and Analysis, Wiley
5. Bhattacharyya, D. K. (2005): Research Methodology, Excel Books, New Delhi
6. Ahuja, R. (2001): Research Methods, Rawat Publications, Jaipur and New Delhi
7. Sulphey, M.M. and Safeer, M.M. (2015). Introduction to Environment Management (3rdedn.). PHI Learning Pvt.Ltd, New Delhi.
8. Tiwari, M., Khulbe, K. and Tiwari A. (2007) Environmental Studies. I.K. International, New Delhi

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO1	H	L				
CO2	L	H				
CO3			H	H		L
CO4					H	
CO5				L	L	H

SPECIALIZATION : PLANT BIOTECHNOLOGY

BOFP0032: FUNDAMENTALS OF PLANT BIOTECHNOLOGY

(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course Outcomes

At the end of this course, student will be able to:

CO1: Grasp the insight of plant biotechnology (Remembering)
CO2: Comprehend the underlying concept of tissue culture (Understanding)
CO3: Learn and analyse the importance of genetic engineering in crop improvement (Analysing)
CO4: Utilize biosafety measures in handling GMOs and transgenics in laboratories (Applying)

Module I: Elementary Plant Biotechnology (5 Hours)

Historical background: plant cell and tissue and organ culture, principle of genetic engineering; totipotency and morphogenesis, scope and importance in crop improvement: plant tissue culture practical application and conventional plant breeding; Advantages - disadvantages

Module II: Basics of Organogenesis (7 Hours)

Organogenesis and somatic embryogenesis in plant tissue culture- development of whole plant - root formation, transfer of plant lets to the soil, hardening, principles of cellular regeneration, single cell culture and its applications, protoplast culture, factors effecting organogenesis, advantages-disadvantages and application

Module III: Micropropagation and Virus Indexing (8 Hours)

Shoot-tip meristem culture - raising virus free plants for rapid, methods of virus indexing *in vitro* mutagenesis; *in vitro* fertilization; *in vitro* germplasm conservation; hybrid embryo rescue, production of secondary metabolites, synthetic seed production technology, production of industrial phytochemicals, advantages of micropropagation in agriculture and horticulture

Module IV: Principles of Genetic Engineering (15 Hours)

Principles of recombinant DNA technology, restriction enzymes; vectors for gene transfer – gene cloning, viral vectors and their benefits, screening and selection of transformants; DNA profiling and blotting techniques, types, procedure, application, advantages-disadvantages,nanobiotechnology and its application

Module V: Genetically Modified Organisms (GMOs) and Transgenics (15 Hours)

GMOs and their significance in biotechnology, transgenic plants and its application in agriculture, different methods of plant genetic transformation, *Agrobacterium tumefaciens*, infection and molecular mechanism of tumor formation, Ti plasmids and RIplasmids, binary vectors, genetic markers, reporter genes and its application in genetic engineering, other methods of plant genetic transformation, environmental issues associated with transgenic crops

Module VI: Biosafety, IPR and Bioethics (10 Hours)

Biosafety and risk assessment issues; national biosafety policies and law, General principles for the laboratory and environmental biosafety; creation of superweeds/superviruses, ecological aspects of GMOs and impact on biodiversity; food and feed safety issues associated with transgenic crops, intellectual properties, copyrights, trademarks, trade secrets, patents; Indian patent act and amendments, patent filing, Implications of intellectual property rights on the commercialization of biotechnology products

Suggested Readings

1. Singh BD. Biotechnology: Expanding Horizon. Kalyani Publication
2. Pierik RLM. *In Vitro* Culture of Higher Plants. Kluwer Academic Publishers
3. George EF, Hall MA, Geert-Jan De Klerk. Plant Propagation by Tissue Culture (3rd Edition), Springer, Netherlands.
4. Herman EB. Media and Techniques for Growth, Regeneration and Storage Agritech Publications, New York, USA.
5. Brown TA. Gene Cloning and DNA Analysis: An Introduction. Blackwell Publishing
6. Watson J. Molecular Biology of Gene

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VII
CO1	H	H	H	H	H	H
CO2	H	H	H		L	
CO3	M			H	M	L
CO4	L	L	M	H	H	H

BOAB0033: ADVANCES IN PLANT BIOTECHNOLOGY

(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course outcomes

At the end of this course, student will be able to:

1. Apply the concept of plant biotechnology into practice (Applying)
2. Work out the significance of tissue culture technique (Understanding)
3. Learn and analyze the importance of molecular techniques in up-scaling crop improvement (Understanding)
4. Figure out the importance of molecular farming in transforming secondary metabolites (Analysing)

Module I: Haploid Production and Cybridization (7 Hours)
Haploid production and uses, anther and microspore culture, pathways of development, factors affecting androgenesis, diploidization of haploids applications of haploids, limitations of haploids, cytoplasmic hybrids: technique of cybridization, application of cybrids, limitations, transgenics developed through cybridization and haploid productions

Module II: Biotransformation (7 Hours)
Hairy root cultures; screening of high yielding cell lines; procedures for extraction of high value industrial products, fractionation, bioassays; growth and production kinetics of cell cultures in shake flasks; scale-up procedures in bioreactors, types of bioreactors for plant cell cultures; Manipulation in production profile by biotic and abiotic elicitation; biotransformation of secondary metabolites

Module III: Molecular Farming and Energy Crops (7 Hours)
Aims and scope, strategies of molecular farming, production of industrial enzymes, biodegradable plastics, antibodies, edible vaccines; manipulation of metabolic pathways for production of secondary metabolites, transplastomics plants; energy crops: concept, types and examples, advantages-disadvantages of biofuels, application

Module IV: Molecular Markers in Crop Improvement (15 Hours)
DNA marker techniques, PCR and hybridization-based methods, methods of physical mapping – restriction mapping, DNA fingerprinting and foot printing methods, Development of sequence based molecular markers - SSRs and SNPs; advanced methods of genotyping, QTL mapping, Marker assisted selection (MAS)

Module V: Advanced Molecular Techniques (12 Hours)
Gel electrophoresis- agarose and PAGE (nucleic acids and proteins), isolation of high molecular weight DNA and analysis, southern hybridization; northern hybridization; western blotting and ELISA RNAi, antisense RNA, biosensor, Microarray studies, Marker-free transgenic development strategies

Module VI: Transgenics and Their Applications (12 Hours)
Target traits and transgenic crops, Genetic engineering for resistance against abiotic and biotic stresses; genetic engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; genetic engineering for quality improvement; Discussion on application of molecular, transformation and genomic tools for the genetic enhancement in some major field crops such as rice, wheat, cotton, maize, soybean, oilseeds, sugarcane

Suggested Readings
1. Singh BD. Biotechnology: Expanding Horizon. Kalyani Publication
2. Pierik RLM. *In Vitro* Culture of Higher Plants. Kluwer Academic Publishers
3. George EF, Hall MA, Geert-Jan De Klerk. Plant Propagation by Tissue Culture (3rd Edition), Springer, Netherlands.
4. Herman EB. Media and Techniques for Growth, Regeneration and Storage Agritech Publications, New York, USA.
5. Brown TA. Gene Cloning and DNA Analysis: An Introduction. Blackwell Publishing Watson J. Molecular Biology of Gene

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO1	H	H	H	H	H	H
CO2	H	H	H	-	-	M
CO3	-	-	L	H	H	H
CO4	-	H	H	-	-	L

SPECIALIZATION PAPER: GENETICS AND PLANT BREEDING

BOGT0034: GENETICS, PLANT BREEDING AND TRANSFORMATION
(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course Outcomes
At the end of this course, student will be able to:
1. Summarize the concepts of cell division and cell cycle (Understanding)
2. Interpret classical genetics (Understanding)
3. Illustrate the role of plant breeding in crop improvement (Understanding)

4. Outline the various techniques of plant genetic engineering (Understanding)
5. Infer the concept of cisgenics (Understanding)

Module I: Fundamentals of cell division and cell cycle (10 Hours)
Mitosis and meiosis: cell cycle, stages, synoptonemal complex, cytokinesis, molecular basis of cell cycle: cyclin dependent kinases (Cdks) and cyclins, cell cycle and cancer

Module II: Plant Genetics: an overview (10 Hours)
Mendelian genetics, multiple alleles, linkage and crossing over, sex linked traits and sex determination, cytoplasmic inheritance, structural and numerical changes in chromosome, mutation

Module III: Plant breeding for crop improvement (20 Hours)
Hybridization techniques in self- and cross-pollinated crops, molecular markers and their applications, role of association mapping and allele mining in crop improvement

Module IV: Recombinant DNA technology and genetic engineering (20 Hours)
Gene cloning, methods of plant transformation, biosafety issues and regulation of GMOs, generation of marker free transgenic lines: cre-lox system, co-transformation, FLP/FRT recombination system, AC/DS transposon system, twin T-DNA binary vector, cisgenics

Suggested Reading

1. Alberts B, Johnson A, Lewis J, Morgan D, Raff M, Roberts K, Walter P. Molecular Biology of the Cell, 6th Edition, W.W. Norton & Co., U.S.
2. Acquaah G. Principles of Plant Genetics and Breeding, Blackwell Publishing Ltd. U.S.A.
3. Snustad DP, Simmons MJ. Principles of Genetics, 6th Edition, John Wiley & Sons, Inc., U.K.
4. Strickberger MW. Genetics, 3rd Edition, Pearson (Prentice Hall)
5. Singh BD. Plant Breeding: Principles and Methods, Kalyani Publishers, India
6. Brown TA. Gene Cloning and DNA Analysis: An Introduction. Blackwell Publishing
7. Primrose SB, Twyman R. Principles of Gene manipulation and Genomics, 7th Edition, Wiley-Blackwell
8. Nigel AS. Plant Biotechnology: The genetic manipulation of plants, 2nd Edition, Oxford University Press
9. Gupta PK. Molecular Biology and Genetic Engineering, Rastogi Publications

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H			
CO2		H		
CO3			H	
CO4				H
CO5				H

BOMB0035: MOLECULAR GENETICS AND BIOINFORMATICS

(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course Outcomes
At the end of this course, student will be able to:
1. Interpret the fundamental processes in biology (Understanding)
2. Summarize the concepts of gene silencing (Understanding)
3. Comprehend the notions of genome editing (Understanding)
4. Utilize the knowledge on bioinformatics to run various biological databases and soft-wares (Applying)

Module 1: Understanding the fundamental processes (20 Hours)
DNA replication, repair and recombination, RNA and protein syntheses and their processing, regulation of gene expression

Module 2: Gene silencing: Its concepts (10 Hours)
Transcriptional and post transcriptional gene silencing, RNAi: History, mechanism, enzymes involved; role of RNAi in crop improvement

Module 3: Introduction to genome editing (15 Hours)
Genome editing: basic concepts, history, techniques of genome editing: TALENs, ZFNs, CRISPR/Cas (CRISPR/Cpf1), application of genome editing in crop improvement

Module 4: Bioinformatics (15 Hours)
Understanding the concepts of bioinformatics, its applications, introduction to online biological databases, phylogenetic

inference package, sites and centers, BLAST, sequence alignment, primer designing, conceptual data modeling

Suggested Reading

1. Watson J, Baker TA, Bell SP, Gann AAF, Levine M, Losick RM. Molecular Biology of the Gene, 7th Edition, Pearson Education
2. Lewin B. Genes IX, Jones and Barlett Publishers
3. Sohail M. Gene silencing by RNA Interference, 1st Edition, CRC Press
4. Hannon GJ. RNAi a guide to gene silencing, 2nd Edition, Cold Spring Harbor Laboratory Press, U.S.
5. Ridge Y. CRISPR: A powerful way to change DNA, Annick Press
6. Lesk AM. Introduction to bioinformatics, 4th Edition, Oxford Attwood TK, Parry-Smith DJ. Introduction to Bioinformatics, Pearson India

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H			
CO2		H		
CO3			H	
CO4				H

SPECIALIZATION PAPER: ANGIOSPERM TAXONOMY

BOTS0038: TAXONOMY OF ANGIOSPERMS AND BIOSYSTEMATICS

(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course Outcomes

At the end of this course, student will be able to:

1. Understand the concepts of plant identification, classification, nomenclature and biosystematics (Understanding)
2. Identification of plant with the help of keys and their relevant literatures(Applying)
3. Comparison of classical plant taxonomy with modern experimental plant taxonomy (Analyzing)
4. Summarize taxonomic hierarchy and principles and rules of botanical Nomenclature (Understanding)
5. Application of numerical taxonomy and phylogenetic systematicin angiosperms (Applying)

Module I: Taxonomy and Biosystematics (10 Hours)

Taxonomy: Components of taxonomy, Phases of taxonomy, Integrative taxonomy, Cyber taxonomy, DNA taxonomy, Reverse taxonomy. Systematics: Development and scope, Aim and Objectives, Significance. Biosystematics: Objectives, Steps, Relationship with Classical Taxonomy

Module II: Identification and Taxonomic Literature (10 Hours)

Methods of Plant identification; Taxonomic Keys: Single access and Multi-access; Character and Character states; Field inventory; Collection; Herbaria: Functions of Herbarium, Preparation of Herbarium; Important herbaria and botanical gardens of the World and India; Virtual herbarium. Taxonomic Literature: Flora, E-flora, Monographs, Revisions, Checklists, Periodicals; Taxonomic Indexes; Ret Data Book

Module III: Taxonomic Hierarchy and Botanical Nomenclature (15 Hours)

Concept of taxa (family, genus, species); Categories and Taxonomic Hierarchy; Infra-species; Species Concept (taxonomic, biological, evolutionary); Principles of Nomenclature (ICNafp); Rules of Nomenclature: Ranks and names; Typification, Priority of Publication; Nomenclature of Taxa; Effective Publication; Valid Publication; Author Citation; Rejection of Names, principle of priority and its limitations; Names of hybrids

Module IV: Systems of classification and Systematic evidences (10 Hours)

Major systems of classification: basis, merits and demerits: Cronquist (1981); Takhtajan's System (1997), APG Classification, with special reference to APG IV (2016). Systematic evidences: Morphology, Anatomy, Embryology, Palynology, Cytology, Phytochemistry, Molecular taxonomy–DNA barcoding

Module V: Numerical Taxonomy, Phylogenetic Systematic (Cladistics) (15 Hours)

Numerical Taxonomy: Principles, Methods, Characters, Variations; OTUs, Character Weighting, Coding, Cluster analysis, Phenogram, Merits and Demerits; Biometrics. Cladistics: Methodology of Cluster Analysis, Applications. Homology and Homoplasy; Monophyly, Paraphyly and Polyphyly; Primitive and Advanced; Phylogenomic

Suggested Readings

1. Pandey, B.P. A textbook of Botany: Angiosperms S. Chand.
2. Sharma, O.P. Plant Taxonomy McGraw-Hill Education

3. Mandal, A.K. Advanced Plant Taxonomy New Central Book Agency
4. Nair, R. Taxonomy of Angiosperms Aph Publishing Coorporation
5. Gupta, R. Plant Taxonomy: Past, Present and Future The Energy and Research Institute TERI.
6. Balfour, A. (Editor) Plant Taxonomy Syrawood Publishing House.
7. Singh, G. Plant Systematics: An Integrated Approach. CRC Press.
8. Bhojwani, S.S., Bhatnagar, S.P. and Dantu, P.K. The Embryology Angiosperms, Vikas Publishing.
9. Davis, P.H. and Heywood, V.H. Principles of Angiosperm Taxonomy, Scientific Publishers (India).
10. Lawrence, G.H.M. Taxonomy of Vascular Plants Scientific Publisher

Mapping of COs to Syllabus

Course Outcomes	**Module I**	**Module II**	**Module III**	**Module IV**	**Module V**
CO1	**H**				
CO2		**H**			
CO3	**M**			**H**	
CO4			**H**		
CO5					**H**

BOBE0039: ECONOMIC BOTANY AND ETHNO-BOTANY

(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course Outcomes

At the end of this course, student will be able to:

CO1: Understand the nature of plant products, aspects and classification of economic important plants (Understanding)
CO2: Taxonomic status of food plants, industrial plants and drug plants and its uses (Understanding)
CO3: Understand the cultivation, extraction processes and uses of different economically useful plants (Understanding)
CO4: Understand the need to conserve floristic and cultural diversity of the region (Understanding)
CO5: Rescue and document Ethno-botanicals for sustainable use of plant resources (Analyzing)

Module I: Introduction to Nature of Plant Products (10 Hours)

Importance and Nature of Plant Products: Protoplasm and its Activities; Photosynthesis; Plant skeleton; Reserved food (Carbohydrates, Fats and Proteins); Secretions and Excretions (Essential Oils, Pigments, Tannins, Latex, Waxes, Alkaloids, Glycosides, Organic Acids, Enzymes, Vitamins, Hormones). Different Aspects of Economic Botany; Classification of Economically Important Plants

Module II: Fibers and Fibers Plants (5 Hours)

Economic Classification of Fibers: Textile Fibers; Surface Fibers; Soft Fibers; Structural Fibers; Brush Fibers; Plaiting and Rough Weaving Fibers; Filling Fibers; Natural Fabrics; Paper Making Fibers. Cotton, Jute, Flax and Agave (Characteristics, Cultivation, Extraction, Uses)

Module III: Forest Products and Resources (5 Hours)

Importance and Structures of Wood; Mechanical Properties and Factors of Wood; General account with special reference to Teak, Sal, Pine and Bamboos

Module IV: Tanning and Dye materials (5 Hours)

Sources of Tanning Materials: Barks, Leaves, Fruits, Roots; Manufacture of Tannins inks. Sources of dyestuffs: Barks, Leaves, Flowers, Fruits, Roots, Woods. General account with special reference to Indigo, Safflower and Lichens

Module V: Oil-Yielding, Sugar-Yielding and Rubber-Yielding Plants (5 Hours)

General account with special reference to Drying oils, semi drying oils; Non-drying oils and Vegetables Fats. Sugarcane and Sugar beet (cultivation, extraction and uses); Para rubber and Assam Rubber: Tapping, Processing and Uses. Fatty oils and their extractions

Module VI: Cereals, Pulses, Beverages and Spices (5 Hours)

Staple food crops - cereals, pulses, millets; tropical, subtropical and temperate fruits; Tea, Coffee processing and uses; Important spices, their family and part used

Module VII: Introduction to Ethno-botany (10 Hours)

Concept, Relevance, Scope and Status; Plant parts used in Ethno-medicine; Role of Ethno-medicine and its scope in modern times. Concept of Protected Areas; CITES, IUCN Red List Categories. Role of Ethno-botany in conservation and sustainable development; Centers of Ethno botanical studies in India; Contributions of AICRPE and FRLHT to ethno-biology of India

Module VIII: Methods and techniques in Ethno botany (15 Hours)
Field activities for data collection: Approach, Documentation, Consent forms, Forest productivity check by analyzing the log books of Forest, Authentication of plant species and Lab Procedures, Preparation of Data Sheet and Data Base. People Biodiversity Register (PBR). Impact of Ethno-botany in herbal medicine industry, land-use development, agriculture, forestry, betterment of rural livelihoods and education; Biodiversity and conservation of useful medicinal plants; Sharing of wealth concept with few examples from India; Plant used in ethno-medicine e.g.: *Emblica officinalis*, *Ocimum sanctum*, *Saracaasoca*, *Rauwolfia serpentina*, *Mentha piperita*, *Aloe vera*, *Eclipta alba*, *Azadirachta indica*, *Centellaasiatica* preparation and their uses.

Suggested Readings

1. Pandey B.P. Economic Botany, Revised edition, S. Chand Publishers, New Delhi References
2. Verma V. Textbook of Economic Botany, First edition, Ane Books Pvt. Ltd., New Delhi
3. The Wealth of India – Raw Materials Series. CSIR publications, New Delhi.
4. Sharma, O.P. Hill's Economic Botany. Tata McGrow Hill, New Delhi.
5. Kocchar, S.L. Economic Botany of the Tropics. McMillan India Ltd., Delhi.
6. Pandey, B.P. Economic Botany. S. Chand & Co., New Delhi.
7. Das, A.P. & Pandey, Advances in Ethno-botany. Bishen Singh Mahendra Pal Singh, Dehra Dun.
8. Saroya, A.S. Herbalism, Phytochemistry and Ethnopharmacology, CRC Press, UK
9. Jain, S. K. & Mudgal, V. A. Handbook of Ethno botany, Bishen Singh Mahendra Pal Singh, Dehra Dun.
10. Nair, M. N. B., Hamami, S. M. &Ashaari, Z. Sustainable Management of Non-Wood Forest Products. Sustainable management of non-wood forest products: proceedings of an international workshop. University Putra Press, Malaysia.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI	Module VII	Module VIII
CO1	H							
CO2		M	M	M	M	M		H
CO3		H			H			
CO4							M	H
CO5							H	
CO6								H

SPECIALIZATION: PLANT ECOLOGY

BOEG0040: ECOLOGY, ENVIRONMENT AND GLOBAL CONCERNS
(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course Outcomes
At the end of this course, student will be able to:
1. Understand about the fundamental characteristic, structural and functional aspect of ecosystem (Understanding)
2. Understand environmental pollution its cause, effects and control (Understanding)
3. Understand the scenario and mechanism of climate change and also various mitigation initiatives undertaken (Understanding)
4. Addresses ecological resilience and its relationship to ecosystem services (Analyzing)

Module I: Ecology and Ecosystem Analysis (12 Hours)
Principles and Scope of Ecology Structure and Functions of Ecosystems - Abiotic and Biotic components; Energy dynamics; Nicheconcept; Eco-physiology; Ecosystem nutrient cycles; Ecosystems Types and Diversity; Concepts relating to limiting factors; Populations and communities characteristics; Population dynamics; Population interaction; Models and mechanisms of ecological succession; Ecosystem Stability

Module II: Environment and Pollution (18 Hours)
Energy and Environment; Components, types and segments of Environment; Environmental pollution: Origin of pollution, types of pollutions; Atmosphere: region and composition of atmosphere; Air pollution: classification and major air pollutants, sources and effect of air pollution; Water pollution: types of pollution and pollutants, sources and effect of water pollution; Soil pollution: sources and effect of soil pollution; Treatment and control of pollution

Module III: Climate Change and Awareness (18 Hours)
Basic concepts and mechanism: Climate change, ozone layer depletion, global warming and greenhouse effect, causes and consequences; Mitigation and adaptation: Carbon storage and sequestration, carbon management: biotic and abiotic, Carbon farming and carbon trading; International responses: Intergovernmental Panel on Climate Change (IPCC) and its role, United

Nations Framework Convention on climate change (UNFCCC), CDM and Kyoto Protocol, REDD+, The Copenhagen Accord; India'sresponse to climate change

Module IV: Ecological Resilience and Ecosystem Services (12 Hours)
Definitions and concepts of ecological resilience; Characteristics of Resilient Ecosystem; Ecological, General, and Spatial Resilience; Linkage between Resilience, Vulnerability and Adaptive Capacity; Components of Resilience-Based Management; Ecosystem service concept, model and classification; Factors and drivers determining ecosystem services; Mapping and assessment of ecosystem services, Ecosystem services in natural resource management

Suggested Readings

1. Odum, E., & Barrett, G. (2009). Fundamentals of ecology. Australia: Cengage Learning.
2. Kormondy, E., & Kormondy, E. (1986). Concepts of Ecology. Prentice Hall, New Delhi.
3. Singh, J.S., Singh, S.P., & Gupta, S. (2014). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
4. Sharma, P.D. (2012). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition
5. Ahluwalia, V., & Malhotra, S. (2013). Environmental Science. New Delhi: Ane Books.
6. Parry, M.L., et al. Climate change 2007: Impacts, Adaptation and Vulnerability, Cambridge University Press
7. Singh, P., Singh, S., Rangabhashiyam, S., & Srivastava, K.K. (2021). Global Climate Change. Elsevier Science, Netherlands
8. Gunderson, L., Allen, C.R., &Holling, C.S. (2012). Foundations of Ecological Resilience, Island Press

Mapping of COs to Syllabus

Course Outcomes	**Module I**	**Module II**	**Module III**	**Module IV**
CO1	**H**			**L**
CO2		**H**	**M**	
CO3		**M**	**H**	**L**
CO4			**L**	**H**

BORG0042: RESTORATION ECOLOGY AND GEOINFORMATICS (4 Credits-60 Hours) (L-T-P: 4-0-0)

Course Outcomes
At the end of this course, student will be able to:
CO1: Understand the ecological perspectives of restoration including factors that regulate ecosystem function (Understanding)
CO2: Understand the ecological theories that have molded restoration ecology (Understanding)
CO3: Relate restoration practices and efforts to different ecological levels (Applying)
CO4: Explores into the planning, execution, monitoring, and assessment of restoration work (Analysing)
CO5: Role of remote sensing as a tool for ecological restoration processes (Applying)

Module I: Introduction to Restoration Ecology (8 Hours)
Concept and Definition of Restoration Ecology; Degradation of Ecosystems; Different Restoration Approaches; Varying Scales of Restoration; Ecosystem Disturbances; Fire Disturbances; Fragmentation; Nutrient and Hydrological Cycling; Keystone Species

Module II: Succession and Assembly (8 Hours)
Theories of Succession; Successional Processes and Restoration; Management of Succession; Monitoring Succession; Ecosystem Resistance and Stability; Regime Shift; Assembly Rules

Module III: Biodiversity and Forest Restoration (8 Hours)
Levels of Biodiversity; Threats to Biodiversity; Extinction; Rate of Extinction and Species vulnerability; Restoration of Genetic Diversity; Restoration of Species Diversity; Ecosystem Diversity; Forest Degradation; Forest Restoration

Module IV: Landscape and Invasive Species (8 Hours)
Definition and Types of Landscape; Landscape matrices; Connectivity and Metapopulation; Landscape Restoration; Process of Invasion; Effects of Invasion on Ecosystems; Methods to Control Invasion; Restoration to Constrain Invasion

Module V: Management of Restoration Plans (8 Hours)
Project Planning; Implementation; Adaptive Management Cycle; Monitoring; Selecting Monitoring Parameters and Methods; Additional Considerations in Developing a Monitoring Plan; Legal Framework and International Agreements

Module VI: Geo-informatics (20 Hours)
Remote sensing fundamentals; Satellite Data and Sensors; Spectral, Temporal, Radiometric and Temporal Resolutions; Image Processing; Image Interpretation and Classification; Accuracy Assessment; Measuring and Monitoring Land Cover, Land Use, Change and Vegetation Characteristics; Conservation and Ecology Applications; Global Positioning System

Suggested Readings

1. Greipsson, S. (2011). Restoration Ecology. United States: Jones and Bartlett Publishers.
2. Holl, K. (2016). Foundations of Restoration Ecology. United States: Island Press.
3. Holl, K. (2020). Primer of Ecological Restoration. United States: Island Press.
4. Aronson, J., (2012). Restoration Ecology: The New Frontier. Germany: Wiley.
5. Sarah, E.G., & Turner, M. (2017). Learning Landscape Ecology: A Practical Guide to Concepts and Techniques. Germany: Springer New York.
6. Lillesand, T. M., & Kiefer, R. W. (1994). Remote Sensing and Image Interpretation. United Kingdom: Wiley.

Mapping of COs to Syllabus

COs	Module I	Module II	Module III	Module IV	Module V	Module VI
CO1	3	1				
CO2		3				
CO3			3	3	1	
CO4					3	
CO5			1	1		3

SPECIALIZATION: PLANT PATHOLOGY AND MICROBIOLOGY

BOPY0043: PLANT PATHOLOGY

(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course Outcomes

At the end of this course, student will be able to:

CO1: Classify various Plant diseases and their causative organisms (Understanding)
CO2: Analyze the roles of pathogens in diseases development (Analyzing)
CO3: Identify and detect various modes of pathogen attack and defense strategies of plants (Applying)
CO4: Asses specific plant diseases caused by various microorganisms (Analyzing)
CO5: Asses and apply disease control measures and techniques (Evaluating)

Module I: Introduction (16 Hours)

Introduction to Plant pathology; The concept of disease in Plants; History of plant pathology; Types of plant diseases; Role of pathogens as causes of plant disease; Significance of plant disease; Basic procedure in diagnosis of plant diseases- Infectious diseases (caused by Parasitic higher plants, Nematodes, Fungi, bacteria, Viruses and Viroids) and Non infectious diseases; Identification of previously unknown disease: Koch’s rules

Module II: Parasitism and Disease Development (8 Hours)

Parasitism and pathogenicity; Development of disease in plants: Stages in the development of disease (Disease cycle); Relationship between disease cycle and epidermis.

Module III: Pathogen attack and Plant Defense Mechanisms (10 Hours)

Mode of pathogen attack via various means (Mechanical force, Chemical, Enzymatic, Microbial toxins); Role of growth regulators in plant disease; Plant defence against pathogen: Pre-existing Structural and chemical defenses, Induce structural and biochemical defense

Module IV: Specific Plant Diseases (20 Hours)

Plant diseases caused by Fungi: Characteristics of fungal pathogen; Symptoms and Isolation of pathogen; Late blight of potato, Downy mildews/Powdery mildews, Ergot of cereals and grasses, Loose smuts of cereals; Plant diseases caused by Bacteria: Characteristics of bacterial pathogens, Identification and symptoms caused; Bacterial blight of beans, Crown gall, Citrus canker; Plant diseases by Viruses: Characteristics of Viruses; Symptoms caused by viruses and their transmission, Viroids; Plant diseases caused by Nematodes: Characteristics of plant pathogenic nematodes; Isolation of nematodes and their symptoms; Root-knot, cyst, lesion caused by nematodes; Plant diseases caused by Protozoa: Charatcteristics; Phloem necrosis of Coffee, Empty root of Cassava

Module V: Disease Control Management (6 Hours)

Control methods: Exclusion of plant pathogens; Eradication or reduced pathogen inoculum; Immunizing or improving the host resistance; overview of integrated pest management

Suggested Reading

1. Agrios GN. Plant pathology, 4th Edition, Academic Press London, UK.
2. Mehrotra RS, Aggarwal A. Plant Pathology, 2mnd Edition, Tata McGraw-Hill Publishing Company Ltd.

3. Singh RP. Plant Pathology, 2nd Edition, Kalyani Publishers.
4. Mehrotra RS, Aggarwal A. Fundamentals of Plant Pathology, Tata McGraw-Hill Publishing Company Ltd.
5. Sambamurty AVSS. A textbook of Plant Pathology, Dreamtech Press, Wiley.
6. Gour HN. Physiological and Molecular Plant Pathology, Scientific Publishers India.
7. Dickinson M. Molecular Plant Pathology, Garland Science

Mapping of COs to syllabus

Cos	Module I	Module II	Module III	Module IV	Module V
CO1	3			1	
CO2		3			
CO3		2	3		
CO4				3	
CO5					3

BOMA0044: MICROBIAL GENETICS AND APPLIED MICROBIOLOGY

(4 Credits-60 Hours) (L-T-P: 4-0-0)

Course Outcomes

At the end of this course, student will be able to:
CO1: Tell the chemistry and functions of microbial cells and organelles (Understanding)
CO2: Apply the concepts of vector and cloning mechanisms in plant improvement (Applying)
CO3: Understand the gene regulatory mechanisms and pathways and their functions (Understanding)
CO4: Understand the roles of microbes in industries and environment (Understanding)
CO5: Detect and identify microorganisms from any samples (Evaluating)
CO6: Use microbes in agriculture, industries and environmental protection (Applying)

Module I: Microbial Cells and organelles (8 Hours)

Over view of prokaryotic cell- structure &functions, cell wall synthesis, Membrane transport in bacteria-simple, group translocation, ABC transporters, Protein export in bacteria. Membrane organelles: lysosomes, mitochondria (with small ribosomes), Golgi bodies, endoplasmic reticulum, nucleus

Module II: Microbial Genetics and Microbial vectors in genetic Engineering (18 Hours)

Structure, function and types of DNA and RNA, DNA replication in bacteria; Gene expression (concept of gene, gene structure, genetic code, transcription and translation, post transcriptional and post translational modifications); Gene regulation in prokaryotes- The operon concept (Lac and Trp operon -induction and repression); Mutations (Definition, types, molecular basis of mutations, detection of mutants); DNA repair mechanisms (Dark repair, photo-reactivation, recombination repair, SOS repair), Transposons; Plasmid (size, copy numbers, classification, applications as vectors; Bacteriophages (types, applications as vectors); vectors for eukaryotes and other higher plants; plasmids and antimicrobial resistance, cloning (basic principle, techniques and applications)

Module III: Microbes Preservation and Fermentation technology (12 Hours)

Importance of preservation of microbes, types of preservation techniques, revival of microbes; History of fermentation, introduction to fermentation processes, Microbial culture selection for fermentation processes. Media formulation and process optimization; Design and operation of Fermenters, Basic concepts for selection of a reactor, Packed bed reactor, Fluidized bed reactor, Trickle bed reactor, Bubble column reactor, Scale up of Bioreactor; basic concept of upstream and down-stream processing

Module IV: Microorganisms in Environmental and Agriculture (15 Hours)

Microbes as tools for pollution abatement, bio-indicators, restoration of degraded ecosystem, biodegradation, bioremediation, biogenic gases; Role of microbes in relation to agriculture: nitrogen economy, plant health, biological control. Symbiotic association: concepts, types and application

Module V: Microorganisms in Food and Pharmaceutical Industries (10 Hours)

Microbes in food and dairy industries: mushroom, fermented foods, microbial spoilage of food and dairy products; Gene manipulation for production microbial toxin, types, mode of action, production of novel commercial products such as biopolymer and antibiotics; basic concepts of immunology, vaccines, immunotherapy, microbes in biological warfare

Suggested Reading

1. Willey JM, Sherwood L, Woolverton CJ (2013) Prescott's Microbiology, 9 th edition, McGraw-Hill, New York.
2. Pelczar M.J., Chan E.C.S. and Krieg N.R. (2003) Microbiology. 5 th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. Waites MJ, Morgan NL, Rockey JS, Higton G. Industrial Microbiology: An Introduction, Wiley-Blackwell

4. Brock T.D. and Madigan M., Biology of Microorganisms, Prentice Hall of India Pvt. Ltd.
5. Moat A.G. and Foster S.W., Microbial Physiology, John Wiley and Sons, New York.

Mapping of COs to Syllabus

Cos	Module I	Module II	Module III	Module IV	Module V
CO1	3				
CO2		3			
CO3		3			
CO4			3		
CO5			3		
CO6			1	3	3

Specialization paper: Plant Physiology and Biochemistry

BOPP0045: ADVANCE PLANT PHYSIOLOGY

(4 CREDITS-60 HOURS) (L-T-P: 4-0-0)

Course Outcomes

At the end of this course, student will be able to:

CO1: Analyze the role of microbes in mineral acquisition (Analyzing)
CO2: Understand the process of photosynthesis and respiration and its regulatory enzymes (Understanding)
CO3: Interpret the signal transduction and gene expression of growth hormones (Understanding)
CO4: Assess the mechanism of plant response towards abiotic and biotic stresses and action of photoreceptors (Evaluating)

Module I: Mineral nutrition (8 Hours)

Mineral Absorption and transport, Role of microbes in nutrient acquisition by plants; Assimilation of mineral nutrients with emphasis on phosphorus and potassium assimilation

Module II: Photosynthesis (10 Hours)

Primary charge separation events in reaction centres; regulatory action of uncoupling agents of photophosphorylation; energy loss during vectorial electron transfer in light reaction; genetics of RUBISCO subunit assembly and organization in plants; physiological and ecological aspects of photosynthesis; efficiency of carbohydrate synthesis

Module III: Respiration (12 Hours)

Regulation of key respiratory enzymes with particular emphasis on phosphofructo kinase, glyceraldehydes-3-phosphate dehydrogenase and pyruvate dehydrogenase; mechanism of action of inhibitors of oxidative phosphorylation; arrangement and organization of protein complexes in mitochondrial electron transport chain

Module IV: Plant growth regulators (12 Hours)

Signal perception and signal transduction, hormone binding receptors, hormone induced changes in gene expression and specific functions of Auxin – cell elongation, Gibberellins – germination of dormant seeds, Cytokinins – cell division and retardation of senescence of plant parts, Abscisic acid – stomatal closure and induction of drought resistance and Ethylene – fruit ripening

Module V: Stress Biology and Sensory Photobiology (18 Hours)

Mechanism of plant response to water (low and high), temperature (low and high), Salt (Salinity and Alkalinity), heavy metals and biotic stresses (Pathogens and insects), Oxygen deficiency.
Sensory Photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins

Suggested Reading

1. Davies PJ. Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands
2. Taiz L and Zeiger E. Plant Physiology, 4th Edition, Sinauer Associates Inc. Publishers, Massachusetts, USA
3. Bajracharya D. (1999) Experiments in Plant Physiology- A Laboratory Manual, Narosa Publishing House, New Delhi
4. Hopkins, W.G. and Huner, A. (2008) Introduction to Plant Physiology, 4th edition, John Wiley and Sons, USA

Mapping of COs to Syllabus

COs	Module I	Module II	Module III	Module IV	Module V
CO1	3				
CO2		3	3		
CO3				3	

CO4					3

BOBM0046: PLANT BIOCHEMISTRY AND METABOLISM
(4 CREDITS-60 HOURS) (L-T-P: 4-0-0)

Course Outcomes
At the end of this course, student will be able to:
CO1: Understand the molecular biology of nitrogen fixation (Understanding)
CO2: Interpret the biosynthesis of secondary metabolites and their defence mechanism (Understanding)
CO3: Rephrase the structure and functions of vitamins (Understanding)
CO4: understand the mechanism of cell signalling (Understanding)
CO5: Determine and estimate different phytochemical compounds from plant samples (Evaluating)

Module I: Nitrogen metabolism (10 Hours)
Process of biological nitrogen fixation; nodule formation-role of NOD genes and nodulins; NIF genes; molecular biology of nitrogenase complex; regulation of nitrogen fixation; nitrogen assimilation in higher plants

Module II: Secondary metabolites (12 Hours)
Biosynthesis and roles of terpenes, phenolic compounds, nitrogen containing compounds; commercial and economic importance of secondary metabolites; role of secondary metabolites in plant defence against insects, herbivores and pathogens

Module III: Vitamins (10 Hours)
Structure, and functions of Thiamine, Riboflavin, Nicotinic Acid, Pantothenic Acid, Pyridoxine, Biotin, Folic Acid, Vitamin B12 , Ascorbic Acid, Vitamin A , D , E and K

Module IV: Cell Signaling (16 Hours)
Overview, second messengers, receptors and G-proteins, phospholipid signaling, role of cyclic nucleotides, calcium-calmodulin cascade, diversity in protein kinases and phosphatases, specific signaling mechanisms and their regulation, e.g. simple and hybrid type of two-component sensor-regulator system in bacteria and plants (examples of chemotaxis, osmosensing, ethylene and cytokinin signaling), quorum sensing

Module V: Biochemical methods (12 Hours)
Determination of mineral nutrients in plant samples; Estimation of chlorophyll and carotenoids from leaf sample; Preparation of standard curve, extraction and estimation of total soluble sugars, starch, total free amino acids, total protein, fats, vitamins, antioxidative enzymes, secondary metabolites from plant samples.

Suggested readings

1. Nelson DL and Cox MM. (2004) Lehninger Principles of Biochemistry, 4th Edition, W.H. Freeman and Company, New York, USA.
2. Davies PJ. Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands
3. Taiz L and Zeiger E. Plant Physiology, 4th Edition, Sinauer Associates Inc. Publishers, Massachusetts, USA
4. Bajracharya D. (1999) Experiments in Plant Physiology- A Laboratory Manual, Narosa Publishing House, New Delhi

Mapping of COs to Syllabus

COs	Module I	Module II	Module III	Module IV	Module V
CO1	3				
CO2		3			
CO3			3		
CO4				3	
CO5					3

SPECIALIZATION PAPER: ADVANCES IN PLANT SCIENCE

BOBB0047: BIOMASS, BIOREFINERY AND CIRCULAR BIOECONOMY
(4 CREDIT, 60 Hours T-L-T:4-0-0)

Course Outcomes
At the end of this course, student will be able to:
CO 1: Identify potential biomass feedstocks including energy crops based on its biochemical composition (Analysing)
CO 2: Have an understanding of the existng and emerging biomass to various technologies (Understanding)

CO 3: Develop a critical thinking about sustainability and its prospect to generate circular bio-economy (Evaluating)
CO 4: Determine sustainable solutions for bioresources by incorporating different technologies and assessment will be explored. (Application)

Module-1 BIOMASS FEEDSTOCK, COMPOSITION AND SUPPLY LOGISTICS (10 Hours)
Biomass Feedstocks I- Harvested Feedstocks (first generation feedstock, second generation, third generation feedstocks) in context to biofuel and biorefinery. Biomass Feedstocks II- Residue Feedstocks (Agricultural waste, Forestry waste, Farm waste, Organic components of residential, commercial, institutional and industrial waste). Biochemical composition of different biomass feedstock. Conventional and Advanced logistic Systems, Feedstock barriers and strategies moving forward, Supply chain and reverse logistics

Module-2 BIOMASS CONVERSION TECHNOLOGIES (12 Hours)
Biomass Conversion Technologies I- Biorefinery Concept -Understanding biorefinery concept, Bio-refineries & endproducts. Biomass Conversion Technologies II- Biochemical Conversion I-(Hydrolysis, enzyme & acid hydrolysis, Fermentation). Biochemical Conversion II- (Anaerobic digestion, Trans-esterification. Biomass). Conversion Technologies III- Thermochemical Conversion -(Combustion, Gasification, Pyrolysis. Other thermochemical conversion technologies, Scaling up emerging technologies.

Module-3 LOW CARBON CIRCULAR ECONOMY and VALUE ADDED CHEMICALS (16 Hours)
Advanced low-carbon economy from biofuel/biopolymer/value added product–Case study, Mixed alcohols (Acetone, ethanol, butanol), C3 sugars (Lactic acid, Propionic acid), C4 sugars (Malic acid), C5 sugars (Furfural, levulinic acid, xylitol), C6 Sugars Hydroxymethylfurfural (HMF), Lignin, PHB, Bio-oil, biochar, biodiesel, bio hydrogen and other value added organic products. carbon credit and carbon economy. Bioeconomy, value creation and business development, Circular economic principles and business models
Biotechnology and other bioprocesses enabling circular bioeconomy. Opportunities, framework conditions and barriers for a circular bioeconomy.

Module-4 BIOREFINERY (10 Hours)
Basic Concept and Types of Integrated biorefinery (Aquaculture and algal biorefinery, waste biorefinery). Economics and Life Cycle Analysis I- (General understanding of LCA, Cradle-to-grave, field to wheels concepts, Goal and scope determination, defining LCA boundaries). Life Cycle Analysis II. Life Cycle Inventory, Life Cycle Assessment. GIS based distribution study.

Module-5: BIOSAFETY, IPR AND ENTREPRENEURSHIP (12 Hours)
History of biosafety, risk assessment, biosafety levels, personal protective equipment, laboratory facilities and safety equipment, disinfection, decontamination, sterilization, regulatory compliance, laboratory security and emergency response, administrative controls, Current trends in biosafety. Patentability search in biofuel sectors. Entrepreneurship essentials: opportunities, ideas and Innovation; feasibility and market research; business plan; Building a business: business models, Start-up ecosystem; Technology and bio-entrepreneurship – case studies.

Suggested readings:
1. Ashok Pandey, R. D. Tyagi, Sunita Varjani. Biomass, Biofuels, Biochemicals: Circular Bioeconomy—Current Developments and Future Outlook. 2021, Elsevier Science Publishing Co Inc.
2. Wiebke Reim, Vinit Parida, David R. Sjodin. Circular Business Models for the Bio-Economy: A Review and New Directions for Future Research. Sustainability; 11, 2558.
3. Juan-Rodrigo Bastidas-Oyanedel, Jens Ejbye Schmidt. Biorefinery "Integrated Sustainable Processes for Biomass Conversion to Biomaterials, Biofuels, and Fertilizers."Springer.
4. Fundamentals of Entrepreneurship. 3rd Edition, Nandan H, 2007, Phi Learning, New Delhi.
5. Entrepreneurship and Small Business Management, 2nd Edition, Mariotti S and Glackin C, 2016, Pearson Publishers.
6. Ipr Biosafety And Bioethics 2013 Edition by GOEL, PEARSON

Mapping of COs to Syllabus

COs	Module 1	Module 2	Module 3	Module 4	Module 5
CO1	H		2		
CO2	M	3			
CO3				3	
CO4			3		
CO5				3	2

BOPD0048: BIOPROSPECTING OF PLANT DIVERSITY AND AUTOMATION
(4 CREDIT, 60 Hours T-L-T:4-0-0)

Course Outcomes

At the end of this course, student will be able to:
CO 1: Identify and explore the prospect of Plant and its molecules in industry (Understanding)
CO 2: Recalling the Bioprospect of various plant molecules for commercialization (Remember)
CO 3: Application of GIS and remote sensing in plant resource utilization and mapping (Analysing)
CO 4: Understanding the impact climate change in soil microbiome affecting Plant diversity (Understanding)
CO 5: Understanding the role of Automation in plant Science (Applications)

Module 1: Introduction to Bioprospecting: (6 Hours)
Definition, Introduction, recent trends in Bioprospecting, Pros and Cons, Omics and insilico bioprospecting, bionic bioprospecting, Bioprospecting Act and Biopiracy.

Module 2: Microbial and Marine Bioprospecting: (8 Hours)
Sources of marine planktons and their Bioprospecting, Isolation and cultivation of Marine Bioresource, Isolation of algal strain, Types of cultivations and its industrial applications, Bioactive chemicals from Seaweeds and their applications. Role of algae in Biodiesel, fertilizers and nanobiotechnology. Isolation of Microbial metabolites and their bioactivity. Endophytic microbial products as Antibiotics.

Module 3: Bioprospecting of Forestry and above ground biomass residues (8 Hours)
Cultivation and uses of Food, Fodder, paddy waste, Fibers, Oil yielding crops, wood and timber, Non-wood forest products(NWFPS): Bamboos, Invasive Plant management and valorization, Gums, Dyes, Resins, Fruits etc, Botany, Chemistry, Properties and uses of Medicinal, herbal and Aromatic plants, rle of plants in phytoremediation of industrial waste

Module 4: Application of Remote Sensing and GIS in Bioresource management and Conservation. (10 Hours)
GIS in agro-residue bioenergy planning, Issues needing attention while using GIS, Life Cycle Assessment (LCA) in agro-residue, Spatial LCA in bioenergy and environmental planning, Satellite sensors used in Remote sensing, Predictor variables, Spectral indices, vegetation index and spatial imagery for biomass distribution

Module 5: Biotransformation and Fermentation technology (10 Hours)
Molecular farming, production of industrial enzymes, biodegradable plastics, antibodies, edible
vaccines; manipulation of metabolic pathways for production of secondary metabolites, transplastomics plants, extraction of high value industrial products, growth and production kinetics of cell cultures in shake flasks; scale-up procedures in bioreactors, types of bioreactors
for plant cell cultures; Manipulation in production profile by biotic and abiotic elicitation. Production of crop plants under organic and conventional fanning system, Bio-fertilizers, Bio-methylation, preparation of compost / vermicomposting. ,

Module 6: Microbiome and Climate Change (8 Hours)
Microbiome data for applications in energy, environment, health, and agriculture, Implication of Soil microbiome, climate change and carbon storage nexus, Clean Development Mechanism, carbon offset, carbon cycle, carbon sequestration, Carbon capture, storage and uptake and Artificial photosynthesis,

Module 7: Automation in Plant Science (10 Hours)
Application of IOT, digital image processing in plants (quantifying disease detection, quantification and Precision agriculture. Big Data in Plant study and conservations, Application of spectral signatures in plant distribution, taxonomy, biochemical estimation, vegetation index (NDVI, PVI, SVI), characterize by its size, shape, boundaries and internal structure ETC

Suggested Readings
1. C Sudhakar Reddy. (2015) Application of remote sensing in plant Sciences. An Overview. Springer India.
2. Charis, G., Danha, G., Muzenda, E., 2019. A review of the application of gis in biomass and solid waste supply chain optimization: gaps and opportunities for developing nations. Waste management 6; 1-11.
3. IoT in Agriculture Investigation on Plant Diseases and Nutrient Level Using Image Analysis Techniques
4. Sathiya S., Cecil, A., Ghodke. P.K., 2022. Plant disease identification using IoT and deep learning algorithms. Artificial Intelligence for Signal Processing and Wireless Communication. doi.org/10.1515/9783110734652-002.
5. Advanced Remote sensing and GIS. Training Manual Developed by CEGIS, USFS and BFD, 2014-15
6. Upadhyay S., Singh S.P. Bioprospecting of Plant Biodiversity for Industrial Molecules. Wiley. ISBN: 9781119717218
7. Jansson, J.K., Hofmockel, K.S. Soil microbiomes and climate change. Nat Rev Microbiol 18, 35–46 (2020). https://doi.org/10.1038/s41579-019-0265-7

Mapping of COs to Syllabus

COs	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6	Module 7
CO1	3		2				
CO2	2	3	3				
CO3				3			

CO4						3	
CO5				1	2		3

LABORATORY COURSES

BOMP6026: MYCOLOGY AND PHYCOLOGY LAB (3 CREDITS-90 HOURS) (L-T-P: 0-0-3)

Course Outcomes

At the end of this course, student will be able to:

1. Learn about the vegetative and reproductive structures of some important classes of fungi and algae (Understanding)
2. Acquire knowledge and importance of mycorrhizae and lichens (Understanding)
3. Learn the techniques of isolation of fungi and algae (Applying)
4. Learn the technique of producing fungal and algal bio-fertilizers (Applying)

Expt.1. Study of thallus organization, Spore producing organs, and accessory structures of *Myxomycotina, Mastigomycotina, Oomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina*

Expt.2. Study of morphological and anatomical features of *Crustose, Foliose* and *Fruticose* lichens

Expt.3. Isolation and characterization of fungi up to species from soil

Expt.4. Study of range of vegetative and reproductive structures of algae in *Cyanophyta, Chlorophyta, Phaeophyta, Rhodophyta, Xanthophyta, Bacillariophyta*, and *Euglenophyta*

Expt.5. Production techniques of fungal and algal based bio-fertilizers

Mapping of COs to syllabus

Course Outcomes	Expt. 1	Expt. 2	Expt. 3	Expt. 4	Expt. 5
CO1	H	L	L	H	L
CO2	L	H	L	L	L
CO3	L	L	H	L	L
CO4	L	L	L	L	H

BOBA6027: BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERMS AND ANGIOSPERMS LAB (3 CREDITS-90 HOURS) (L-T- P: 0-0-3)

Course Outcomes

At the end of this course, student will be able to:

1. Interpret the concepts of classification system and identification of few important bryophytes (Understanding)
2. Infer the concepts of classification system and identification of few important pteridophytes (Understanding)
3. Summarize the concepts of classification system and identification of few important gymnosperms (Understanding)
4. Collect, prepare and document herbarium specimens through non-destructive field collection method so as to get acquainted with herbarium technique (Applying)
5. Differentiate between monocots and dicots (Understanding)
6. Interpret sporogenesis and gametogenesis in angiosperms (Understanding)

Part 1: Bryophytes, Pteridophytes and Gymnosperms

Expt.1. Study of morphology and reproductive structures of the following bryophytes: *Riccia, Marchantia, Anthocerus, Sphagnum, Polytrichum, Funeria, Porella*.

Expt.2. Study of morphology and reproductive structures and observe arrangement of Sori on a receptacle of the following pteridophytes: *Lycopodium, Selaginella, Marsilea, Equisetum, Azolla, Salvinia, Adiantum*

Expt.3. To study the anatomy, morphology and reproductive features of the following gymnosperms: *Cycas, Pinus, Cryptomeria, Thuja, Podocarpus, Gnetum* , *Zamia*, *Ginkgo*

Part 2: Angiosperms

Expt.4. Collection, preparation and documentation of herbarium specimens through non-destructive field collection methodso as to get acquainted with herbarium technique.

Expt.5. Taxonomic study of selected families of dicots and monocots of angiospermic plants with the help of analytical drawings, botanical description and identification up to the rank of species.

Expt.6. Study of various stages of sporogenesis and gametogenesis in selected species of angiospermic plants

Mapping of COs to Syllabus

Course Outcomes	Expt. 1	Expt. 2	Expt. 3	Expt. 4	Expt. 5	Expt. 6
CO1	H					
CO2		H				
CO3			H			
CO4				H		

CO5					H	
CO6						H

BOCB6028: CELL & MOLECULAR BIOLOGY, PLANT PHYSIOLOGY & BIOCHEMISTRY LAB (3 CREDITS-90 HOURS) (L-T- P: 0-0-3)

Course Outcomes

At the end of this course, student will be able to:

CO 1: Get acquainted with tools and techniques of molecular biology (Remembering)

CO 2: Perform isolation of genomic DNA and their quantification and understand how to calculate recombination frequencies (Understanding)

CO 3: Analyze the concept of osmosis and impact of organic solvent in membrane permeability (Analyzing)

CO 4: Understand the underlying principle behind respiration, transpiration and photosynthesis. (Understanding)

CO 5: Analyze the functions of phytohormones and the properties of plant biomolecules (Analyzing)

Part 1: Cell & Molecular Biology

Expt.1. Acquaintance with molecular biology laboratory and instruments

Expt.2. Practical on cytoplasmic streaming in plant cell

Expt.3. Extraction of DNA from strawberry/banana by alcohol precipitation method

Expt.4. Isolation of genomic DNA from plant materials using SDS/CTAB method

Expt.5. Calculation of recombination frequencies of genes

Part 2: Plant Physiology

Expt.6. Determination of osmotic potential in potato tuber

Expt.7. To study the effect of different organic solvents (alcohol, formalin, benzene) on the permeability of plasma membrane of beet root

Expt.8. Determination of the effect of CO_2 concentration on the rate of photosynthesis by inverted funnel method

Expt.9. Determination of the effect of intensity of light on the rate of photosynthesis

Expt.10. To study the effect of different Phytohormones on the germination of seeds

Part 3: Plant Biochemistry

Expt.11. Estimation of protein using calibration curve following the protocol of Lowry et al., method

Expt.12. Estimation of nitrate reductase activity

Expt.13. To study the effect of NR activity in presence of light and dark period

Expt.14. Preparing the calibration curve of nitrite using azo-coupling method of Snell and Snel

Expt.15. Isolation of Plant DNA and their spectrophotometric quantification

Mapping of COs to Syllabus

Course Outcomes	Expt. 1	Expt. 2	Expt. 3	Expt. 4	Expt. 5	Expt. 6	Expt. 7	Expt. 8
CO1	H	H	H	H	H			
CO2			H	H	H			
CO3						H	H	H
CO4						H	H	
CO5	H		H	H				
CO6							H	

Course Outcomes	Expt. 9	Expt. 10	Expt. 11	Expt. 12	Expt. 13	Expt. 14	Expt. 15
CO1							H
CO2							H
CO3	H	H					
CO4			H				
CO5			H	H	H	H	H
CO6		H	H	H	H	H	

BOPP6029: PLANT MICROBIOLOGY AND PLANT PATHOLOGY LAB (3 CREDITS-90 HOURS) (L-T-P: 0-0-3)

Course Outcomes

At the end of this course, student will be able to:

1. Prepare different media used in microorganism isolation (Applying)
2. Apply various techniques for identifying different microbes (Applying)

3. Develop protocols and methods for characterizing microbes (Creating)
4. Identify chemicals agents, plants pathogens and their symptoms on diseased plant (Applying)

Expt.1. Preparation of nutrient media (solid/liquid) for culture
Expt.2. Staining techniques (Grams staining, flagella staining, capsule staining and acid fast staining of bacteria)
Expt.3. Isolation and characterization of pure cultures of microbes from soil, water and plant samples
Expt.4. Estimation of bacterial growth by spectrophotometric method
Expt.5. Culturing and isolation techniques of viruses (through seminar/virus lab visit)
Expt.6. In vitro and in vivo evaluation of chemicals against plant pathogens
Expt.7. Detailed study of symptoms of representative diseases of plantation crops, Collection and dry preservation of diseased specimens of important crops

Mapping of COs to syllabus

Course Outcomes	Expt. 1	Expt. 2	Expt. 3	Expt. 4	Expt. 5	Expt. 6	Expt. 7
CO1	H	H	M	L	L		
CO2	M	H	H	L	M		
CO3	M	M	H	M	M		
CO4					L	H	H

BOPE6030: PLANT ECOLOGY LAB (3 CREDITS-90 HOURS) (L-T-P: 0-0-3)

Course Outcomes

At the end of this course, student will be able to:

1. Gain knowledge about the population and communities characteristics in a given field
2. Gain knowledge about the concepts of analyzing edaphic characteristics
3. Gain knowledge about the analysis of physicochemical properties of water bodies

Expt.1. To determine the minimum size of the quadrat by species area-curve method.
Expt.2. To determine abundance, density, frequency, basal covers of plant communities by quadrat method.
Expt.3. To determine minimum number of quadrats required for reliable estimate of biomass in grasslands.
Expt.4. To compare protected and unprotected grassland stands using community coefficients (similarity indices).
Expt.5. Estimation of Importance Value Index (IVI) of the species in a grassland/woodland using quadrat method.
Expt.6. To estimate the above ground and below ground biomass from unit area.
Expt.7. To analyze the edaphic characteristics- Soil profile, Texture, Soil moisture, Water holding capacity, Porosity, pH, Organic matter content, and quantitative estimation of N, P, K.
Expt.8. To study the physicochemical characteristics from polluted and unpolluted water bodies: DO, COD, BOD, pH, Hardness, Alkalinity, Conductivity, Free CO_2, Chloride, Nitrate and Phosphate.
Expt.9. Field Study

Mapping of CO's to Syllabus

Course Outcomes	Expt. 1	Expt. 2	Expt. 3	Expt. 4	Expt. 5	Expt. 6	Expt. 7	Expt. 8	Expt. 9
CO1	H	H	H	H	H	H			H
CO2				L	L	L	H		M
CO3								H	M

BOCT6031: CYTOGENETICS, MOLECULAR TECHNIQUES AND TISSUE CULTURE LAB (3 CREDITS-90 HOURS) (L-T-P: 0- 0-3)

Course Outcomes

At the end of this course, student will be able to:

1. Interpret mitosis, meiosis and chromosomal aberration (Understanding)
2. Solve problems based on gene interactions (Applying)
3. Show hybridization in self and cross pollinated crops (Applying)
4. Interpret the basics of plant tissue culture (Understanding)
5. Utilize various chromatographic techniques to separate amino acids and plant pigments (Applying)
6. Isolate biomolecules and learn to use a thermal cycler (Applying)
7. Design primers using various software and use BLAST to identify sequences of similarity (Applying)
8. Develop somatic embryos and artificial seeds (Creating)

Part 1: Cytogenetics

Expt.1. Identification of mitosis from suitable plant material (Onion and garlic root tips)
Expt.2. Identification of meiosis from suitable plant material (Onion floral buds)
Expt.3. Study of chromosomal aberrations in plant (*Rhoeo*)
Expt.4. Study of numerical problems involving gene interactions
Expt.5. Practice of hybridization technique in self and cross pollinated plants species

Part 2: Molecular Techniques & Bioinformatics

Expt.6. Separation of amino acids and plant pigments by paper chromatography and thin layer chromatography (TLC)
Expt.7. Isolation of plasmid/genomic DNA
Expt.8. Isolation of total RNA from plant sample using Trizol method
Expt.9. Understanding the functioning of a thermal cycler/ Amplification of a gene using PCR
Expt.10. Designing of primers and identifying regions of similarity in biological sequences using BLAST

Part 3: Tissue culture

Expt.11. Preparation of MS nutrient medium and study of the sterilization techniques
Expt.12. Induction of callus from explants
Expt.13. Study of somatic embryogenesis in *Daucus carota*
Expt.14. Study of embryo culture using suitable explants
Expt.15. Preparation of artificial seeds

Mapping of COs to Syllabus

Course Outcomes	Expt. 1	Expt. 2	Expt. 3	Expt. 4	Expt. 5	Expt. 6	Expt. 7	Expt. 8
CO1	H	H	H					
CO2				H				
CO3					H			
CO4								
CO5						H		
CO6							H	H
CO7								
CO8								

Course Outcomes	Expt. 9	Expt. 10	Expt. 11	Expt. 12	Expt. 13	Expt. 14	Expt. 15
CO1							
CO2							
CO3							
CO4			H	H			
CO5							
CO6	H						
CO7		H					
CO8					H	H	H

BODI6032: DISSERTATION PHASE I (4 CREDITS-120 HOURS)

Description

1. Review of literature related to the research problem assigned to the students.
2. Practicing research ethics and methodology
3. Writing review articles related to the research problem.
4. Publishing these review articles in peer-reviewed journals.
5. Initial setting up of experiments to resolve the research problem
6. Writing and presenting the synopsis of the research problem.

BOER6033: ENVIRONMENTAL MANAGEMENT, RESEARCH METHODOLOGY AND BIOSTATISTICS & BIOCHEMICAL LAB
(2 Credits-60 Hours) (L-T-P: 0-0-2)

Course Outcomes

At the end of this course, student will be able to:

1. Apply ideas gained for experimental surveys and writing sound scientific papers (Applying)

2. Apply the concepts of statistics for interpreting scientific data (Applying)
3. Develop ideas for small scale start-ups (Creating)

Expt.1. Practicals on design of vermicompost/mushroom unit
Expt.2. Survey of environment risk prone areas
Expt.3. Scientific search engine tour for e-resources, research article, review article, scientific problems
Expt.4. Calculation of mean, median, mode, standard deviation, quartile deviation and coefficient of variation from a given dataset
Expt.5. Calculation of chi square statistic (goodness of fit & independence of attributes)
Expt.6. Calculation of student's t-test
Expt.7. Calculation of analysis of variance (ANOVA)
Expt.8. Designing CRD for an experimental layout
Expt.9. Designing RBD for an experimental layout
Expt.10. Determination of coefficients of partial and multiple correlation
Expt.11. Determination of the regression coefficient

Mapping of CO's to Syllabus

Course Outcomes	xpt.1	xpt.2	Expt. 3	Expt. 4	Expt. 5	Expt. 6	Expt. 7	Expt. 8	xpt.9	Expt. 10	Expt. 11
CO1			H								
CO2				H	H	H	H	H	H	H	H
CO3	H	H									

BODI6034: DISSERTATION PHASE II

(12 Credits-360Hours)

Description

1. Conducting experiments to resolve the research problem
2. Writing research articles and reviewing papers related to the research problem
3. Publishing these research and review papers in peer-reviewed journals
4. Presenting, explaining and defending the dissertation
5. Writing the dissertation

DEPARTMENT OF ZOOLOGY
DETAILED SYLLABUS

VISION:
- To develop the Department as an interdisciplinary centre for learning, research, and innovation
- To develop the Department into a hub of biodiversity research while making the surrounding a natural laboratory

MISSION:
- To provide a better understanding of Zoological Sciences through interaction with the natural environment and sensitizing the students about their social responsibilities
- to expose the learners to recent advances in Zoology and to provide high quality education with an emphasis on learning and research.

PROGRAMME: BSC ZOOLOGY (HONOURS)

PROGRAM OUTCOMES (PO) - BSC PROGRAMME

PO 1: **Critical Thinking**: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspective.

PO 2: **Effective Communication**: Speak, read, write and listen clearly in person and through electronic media, and make meaning of the world by connecting people, ideas, books, media and technology.

PO 3: **Social Interaction**: Elicit views of others, mediate disagreements and help reach conclusions in group settings.

PO 4: **Effective Citizenship**: Demonstrate empathetic social concern and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO 5: **Ethics**: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

PO 6: **Environment and Sustainability**: Understand the issues of environmental contexts and sustainable development.

PO 7: **Self-directed and Life-long Learning**: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.

PROGRAMME SPECIFIC OUTCOMES (PSOs)- BSc (Honours) Zoology

PSO 1: **Knowledge and Concept:** Acquire detailed knowledge on the extensive diversity of organisms inhabiting varied ecological niches of the earth as well as understand the complexity of the various life-systems operating in these organisms.

PSO 2: **Applying knowledge for self-sustenance:** Build foundations for novel thinking through application-based studies such assericulture and aquarium fish keeping, thus ensuring better opportunities for self-sustenance in future.

PSO 3: **Skills in handling scientific instruments:** Develop interest as well as proficiency in handling scientific instrumentsintroduced as part of practical courses, thereby warranting all-around growth.

PSO 4: **Conservation strategies:** Recognize the importance of conservation and encourage designing of effective strategies toaddress present conservation issues with preference to sustainable development.

COURSES OFFERED IN BSC (HONOURS) ZOOLOGY

Sl. No	COURSE NAME
1.1	Environmental Studies
1.2	English Communication
1.3	Foundations of Service Learning
1.4	Non-chordates I: Protista to Pseudocoelomates
1.5	Perspectives in Ecology
1.6	Non-Chordates II: Coelomates
1.7	Cell Biology
1.8	Animal Diversity
1.9	Atomic Structure, Bonding, General Organic Chemistry and Aliphatic Hydrocarbons
2.0	Environment and Public Health
2.1	Diversity of Chordates
2.2	Animal Physiology: Controlling and Coordinating Systems

2.3	Fundamentals of Biochemistry
2.4	Research Methodology
2.5	Comparative Anatomy of Vertebrates
2.6	Animal Physiology: Life-Sustaining Systems
2.7	Biochemistry of Metabolic Processes
2.8	Sericulture
2.9	Aquarium Fish Keeping
3.0	Environmental Biotechnology
3.1	Economic Botany and Plant Biotechnology
3.2	Chemical Energetics, Equilibria and Functional Organic Chemistry - I
3.3	Molecular Biology
3.4	Principles of Genetics
3.5	Wildlife Conservation and Management
3.6	Animal Behaviour and Chronobiology
3.7	Computational Biology
3.8	Animal Biotechnology
3.9	Developmental Biology
4.0	Evolutionary Biology
4.1	Immunology
4.2	Parasitology
4.3	Fish and Fisheries
4.4	Biology of Insecta
4.5	Non-chordates I: Protista to Pseudocoelomates Lab
4.6	Perspectives in Ecology Lab
4.7	Non-Chordates II: Coelomates Lab
4.8	Cell Biology Lab
4.9	Animal Diversity Lab
5.0	Atomic Structure, Bonding, General Organic Chemistry and Aliphatic Hydrocarbons Lab
5.1	Environment and Public Health Lab
5.2	Diversity of Chordates Lab
5.3	Animal Physiology: Controlling and Coordinating Systems Lab
5.4	Fundamentals of Biochemistry Lab
5.5	Comparative Anatomy of Vertebrates Lab
5.6	Animal Physiology: Life-Sustaining Systems Lab
5.7	Biochemistry of Metabolic Processes Lab
5.8	Environmental Biotechnology Lab
5.9	Chemical Energetics, Equilibria and Functional Organic Chemistry – I Lab
6.0	Economic Botany and Plant Biotechnology Lab
6.1	Molecular Biology Lab
6.2	Principles of Genetics Lab
6.3	Wildlife Conservation and Management Lab
6.4	Animal Behaviour and Chronobiology Lab
6.5	Computational Biology Lab
6.6	Animal Biotechnology Lab
6.7	Developmental Biology Lab
6.8	Evolutionary Biology Lab
6.9	Immunology Lab
7.0	Parasitology Lab
7.1	Fish and Fisheries Lab
7.2	Biology of Insecta Lab

BSC (HONOURS) ZOOLOGY MAPPING OF COURSES TO PO/PSO

Sl. NO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
1.1						H					H
1.2					M	M		M	M		H

1.3	H				M	M		H	M	M	
1.4	H					M		H	H		
1.5		H	H	H					M		
1.6	H							H	M		
1.7	H							H	M		
1.8	M							H	M	H	
1.9	H							M	H	H	
2.0						H					H
2.1	H							H	M		
2.2	H						H	H			
2.3								H	M	H	
2.4						H		H	H		M
2.5	H							H	H		
2.6	M							H	H	H	
2.7						H		H			M
2.8	M							M			
2.9	H							H	H		
3.0								H	M	H	
3.1	M							M			
3.2	H							H	H	H	
3.3	H		M		H					H	
3.4								H	M		
3.5								H	H		
3.6	M							H	H		
3.7	M							H	H	H	
3.8								H	H	H	
3.9	H							H	H	H	
4.0								H	H	H	
4.1	H							H	H		
4.2	H							H	H		
4.3	H							H	H	H	
4.4	H				M			H	H	M	
4.5	M							H			H
4.6	M				M			H	M	M	H
4.7	H							H			
4.8	H				M			H	H	H	
4.9	H							H	H		
5.0	H							H	H	M	
5.1	H				H			H	H		
5.2	H				H			H	H	H	
5.3	H							H	M		
5.4	M							M	M		
5.5	M				M			H	H	H	
5.6								H	M	M	
5.7	H							H	H		M
5.8	H				H			H	H	H	
5.9	M							H	H		
6.0	M				M			H	H	M	H
6.1	M							H	H		
6.2					M			H	H	H	
6.3	M							H	H		
6.4	M				M			H	M	H	
6.5	H				M			M	H	M	M
6.6	M				M			H	M	M	
6.7	H				M			M	H	H	
6.8	M				M			H	M	M	M

6.9	M				M			H	M	M	
7.0	H				M			M	H	M	
7.1	H				H			M	M	M	
7.2	M				H			M	M	M	M

PROGRAMME: MSC ZOOLOGY

PROGRAM OUTCOMES (PO)- MSC ZOOLOGY

PO 1: **Critical Thinking**: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational and personal) from different perspective.

PO 2: **Effective Communication**: Speak, read, write and listen clearly in person and through electronic media, and make meaning of the world by connecting people, ideas, books, media and technology.

PO 3: **Social Interaction**: Elicit views of others, mediate disagreements and help reach conclusions in group settings.

PO 4: **Effective Citizenship**: Demonstrate empathetic social concern and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO 5: **Ethics**: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

PO 6: **Environment and Sustainability**: Understand the issues of environmental contexts and sustainable development.

PO 7: **Self-directed and Life-long Learning**: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.

PO 8: **Skill Development**: Acquire and develop skills in handling scientific instruments, planning and executing biological research for employability and social service.

PO 9: **Entrepreneurship**: Inculcate a holistic approach towards amalgamating and applying the acquired knowledge, ideas and views towards formulating a model that would not only encourage financial stability of the person concerned but also generate employability and strengthen the socio-economic aspect of a region or locality as a whole.

PO 10: **Creative Thinking**: Promote creative thinking and innovative ideas for the welfare of the society.

PROGRAMME SPECIFIC OUTCOMES (PSOs)- MSc ZOOLOGY

PSO 1: **Knowledge and concept**: To acquire in-depth knowledge about the complexity of life systems at the molecular level.

PSO 2: **Research-inclined mindset**: To apply and analyze the various research techniques through minor dissertation projects, thus inculcating the fundamentals for future scientific studies.

PSO 3: **Applied Zoology and Entrepreneurship**: To apply the acquired knowledge to invigorate the existing areas of application-based zoological studies for creating productive models for self-sustenance.

PSO 4: **Conservation Models**: To specifically recognize the existing conservation issues with regards to both animal and environment and develop strategies to address these issues through ecologically sustainable methods.

COURSES OFFERED IN MSC ZOOLOGY

Sl. No	**Course Name**
1.1	Research Methodology and Biostatistics
1.2	Developmental Biology
1.3	Insects: Structure and Function
1.4	Insect Physiology
1.5	Cell and Molecular Biology I
1.6	Immunology I
1.7	Taxonomy and Functional Anatomy
1.8	Aquaculture and Fish Genetics
1.9	Animal Ecology and Biogeography
2.0	Wildlife Conservation and Management
2.1	Insect Ecology
2.2	Principles of Pest Management
2.3	Cell and Molecular Biology II
2.4	Immunology II
2.5	Capture Fishery and Post-Harvest Technology
2.6	Limnology, Fisher Economics, Ornamental Fishery and Fish Pathology
2.7	Wildlife Resource Management, Laws and Techniques In Population Study

2.8	Techniques in Wildlife Study, Wildlife Health, Forensics, and Conflict
2.9	Biosystematics and Evolution
3.0	Cell Biology and Immunology – Theory and Applications
3.1	Molecular Biology and Genetics
3.2	Animal Physiology
3.3	Ecology and Environmental Biology
3.4	Endocrinology and Biochemistry
3.5	Applied Zoology
3.6	Ethology and Population Genetics
3.7	Service Learning in Zoology
3.8	Project Management, Reporting, and Documentation
3.9	Dissertation Phase I
4.0	Introduction to Journalism and Photography
4.1	Dissertation Phase II
4.2	Teaching Methodology and Classroom Management
4.3	Specialization Lab I-Entomology
4.4	Specialization Lab I-Cell and Molecular Biology
4.5	Specialization Lab I-Fishery Science
4.6	Specialization Lab I-Animal Ecology and Wildlife Biology
4.7	Specialization Lab II-Entomology
4.8	Specialization Lab II- Cell and Molecular Biology
4.9	Specialization Lab II- Fishery Science
5.0	Specialization Lab II- Animal Ecology and Wildlife Biology
5.1	Biosystematics and Environmental Biology Lab
5.2	Cell Biology, Genetics and Basic Bioinformatics Lab
5.3	Developmental Biology and Biochemistry Lab
5.4	Ethology and Population Genetics Lab

Mapping of Courses to PO/PSO

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
1.1	M	H			H			H		H		H	M	M
1.2	H				M						H	M		
1.3											H			
1.4	M										H			
1.5	M										H	M		
1.6											H	M		
1.7	M										H			
1.8							M				H	M		M
1.9											H			
2.0	M			M	H	H	H				H	M		H
2.1											H			H
2.2							H	M			H		M	
2.3											H			
2.4											H			
2.5							H				H	M	M	
2.6											H		H	H
2.7							H	H			H	M		H
2.8					M	H	H	H			H	M		H
2.9	H										H			
3.0	M						H				H	M		
3.1	H				M						H			
3.2											M			
3.3						H					M			H
3.4											H	M		
3.5	M				M		H	H	H	H			H	
3.6	H				H						H	M		M

3.7			H		H		H			H	H	M	M	H
3.8		H	M	M			H	H		H			M	
3.9		M	M		M									
4.0		H			H		H	H				M	M	
4.1		H	M		H									
4.2								H					M	
4.3		M					M							
4.4		M					M							
4.5		M					M							
4.6		M				H	H							
4.7		M					H							
4.8		M					H							
4.9		M					H							
5.0		M												
5.1		M				H	H							
5.2		M					H							
5.3		M					H							
5.4		M					H							M

DETAILED SYLLABUS
THEORY COURSES

BTRM0003: RESEARCH METHODOLOGY AND BIOSTATISTICS (4 CREDITS – 60 HOURS) [L-T-P: 4-0-0]

Course Outcomes

At the end of the course students will be able to:
1. Identify the forms of research – basic, applied, interdisciplinary, etc. (Analysing)
2. Explain Ethical conduct of research and its communication (Understanding)
3. Determination of Statistical methods of data analysis and interpretation (Evaluating)

Module I: Introduction to Scientific Research (15 hours)

a) Definition, basic and applied research, interdisciplinary research,
b) Discriminative reading, reading and reviewing scientific literature – consulting source material, primary and secondary literature, biological abstract, current content, review, monograph, peer- reviewed journals, e-resources; research and review articles
c) Introduction on scientific problems, your scientific problem, methods and techniques, research conditions, data types, techniques, repeatability, reproducibility and reliability, validity, effect measure and choice of statistical test, experimental protocol, experimental routine
d) Scientific communication - scientific paper, scientific posters

Module II: Ethics and Scientific Conduct (5 hours)

Brief introduction to ethics, scientific conduct and misconduct-plagiarism, authorship issues, investigation and punishment of scientific misconduct, ethics of animal and human research

Module III: (15 hours)

a) Introduction to Biostatistics: definition and applications of biostatistics;
b) Data-types and presentation: types of biological data, accuracy and significant figures;
c) Populations and samples: populations, samples from populations, random sampling, variables and attributes, statisticalerrors
d) Frequency distributions
e) Graphical representation of data: line diagram, bar diagram, pie chart, histogram
f) Measures of central tendency: the arithmetic mean, median and mode
g) Measures of dispersion: range, mean deviation, variance, standard deviation, standard error of mean, standard score

Module IV: (6 hours)

a) Permutations and combinations, sets
b) Probability: introduction, counting possible outcomes, probability of an event, adding and multiplying probabilities
c) Probability distributions: Binomial, Poisson and Normal distribution

Module V: (19 hours)

a) Testing of hypothesis and goodness of fit: Null hypothesis, level of significance, errors of influence,
Student's t-test, paired t-test, Fischer's test, Chi-square test, linear correlation and linear regression
b) Analysis of variance: variances of samples and their means, F-distribution, partitioning of the total sum of squares anddegrees of freedom, models and types of ANOVA

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	L	L	H	M
CO 2	L	H			
CO 3	M	M	H	H	H

ZGDB0005: DEVELOPMENTAL BIOLOGY (4 CREDITS–60 HOURS) (L-T-P: 4-0-0)

Course Outcomes

1. Summarize the mechanisms underlying the process of development. (Remembering)
2. Distinguish different mechanisms of cellular dynamics through experimental embryology. (Analyzing)
3. Apply the concepts of stem cells in relation to health sciences. (Applying)
4. Analyze the various teratogenic agents and environmental estrogens. (Analyzing)
5. Evaluate the interactions of maternal effect of gene, gap gene, pair-rule gene, and hox- gene in development with

respect to Drosophila. (Evaluating)
6. Discuss the various methods of assisted reproductive technology. (Creating)

Module I (14 hours)

a) Fertilization-pre and post fertilization events, activation of eggs, gamete fusion and prevention of phylogeny
b) General concept of Induction: mesoderm development, Determination: Imaginal disc of insects, Differentiation: Formation of fruiting bodies in Dictyostelium
c) Neo-cytoplasmic interaction in development of unicellular organisms and in early development and differentiations of multicellular organisms, importance and role of cytoplasm, hybridization experiments, nature of changes in nuclei, cell hybridization, nuclear transplantation experiments.

Module II (10 hours)

a) Principles of experimental embryology: the developmental dynamics of cell specification, stem cells and developmentalcommitment, totipotency and pluripotency.
b) Morphogenesis and cell adhesion- the thermodynamic model of cell interactions, concept of morphogen gradient andmorphogenetic field, cell adhesion molecules.

Module III (10 hours)

Role of maternal contribution in early embryonic development in Drosophila: maternal effect genes, gap genes, pair rule genes and hox genes in development.

Module IV (10 hours)

Organogenesis: Vulva formation in *Caenorhapditis elegans*; Regeneration of Salamander limbs; Lens regeneration in amphibia; Bone and neural regeneration-Medical Advances in regeneration.

Module V (16 hours)

a) medical implications of Developmental Biology - Genetic error of human development; Environmental assault on human development, Teratogenic agents (Retinoic acid, pathogens, alcohol, drugs and chemicals, heavy metals); Environmental estrogens.
b) Infertility- In vitro fertilization and embryo transfer. Cloning experiments- Amphibians and Mammals. Embryonic stem cellsand their applications; ethical issues
c) Sex determination-Timing and gene expression in mammalian sex determination, Brain sex determination pathways in invertebrates and flies, Hormone disruptors and sex determination problems, Temperature-dependent sex determination in turtles, Evolution of sex from invertebrate to vertebrate; ethical issues.

Suggested Readings

1. Balinsky, B.I. An Introduction to Embryology. W.B Saunders Co., Philadelphia.
2. Gilbert, S.F. Developmental Biology. Sinamer Associates Inc. Saunderland, Massachusetts, U.S.A.
3. John E. Hall: Textbook of Medical Physiology. Guyton & Hall
4. Kalthoff: Analysis of biological development. McGraw-Hill, 1996.
5. Karp, G. and Berrill, N.J. Development. McGraw Hill, New York.
6. Nagabhushanam, R. and Sarojini, R. Invertebrate Embryology. Oxford and IBA Publishing Co.
7. Oppenheimer, S.B. Introduction to Embryonic Development. Allyn and Bacon, Inc.
8. Saunders, J.W. Developmental Biology. MacMillan Co., London.
9. Tyagi and Shukla, Development of Fishes. Jaya Publishing House, New Delhi.
10. Wolpert: Principles of development. Oxford.
11. N. Arumugan, A textbook on Embryology, Saras Publication.
12. Gurbachan S. Miglani, Developmental Genetics, I.K. International Publishing House Pvt. Ltd.
13. VermaP.S. and Agarwal V.K, Chordate Embryology, S. Chand Publishing.
14. Chordate Embryology by Verma P.S. and Agarwal V.K., S. Chand Publishing.
15. Saidapur.S.K. Reproductive cycles of Indian vertebrates. (Allied Publishers Ltd. New Delhi)
16. Sarkar. H.B.D Principles of Vertebrate reproductive Biology
17. Chester-Jones I: Fundamentals of Comparative vertebrate Endocrinology (Pleum Press: NY)

Mapping COs to syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO1	L					
CO2		H				
CO3				H		
CO4						H
CO5			H		H	

CO6						H

SPECIALISATION I: ENTOMOLOGY

ZGIF0008: INSECTS- STRUCTURE AND FUNCTION (4 CREDITS-60 HOURS; L-T-P: 4-0-0)

Course/Learning Outcomes (CO)

At the end of this course students will be able to:

1. Recall the basics of insect classification of different insect orders up to family level. (Remembering)
2. Identify details of insects' morphology, origin and locomotion and the different receptor organs. (Applying)
3. Discuss the basic concepts of insect-plant interactions. (Creating)

Module I (20 hours)

a) Origin and evolution of insects
b) Segmentation of insect: head, thorax and abdomen: body tagmata, sclerites and segmentation, Type of mouthparts, antennae, legs, their modifications and functional significance; model Genitalia and their modifications; Embryonic and post-embryonic development; Types of metamorphosis in insects.
c) Wings: wing structure, venation and wing coupling; Insect flight taking Drosophila as a model.

Module II (20 hours)

Basic concept of surveillance and sampling of insect.

Classification of insect up to family with example : a) Coleoptera, Diptera, Hymenoptera; b) Lepidoptera, Odonata; c) Orthoptera, Hemiptera and; Insect molecular taxonomy-DNA as a new tool for insect identification

Module III (8 hours)

Insect integument: Structure, chemical composition, bio-composition of chitin, function of integument

Module IV (12 hours)

a) Receptor organ in insects (Chemoreceptors,
b) mechano receptors and photoreceptors);
c) Sound and Light producing organs in insects;
d) Locomotion in insects,
e) Insect Muscle,
f) Insect eye.

Suggested Readings

1. R.F. Chapman, The Insect Structure and Functions, Cambridge University Press
2. D.B. Tembhare, Modern Entomology, Himalaya Publishing House
3. K.P. Srivastava, Textbook of Applied Entomology Vol- I & Vol- II, Kalyani Publishers
4. Abhishek Shukla and Sushil Kumar Saxena, Introduction to General and Applied Entomology, Astral International (P) Ltd.
5. H. Maxwel-Lefroy & F.M. Howlett, Indian Insect Pests, Astral International (P) Ltd.
6. Abhishek Shukla, A Handbook on Economic Entomology, Astral International (P) Ltd.
7. T.V. Sathe & Jyoti M. Oulkar, Insect Pest Management: Ecological Concepts, Astral International (P) Ltd.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	M	H		L
CO 2	H	H	H	H
CO 3	L	H		
CO 4	H	M	M	M
CO5	H			

ZGIP0009: INSECT PHYSIOLOGY (4 CREDITS-60 HOURS; L-T-P: 4-0-0)

Course/Learning Outcomes

1. Explain the development and physiology of different systems; hormones and pheromones. (Understanding)
2. Compare the morphology of insect organ systems. (Analysing)
3. Examine how the morphology of an organ is related to its function and how these systems help the insects to adaptto the environment. (Analysing)
4. Develop a sound knowledge on the insect metabolism, muscle and the physiology of insect vision (Applying)

Module I (25 hours)

a) **Digestive System:** Different types of alimentary canal, salivary glands, physiology of digestion and absorption.

b) **Respiratory System**: General organization of respiratory system, classification of respiratory system, respiration in terrestrial insects-different types of spiracles and their structure, opening and closing mechanism of spiracle, trachea and tracheoles, air sac, ventilation of tracheal system, mechanism of gaseous exchange, respiration in aquatic insects, physiology of gill andplastron respiration, respiration in parasitic insects.

c) **Circulatory system**: Diaphragm and sinuses, dorsal vessels, accessory pulsatory organs, blood circulation, chemical composition of haemolymph, different types of haemocytes and their functions.

Module II (18 hours)

a) **Nervous system:** Structure and types of neurons, central nervous system basic plan, gross anatomy and microanatomy of brain and ganglion, sympathetic nervous system, nerve impulse transmission.

b) **Excretory System**: Basic and cryptonephridial system, malpighian tubules-anatomy and histology, Accessory organs of excretion, metabolic pathways of formation of uric acid and ammonia, elimination of Uric acid by malpighian tubules;

c) **Diapause**: Hormonal control of embryonic, larva, pupal and reproductive diapause

Module III (17 hours)

a) **Reproductive System:** male and female reproductive system, spermatogenesis, oogenesis; Hormonal control of reproduction in male and female insects;

b) **Neuroendocrine System**: Neuroendocrine organs, hormones produced by neurosecretory cells, corpus allatum, corpus cardiacum and prothoracic gland, their chemical nature and functions; Insect immunity; Growth and metamorphosis of insects; Insect Pheromones.

Suggested Readings

1. The Insect Structure and Functions, R.F. Chapman, Cambridge University Press
2. Modern Entomology, D.B. Tembhare Himalaya Publishing House
3. Text Book of Applied Entomology Vol- I & Vol- II, K.P. Srivastava, Kalyani Publishers
4. Introduction to General and Applied Entomology, Abhishek Shukla and Sushil kumar Saxena, Astral International (P)Ltd.
5. Indian Insect Pests, H. Maxwel-Lefroy & F.M. Howlett, Astral International (P) Ltd.
6. A Handbook on Economic Entomology, Abhishek Shukla, Astral International (P) Ltd.
7. Insect Pest Management: Ecological Concepts, T.V.Sathe & Jyoti M. Oulkar, Astral International (P) Ltd.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1	H	H	H
CO 2	H	H	H
CO 3	H	H	H

SPECIALIZATION II: CELL AND MOLECULAR BIOLOGY SPECIALIZATION

ZGCB0010: CELL AND MOLECULAR BIOLOGY-I (4 CREDITS; 60 HRS; 4-0-0)

Course Outcomes

1. Define the structure and working of various components of the cell such as biomembrane structure and organization; genes and gene regulation and protein hierarchical structure. (Remembering).
2. Describe the various types of protein in the cell organization. (Understanding)
3. Study the positive and negative control of gene expression and also the molecular structure of chromosomes.(Analysing)
4. Recommend the use, Ramachandran plot for the prediction of secondary structure of protein. (Evaluating, creating)

Module I (10 hrs)

Transport across cell membrane: Mechanism of diffusion, Facilitated diffusion; Osmosis and water channels, movement, Flick's law, Donnan equilibrium; Uniporter-catalyzed transport, difference between uniport-catalyzed transport and passive diffusion, GLUT- 1 transport & its kinetics; Intracellular ion environment and membrane electric potential; Active transport - P-class ion pumps, F-class and V-class ion pumps and ABC superfamily, Plasma Membrane Ca++ ATPase pump, Muscle Ca++ ATPase pump and Na+/K+ ATPase pump; Cotransport by symportors and antiporters; Transport across epithelia, Receptor mediated endocytosis.

Module II (15 hrshrs)

Cytoskeleton: Microfilaments: Actin cytoskeleton, G-actin and F-actin; structural and functional polarity. Cortical actin network, erythrocyte and platelet cytoskeleton; Actin bundle support projecting fingers of membrane; Dynamics of actin assembly, actin polymerization; Toxins effect on actin monomer - polymer equilibrium, stabilization of actin filaments by actin capping proteins; Movement with actin polymerization (a) Intracellular bacterial and viral movements (b) Actin polymerization at the leading edge of moving cells; Myosin: (a) Structure and mechanism of movement with actin (b) Conformational changes in myosin during movement.

Microtubules: Microtubules structure and microtubule assembly from organizing centers, Microtubule dynamics, Microtubule associated proteins (MAP's) and crosslinking of microtubules.

Microtubules and mitosis (a) Centrosome duplication (b) Kinetochore and force for poleward chromosome movement (c) Organization of spindle pole and orientation of assembly (d) Formation of poles and capture of chromosomes (e) Kinetochore and force of poleward chromosome movement (f) Astral microtubule and cytokinesis (g) Microtubules and plant cell formation.

Module III (20 hrs)

Molecular structure of genes and chromosomes: Definition of gene; Chromosomal organization of genes- coding and non-coding DNA; Functional re-arrangements in chromosomal DNA; Organizing cellular DNA into chromosomes; Morphological and functional elements of eukaryotic chromosomes.

Regulation of Gene expression: Operon concept; Positive and Negative regulation; Inducers and corepressors; Regulation by attenuation-his and trp operons.

Module IV (15 hrs)

Protein structure and function: Structure and chemistry of amino acids; Hierarchical structure of proteins-Secondary structure: α-helix, β-pleated sheets and bends; Prediction of secondary structure, Ramachandran plot; Tertiary structure, forces stabilizing tertiary structure; Domains and Motifs; Quarternary structure of proteins

DNA binding proteins and gene regulation: DNA binding domain**;** Homeodomain proteins; Zinc finger proteins**;** Winged-helix (Forked head) proteins; Leucine-Zipper proteins; Helix Loop helix proteins.

Suggested Readings

1. Cooper, G. M., Cell (A Molecular Approach)
2. DeRobertis&DeRobertis: Cell and Molecular Biology
3. Lodish et al: Molecular Cell Biology
4. Karp: Cell and Molecular Biology
5. Becker et al: World of Cell
6. T.A. Brown: Genome
7. Griffith et al: Modern Genetic Analysis
8. Hartl& Jones: Essential Genetics: A Genome Perspective
9. Ram Mahabal, Fundamental of Cytogenetics and Genetics
10. Lewin, Genes VIII

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	L			
CO2		M		
CO3			H	
CO4				H

ZGIY0011: IMMUNOLOGY-I (CREDIT 4; 60 HRS; 4-0-0)

Course Outcomes

1. Define the basic concepts of the immune system and its components. (Remembering)
2. Analyze the antigen-antibody reactions. (Analyzing)
3. Demonstrating the general organization and inheritance of major histocompatibility complex. (Understanding)
4. Recommend the list of various agents responsible for hypersensitivity reaction Develop a network of various components and complexes of the immune system and make a checklist of organ specific and systemic autoimmune diseases. (Evaluating)

Module I (15 hrs)

Cells and organs of immune system: Hematopoiesis- B-Lymphocytes, T-lymphocytes and Null cells; Mononuclear cells (antimicrobial and cytotoxic activities, secretion of factors); Granulocytic cells (Neutrophils, Eosinophils and Basophils); Mast cells; Dendritic cells and Langerhans cells; Organs of immune system: Primary lymphoid organs (Thymus and bone marrow), Secondary lymphoid organs (Lymph nodes, spleen, mucosal associated lymphoid tissue and cutaneous associated lymphoid tissue, tonsils and Peyer's patches; Lymphatic system.

Molecular Immunology: Components of immunity**;** Innate (nonspecific) immunity**-** Anatomic barriers**,** Chemical barriers**,** Phagocytic barriers**,** Inflammatory barriers; Adaptive (specific) immunity-Humoral and cell-mediated immunity (CMI):(a)

Recognition of antigen by B-and T-lymphocytes and antigen presenting cell (APC)(b) Clonal selection of lymphocytes**;** Cellular interactions required for generation of immune responses(a) Activation and proliferation of B and T cells (b) Generation of humoral immune responses (c) Generation of Cell mediated immune responses.

Module II (15 hrs)
Antigens: Immunogenicity versus antigenicity**;** Factors that influence immunogenicity**,** Contribution of the immunogens (foreignness, molecular size, chemical composition and heterogenesity, susceptibility to antigen processing and presentation); Haptens and epitopes; Immunogen dosage and route of administration and adjuvants.
Immunoglobulins structure and function: Molecular structure of Ig**;** Immunoglobulin classes (lgG, lgM, IgE and lgD and their biological activities; Immunoglobulin - mediated effector functions (Opsonization, activation of complement, antibody dependent cell- mediated cytotoxicity , neutralization); Antigenic determinants on immunoglobulin (isotype, allotype and idiotype); Monoclonal antibodies: Formation and selection of hybrid cells, Production of monoclonal antibodies, Clinical uses of monoclonal antibodies, Catalytic monoclonal antibodies (abzymes).
Antigen - Antibody Interaction: Antibody affinity and activity; Cross reactivity; Agglutination reactions; Precipitation reaction.

Module III (20 hrs)
Major Histocomptability complex: General organization and inheritance of MHC; Location and function of MHC; MHC haplotypes; MHC molecules and gene: Structure of class I molecules; Structure of class II molecules; Organization of class I and II genes; Peptide binding by MHC molecules; Class III molecules; Regulation of MHC expression; MHC and immune responsiveness; MHC and disease susceptibility.
Antigen processing and presentation: Role of antigen presenting cell**,** Early evidence for the necessity of antigen processing; Cells that function in antigen presentation; Evidence for two processing and presentation pathways; Endogenous antigens (The cytosolic pathway): (a) Peptide generation by proteosomes (b) Peptide transport from the cytosol to rER (c) Assembly of peptide with class I MHC molecules**;** Exogenous antigens (The endocytic pathway)(a) Peptide generation in endocytic vesicles(b) Transport of class II MHC molecules to endocytic vesicles.(c) Assembly of peptide with class 11 MHC molecules.

Module IV (10 hrs)
Hypersensitivity: Type I, II, III and IV; *In vivo* and *in vitro*
Autoimmunity: Organ specific autoimmune disease; Systemic autoimmune disease.

Suggested Readings
1. Kuby et al.: Kuby Immunology
2. Abbas A.K., Lichtman A.K. and Pober J.S. Cellular and Molecular Immunology
3. Roitt et al, Essential Immunology
4. Price C.P., Newman D.J., Principles and Practices of Immunology
5. Kindt T.J., Osborne B.A., Goldsby R., Immunology

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
1	L			
2		H		
3			M	
4				M

SPECIALIZATION III: FISHERY SCIENCE

ZGTF0012: TAXONOMY AND FUNCTIONAL ANATOMY (4 CREDITS- 60 HOURS/L-T-P: 4-0-0)

Course Outcomes
1. Demonstrate the knowledge of non-piscine fishery resources and their importance in fisheries. (Understanding)
2. Apply the knowledge of fish biology and its importance in fishery practices for the development of future entrepreneurship. (Applying)
3. Develop fundamental skill to identify and classify various groups of fishes, their relationship with morpho-anatomicaland molecular techniques. (Creating)

Module I (10 hours)
a) **Fin fish taxonomy:** General characters and classification, major fish groups (extant & extinct), phylogeny of fishes;
b) **Gross external anatomy of fishes:** skin and its derivatives, scales and their significance; Significance of fish osteology in taxonomy.
c) Fish barcoding.

Module II (30 hours)

a) **Fin fish functional biology:** Food and feeding habits: Food– Kinds and varieties, abundance of food and its availability,structural adaptation, search for food, classification based on food and feeding habits;

b) **Respiratory organs in fishes** – Modification of gills and Tracheae in relation to habit – Structural adaptations of air breathing fishes;

c) **Age and growth:** Growth, length weight relationships, condition factors, morphometric indices and bioenergetics index, variation in growth rate, age determination;

d) **Fin fish reproductive biology:** Modes of reproduction, reproductive cycle, gonad maturity stages, Hormonal regulation of gonadal development, activity of Gonadotropin-releasing hormone, modes of spawning; Environmental factors controlling reproduction and factors affecting development.

Module III (20 hours)

a) Shellfish taxonomy:

General characters and classification of major groups of crustacean and molluscs.

b) Food and feeding biology of Shellfish:

- Food, feeding habits and adaptations of cultured prawn and shrimps.
- Food, feeding habits and adaptations of cultured Molluscs.

c) Shellfish reproductive biology:

- Reproductive patterns in prawn and shrimp, reproductive organs, gonad maturity, spawning and fertilization.
- Endocrine organs in crustaceans and their role in reproduction.
- Reproductive patterns in Molluscs, reproductive organs, gonad maturity, spawning and fertilization.

Suggested Readings

1. Barrington, F.J.W. Invertebrates: Structure and Functions. EIBS.
2. Carl, B.E. Biology of Fishes. Saunders,
3. Fretter, V. & A. Graham.The functional anatomy of vertebrates. Academic Press Inc. (Lon.) Ltd.
4. Kaestner, A. Invertebrate Zoology. Vol. I – III, John Wiley & Sons
5. Kurian, C.V. & V.O. Sabastian. Prawns and Prawn Fisheries of India.
6. Lagler, K.E. et. Al. Ichthyology. John Wiley,
7. Low, M.S. & G.M. Calliet (eds.). Readings in Ichthyology. Prentice Hall,
8. Moyle Peterb, Fishes: An Introduction to Ichthyology. Prentice Hall.
9. Nikolsky, G.V. Ecology of Fishes. Academic Press, NY. Howar, W.S. & D.J. Randal. Fish Physiology, Vols.1–4, Academic Press,NY
10. Norman, J.R. & P.H. Greenwood.A History of Fishes, Ernest Benn Ltd.
11. Jayaram K. C. The fresh water fishes of India, Pakistan, Bangladesh, Burma and Sri Lanka.
12. Jhingran V. G. Fish and Fisheries of India.
13. Lagler, K.F. Ichthyology. John Wiley Publication
14. Norman, J.R. & P.H. Green Wood.A history of fishes.
15. Bond, E. Carl. Biology of fishes.
16. Kumar S and Thembre M Anatomy and Physiology of Fishes (Vikas Publishing House)
17. Srivastava, C.B.L. Textbook of Fishery Science and Indian Fisheries. KutubMahal
18. Khanna S. S. and H. R. Singh. A textbook of Fish Biology and Fisheries, Narendra Publishing House
19. Beaven C R. Handbook of the freshwater fishes of India (Narendra Publishing House)
20. Biswas K P A Text Book of Fish, Fisheries and Technology, (Narendra Publishing House)
21. Brown E and Margaret 1957 Physiology of Fishes Vol I & II (Academic Press, Inc. Publishers)
22. Daniels R J R Freshwater fishes of Peninsular India (Universities press)
23. Lagler, K.F. Ichthyology. John Wiley Publication
24. Love, M.S. & Cailliet, G.M. Readings in Ichthyology. Prentice Hall Publications, 1979.
25. Norman, J.R. & P.H. Green Wood. A history of fishes.
26. Pandey. Fish and Fisheries. Rastogi Publications

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO 1			H
CO 2		H	
CO 3	H		

ZGAF0013: AQUACULTURE AND FISH GENETICS (4 CREDITS-60 HOURS/ L-T-P: 4-0-0)

Course Outcomes

1. Compare various freshwater fish culture methodologies and their significance. (Understanding)
2. Utilize the knowledge on the process of fishery and aquaculture management for development of future entrepreneurship. (Applying)
3. Utilize the knowledge of nutritional requirements in fishery and development of skill on fish feed formulation for a profitable fish farming system. (Applying)
4. Apply the knowledge of the application of modern biotechnological tools and their role in the development of fishery. (Applying)

Module I (15 hours)

a) **Fishery Management:** Construction of fish farm and reclamation of swamps; Selection of species for culture – Biological principles, Preparation and management of nursery ponds, rearing ponds and stocking ponds along with control of weeds, pests and predators, Construction of hatcheries and their management.

b) **Aquaculture Management**: Feed, health and water quality management.

Module II (15 hours)

Freshwater fish culture: Indian Major carps and exotic carps - Composite Fish Culture; Air breathing fishes; Integrated Fish Farming – Paddy cum Fish Culture and Fish cum Livestock Culture, Monoculture, Monosex culture; Sewage fed fisheries, Catfish culture, Trout culture, Freshwater prawn culture; shrimps and Crab culture; cage culture and pen culture, Lobster culture, Mussel culture; Pearl oyster culture; Edible oyster culture

Module III (15 hours)

a) **Fish nutrition:** Nutritional requirements, formulation and preparation of fish feeds Food & Feeding habits of commercially important fishes. Larval nutrition — Importance of live feed and artificial feed, Different types of feed available for larvae.

b) **Fish seed resources:** Procurement and transportation of seed from natural resources.

Module IV (15 hours)

a) **Fishery Genetics and Biotechnology:** Inheritance in fishes, sex determination, hybridization

b) **Cytogenetics and molecular techniques in fisheries:** Comet Assay, Micronuclei Test, Fish cell lines and cell culture. Application of biotechnological tools: Recombinant DNA, Transgenesis, Gynogenesis and Androgenesis, Jellyfish Green Fluorescent Proteins and their applications; Cryopreservation.

Suggested Readings

1. Arumugam, N. Aquaculture & Fisheries, Saras Publication
2. Bardach, J.E., Ryther, J.H. and McLarney, W.O. Aquaculture. John Wiley & Sons Inc., USA.
3. Beaven C R Handbook of the freshwater fishes of India (Narendra Publishing House)
4. Boris, Gomelsky. Fish Genetics. VDMVerlag
5. C.I.F.R.I., Prawn Fisheries Bulletin
6. Chakroff,M., Freshwater Fish Pond Culture and Management, Scientific Publishers
7. Christenson, K. Aquaculture: Introduction to Aquaculture for Small Farmers. Createspace Independent Publishing Platform
8. Daniels R J R Freshwater fishes of Peninsular India (Universities press)
9. Dholakia, A.D. Identification of Prawns/Shrimps of India and Their Culture. Daya Publishing House
10. Elizabeth Gosling. Bivalve Molluscs: Biology, Ecology and Culture Wiley-Blackwell
11. Ghosh, S.., Palanisamy, K. and Pathak, S.C. Shrimp and Freshwater Hatchery Public Relations
12. Division, National Bank for Agriculture and Rural Development, Bombay.
13. Gray, Camillo W. Guide to Shrimp and Prawn Culture in Bangladesh. University of Stirling Institute of Aquaculture
14. Gupta S.K., Gupta P.C. General & Applied Ichthyology. S Chand & Company
15. Hall, C. B., Ponds and Fish Culture, Agro Botanical Publishers
16. Harvey, B. J. and Hoar, W. S. Theory and practice of induced breeding in fishes.
17. Hora, S. L. and Pillay, T.V. R. Handbook on Fish Culture in the Indo-Pacific Region, Fisheries Division, Biology Branch, FAO,
18. Huet, M., Textbook of Fish Culture, Breeding and Cultivation of Fish, Fishing News (Books) Ltd..
19. CAR. Handbook of Fisheries and Aquaculture Reddy,
20. M.S. A Text Book of Aquaculture, Discovery Publishing Pvt. Ltd
21. Jhingran V. G. Fish and Fisheries of India.
22. Kolappan Nisha. Identification of Genetic Relation Between Fish Species Using Sds-Page. Lambert Academic Publishing
23. Kurian, C.V. and Sebastian,V.O. Prawns and prawn Fishery of India. Hindustan Publishing Corporation (India), New Delhi.

24. Lakra W. S., Abidi SAH, Mukherjee SC and Ayyappan S. 2004.Fisheries Biotechnology.
25. Lucas, J.S. Aquaculture: Farming aquatic animals and plants (Fishing News Books)
26. MacKenzie, Simon A. Genomics in Aquaculture Academic Press
27. Michael Bernard New (Editor), Wagner Cotton iValenti(Editor), James H. Tidwell(Editor). Freshwater Prawns: Biology and Farming Wiley-Blackwell
28. Mikhalev, Viktor. Genetics and Fish Breeding.Arcler
29. Nigel Preston (Editor), Dean R. Jerry (Editor)Biology and Culture of Farmed Marine Shrimps. CRC Press
30. Pandian, T.J. (Editor), C.A. Strüssmann (Editor), M.P. Marian (Editor). Fish Genetics and Aquaculture Biotechnology.CRC Press
31. Pandian, T.J. Genetic Sex Differentiation in Fish. CRC Press
32. Pillay, T. V. R.1993. Aquaculture – Principles and Practices. Fishing News Book.
33. Pillay, T.V.R. and M.N. Kutty, Aquaculture: Principles and Practices. Wiley India Pvt Ltd; Second edition
34. Rao, K. L. 1975. India's water wealth.
35. Rath, R.K. Freshwater Aquaculture Scientific Publishers Journals Dept
36. Ravishankar Piska, 1999. Fisheries and Aquaculture. Lahari Publications, Hyderabad.
37. Santhanam R. Fisheries Science, Daya Publishing House, 1990.
38. Selvamani B.R & Mahadevan R.K 2008 Freshwater fish farming (Campus Books International)
39. Singh, B.& A. Dey. Fish and Fisheries. Invincible Publishers
40. Singh, N.P. & B. Santosh. Handbook of freshwater aquaculture. New India Publishing Agency
41. Turner, Bruce. Evolutionary Genetics of Fishes (Monographs in Evolutionary Biology).Springer

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1		H		
CO 2	H			
CO 3			H	
CO 4				H

SPECIALIZATION IV: ANIMAL ECOLOGY AND WILDLIFE BIOLOGY

ZGEB0014: ANIMAL ECOLOGY AND BIOGEOGRAPHY (4 CREDITS: 60 HOURS, L-T-P: 4-0-0)

Course Outcomes (CO)

1. Define basic ecological concepts and have a deep understanding of the theories of ecology. (Remembering)
2. Explain the concepts of landscape ecology, its importance in designing protected areas, reasons of difference in species diversity across different habitats, role of humans in fragmented habitats of wildlife. (Understanding)
3. Examine the quality of Wildlife habitat, document and monitor different biodiversity around themselves and to Identify different types of animal signs through animal mark and sign analysis. (Applying, Analysing)
4. Outline the different theories and processes of Biogeography, dispersal of species and barriers to their dispersal and Case studies which would provide them a deep insight to Indian biogeography. (Understanding)

Module I: Basic Ecological concept (15 hours)

a) Habitat & Niche, Ecological Versatility & Niche dimension.
b) Competitive displacement: Gause's principle of Competitive Exclusion, Predator-Prey relation: Lotka Volterra Model ofInterspecific Competition, Ecological equivalents.
c) Species diversity, Species richness, Global patterns in species richness, Theories of species richness, Invasive species and itseffect on species richness.
d) Ecosystem model

Module II: Habitat and landscape ecology (25 hours)

a) Introduction to Habitat Ecology: Ecology of major habitats- Grasslands, Wetlands, Forests, Physical and anthropogenicfactors influencing habitats.
b) Introduction to Landscape Ecology: Edge, ecotones, Edge effect interspersion and juxtaposition. Habitat fragmentation andits effect on the resident community.
c) Metapopulation concept and its application in designing Nature reserve; Theory of Island Biogeography.
d) Measuring Wildlife habitat: Inventory, evaluation and monitoring of wildlife habitat - availability, quality, palatability of graze and browse. Inventory of unique habitats, their distribution and need for conservation, Animals signs as indicators of habitatuse.

Module III: Principles of Biogeography (10 hours)

History of biogeography. Ecology of dispersal and faunal exchange, barriers, mode of dispersal, origins and radiation; island biogeography: endemism, refugia. Continental drift; dispersal and vicariance biogeography; dispersal mechanisms and dispersal barriers.

Module IV: Indian biogeography (10 hours)

India's biogeographic classification. Case studies of Indian fauna explaining Biogeographic Theories. Biogeographic affinities of the fauna and flora of the Indian sub-continent.

Suggested Readings

1. Smith TM and Smith RL (2012). Element of Ecology (9th edition). Pearson Publication
2. Begon M, Townsend CR and Harper JL (2006). Ecology From individuals to Ecosystems (4th edition). Blackwell Publishing
3. Ricklefs RE and Miller GL (1999). Ecology (4th edition). WH Freeman Publication
4. Mani MS (1974). Ecology and Biogeography in India. Springer Netherlands
5. Cox CB, Moore PD and Ladle R (2010). Biogeography: An Ecological and Evolutionary Approach (9th Edition). Wiley-Blackwell.
6. Huggett RJ (2004). Fundamentals of Biogeography (2nd edition). Routledge London and New York
7. Ladle R and Whittaker RJ (2011). Conservation Biogeography. Wiley Blackwell
8. MacArthur RH (1984). Geographical Ecology: Patterns in the Distribution of Species. Princeton University Press.
9. MacArthur RH and Wilson EO (2001). The Theory of Island Biogeography. Princeton University Press.
10. Mayr E (1969). Principles of Systematic Zoology. Tata McGraw Hill Publ. Co.
11. Mayr E and Ashlock PD (1991). Principles of Systematic Zoology. McGraw Hill International Edition.
12. Simpson GG (1961). Principles of Animal Taxonomy. Columbia University Press.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H	M	M	M
CO2		H	L	
CO3		M	L	
CO4			H	H

ZGWM0015: WILDLIFE CONSERVATION AND MANAGEMENT (4 CREDITS: 60 HOURS, L-T-P: 4-0-0)

Course outcome (CO)

1. Relate different principles and practices of wildlife management and make use the concepts of conservation (Understanding, applying)
2. Explain the concepts of wildlife management and applying theories on habitat management (Understanding, Applying)
3. Explain about different plant diversity, phytoresource utilization and their importance, threatened plants of India with respect to Northeast India. (Understanding)

Module I: Conservation Biology (20 hours)

a) Introduction to conservation biology: Values of biodiversity and conservation ethics, Patterns and process of biodiversity, losses and threats to biodiversity. Geological and present extinctions, changes in species composition and problem of climate change.
b) Strategies for conservation –
   - In situ conservation: International efforts and Indian initiatives; protected areas in India – sanctuaries, national parks,biosphere reserves, sacred groove and Community Reserve. Ecological restoration and its significance
   - Ex situ conservation: Principles and practices; botanical gardens, fields gene banks, seed banks, cryobanks; non-formalconservation efforts.

Module II: Wildlife Management (25 hours)

a) Principles and practices of wildlife management; Management of special habitats: riparian zones, Grasslands, wetlands.
b) Species conservation projects: Tiger, Lion, Rhino, Crocodile, Turtle, Adjutant stork.
c) Management plan for Protected Areas: Principles of planning, objectives, resource surveys, analysis of surrounding region, management zones, theme plans, communications, staff and visitor amenities, monitoring. Financing protected areas; Needfor wildlife management planning

Module III: Plant diversity and Phytoresources (15 hours)

a) Plant Biodiversity: Concept, status in India, utilization and concerns.

b) Forest products: Important timber yielding planting. Timber types,
c) Non-Timber Forest products
d) Plants used as avenue trees for shade, pollution control and aesthetics. e) Threatened plants of India with special referenceto NE India

Suggested Readings

1. Hillis DM (1996) (ed). Molecular Systematics. Sinauer Publ Inc. Dash, M. Fundamentals of Ecology, Tata McGraw Hill
2. Gopal, R. Wildlife Management, Allied International
3. Saharia, V. Wildlife conservation
4. Primack- Essentials of Conservation Biology
5. Dyke- Conservation Biology- Foundation, Concepts, Applications
6. Primack- A primer of Conservation Biology
7. Singh- Textbook of Wildlife Management
8. Bailey- Principles of Wildlife Management
9. Krausman and Cain- Wildlife Management and Conservation
10. B.B. Dutta- A handbook of Plant Resource Utilization and Conservation
11. Kibue- Wildlife Conservation and Utilization
12. Trivedi and Sharma- Plant Resource Utilization and Conservation

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO1	H	M	L
CO2	M	H	
CO3			H

SPECIALISATION I: ENTOMOLOGY

ZGIG0017: INSECT ECOLOGY (4 CREDITS-60 HOURS, L-T-P: 4-0-0)

Course Outcomes

1. Apply the basics of insect ecology to the development of their research (Applying)
2. Acquire knowledge on behavioural ecology, insect association, interactions and population ecology (Applying)
3. Outline and interpret the concepts of ecology, basic principles of distribution and abundance of organisms and their causes and the impact of climate change on insect diversity (Understanding)
4. Explain the life history of some insects (Understanding)
5. Estimate the diversity of insects using different diversity indices (Creating)

Module I (15 hours)

a) Dynamics of insect life system-determinants of insect abundance, population change, birth rate, Death rate, movements; ; Law of minimum, law of tolerance
b) Population growth models, Exponential and logistic model, discrete and continuous growth model, concept of carrying capacity, life tables and their application to insect biology, survivorship curves, case study of insect life tables,

Module II (9 hours)

a) Regulation of insect populations, Population dynamics- Factors affecting abundance- Environmental factors,dispersal and migration, Seasonality in insects. Diapause (Quiescence) -aestivation, hibernation.
b) Dominance of insect-cause of success; Adaptation of insect- aquatic, terrestrial, soil, boring wood

Module III (18 hours)

c) Calculation of some diversity indices: Shannon, Simpson Problem solving in ecology
d) Insect biodiversity, threats to insect biodiversity, impact of climate change on insect communities;
e) Insect plant interaction Pollination Biology with special reference to Bees

Module IV (18 hours)

a) Insect behavior: chemotropism, thigmotropism, hydrotropism, rheotropism, anemotropism, phototropism, thermotropism, geotropism, instinct.Protective behavior: mimicry crypsis, warning coloration. Behavioral defense, chemical defense; Breeding behavior.

Suggested Readings

1. The Insect Structure and Functions, R.F. Chapman, Cambridge University Press
2. Modern Entomology, D.B. Tembhare Himalaya Publishing House

3. Text Book of Applied Entomology Vol- I &Vol- II, K.P. Srivastava, Kalyani Publishers
4. Introduction to General and Applied Entomology, Abhishek Shuklaand Sushilkumar Saxena, Astral International (P) Ltd.
5. Indian Insect Pests, H. Maxwel-Lefroy &F.M. Howlett, Astral International(P) Ltd.
6. A Handbook on Economic Entomology, Abhishek Shukla, Astral International(P) Ltd.
7. Insect Pest Management: EcologicalConcepts, T.V. Sathe & JyotiM.Oulkar, Astral International (P) Ltd.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H		L	L
CO 2	M		H	H
CO 3	H	M		
CO 4				M
CO5	H	H	H	

ZGPM0035: APPLIED ENTOMOLOGY AND PRINCIPLES OF PEST MANAGEMENT (4 CREDITS-60 HOURS, L-T-P: 4-0-0)

Course Outcomes

At the end of this course students will be able to:

1. Illustrate the classification and life histories of the important household and agricultural and forest pests. (Understanding)
2. Apply the latest knowledge of pesticides application equipment. (Applying)
3. Determine latest concepts of the principles of biological control, rearing, screening, and conservation of natural enemies and their problems in biological control. (Evaluating)

Module I (10 hours)

Definition of Insect Pest; Classification of Insect Pest; Major pest of rice, wheat, cotton, vegetables, tea, jute, pulses, stored grain pest- life history, nature of damage and control.

Module II Pest Control (24 hours)

a) Primary control measures: Physical, mechanical, traditional and legislative measure.
b) Chemical Control Measures: Nomenclature and Classification of Insecticides; Mode of action of Insecticides; Advantage and Hazards of Insecticides; LD_{50} and LC_{50}.
c) Biological control measures
d) Autocidal control measures
e) Integrated Pest Management (IPM)

Module III Industrial Entomology and Pest of Medical Importance (16 hours)

a) Apiculture, Sericulture (Muga, Eri, Mulberry and Tasar), Lac culture.
b) Insects of medical importance: Mode of Transmission; Common Vector Insects (Mosquitoes, House flies, Sand flies, Human louse and Tsetse flies)- Morphology with role in disease transmission and control

Module IV Forest Entomology and Forensic Entomology (10 hours)

a) Insect common to forest and their damage, defoliators, borers and sap suckers.
b) Insects of Forensic importance; Carcass condition and incidental attack by insects; Investigation methodology by forensic insects.

Suggested Readings

1. The Insect Structure and Functions, R.F. Chapman, Cambridge University Press
2. Modern Entomology, D.B. Tembhare Himalaya Publishing House
3. Text Book of Applied Entomology Vol- I & Vol- II, K.P. Srivastava, Kalyani Publishers
4. Introduction to General and Applied Entomology, Abhishek Shukla and Sushil Kumar Saxena, Astral International (P) Ltd.
5. Indian Insect Pests, H. Maxwel-Lefroy & F.M. Howlett, Astral International (P) Ltd.
6. A Handbook on Economic Entomology, Abhishek Shukla, Astral International (P) Ltd.
7. Insect Pest Management: Ecological Concepts, T.V. Sathe & Jyoti M. Oulkar, Astral International (P) Ltd.
8. Indian Pest Aphids, T.V. Sathe & B.V. Jadhav, Astral International (P) Ltd.
9. Insect Pest Predators, T.V. Sathe & Y.A. Bhosale, Astral International (P) Ltd.
10. Insect Predators and Pest Management, Vaishali J. Patil & T.V. Sathe, Astral International (P) Ltd.
11. Insect in Vegetables, Dhamo K. Butani & M.G. Jotwani, Astral International (P) Ltd.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III

CO 1	H	H	H
CO 2	H	H	L
CO 3	H	M	H

SPECIALIZATION II: CELL AND MOLECULAR BIOLOGY

ZGMB0019: CELL AND MOLECULAR BIOLOGY-II (4 CREDIT; 60 HRS; 4-0-0)

COURSE OUTCOMES

1. Define the cell adhesion molecules and their role in cell junctions. (Remembering)
2. Demonstrating the concept of protein targeting. (Understanding)
3. Make use of various theory of aging for understanding its process. (Applying)
4. Analyze the genetics and physical mapping of mutation. (Analyzing)
5. Estimate the effect of Cyclins and cyclin - dependent kinases in cell cycle regulation. (Evaluating)

Module I (15 hours)

Cell-Cell Signaling: Endocrine, paracrine and autocrine signaling; Receptor Proteins- Cell Surface receptors and intracellular receptors; Cell Surface receptors-G-protein coupled receptors, ion channel receptors, tyrosine kinase-linked receptors and receptors with intrinsic enzymatic Activity; Second messenger System - cAMP and IP3, DAG; MAP kinase cascade, JAK/STATand TGF –β / Smad signaling, NF-kB signaling; Signaling from plasma membrane to nucleus (a) CREB links cAMP signals to transcription (b) MAP kinase. Wnt pathway, Hedgehog pathway and Notch pathway

Module II (10 hours)

Protein sorting and targeting to organelles: Protein traffic through the endomembrane system; Targeting of proteins to the Rough Endoplasmic Reticulum and Golgi complex; Anterograde and retrograde transport; Signal-mediated protein transport to organelles (i) Nucleus (ii) Mitochondria (iii) Peroxisome

Module III (10 hours)

Genetic analysis in Cell Biology: Mutation: type and causes; Isolation and analysis of mutants; Physical and Genetic mapping of mutations; Molecular cloning of genes defined by mutations.

Module IV (15 hours)

a) Cell Cycle: Bacterial cell cycle (Helmstetier - Cooper or I+C+D model); Partition and cytokinesis; Eukaryotic cell cycle – G l, S, G 2 and M phases; Cell cycle checkpoints; Molecular basis of cell cycle regulation(a) Cyclins and cyclin - dependent kinases(b) Regulation of CDK cyclin activity.
b) Cell Death: Apoptosis and necrosis; Apoptosis-its characteristics; Genes involved in apoptosis.

Module V (10 hours)

a) Aging, the biology of senescence: Maximum life span and life expectancy; Causes of aging: (i) General wear and tear andgenetic instability (ii) Free radicals, oxidative damage and antioxidants (iii) Telomerases and aging.
b) Cancer: Tumor cells and onset of cancer; Proto-oncogenesis and tumor suppressor genes; Mutation causing loss of cell cycle;Mutations affecting genuine stability.

Suggested Readings

1. Cooper, G.M., Cell (A Molecular Approach)
2. Sadava, D.E., Cell Biology
3. Karp, G., Cell and Molecular Approach
4. Kish, V.M. and Kleinsmith L.J., Cell and Molecular Biology
5. Gardener, Principles of Genetics
6. Strickberger, Genetics
7. Ram mahabal, Fundamental of Cytogenetics and Genetics

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
1	L				
2		M			
3			H		
4				M	
5					H

ZGIM0020: IMMUNOLOGY II (4 CREDIT; 60HRS; 4-0-0)

Course Outcomes

1. Define the basic organization and expression of the immunoglobulin genes. (Remembering)
2. Understanding the role of various cytokines related to diseases. (Understanding)
3. Make use of avirrulent strain of microorganism for the development of vaccine and Analyzing the role of immune responses to various infectious diseases. (Analysing)
4. Recommend the use of various tumor suppressive drugs for preventing the graft rejection and also to develop various methods for immunization. (Creating)

Module I (20 hours)

Organization and expression of Ig genes: Multigene organization of lg genes; Light-chain multigene family; Heavy chain multigene family; Variable region gene rearrangement, V-J rearrangements in light chain DNA, V-D-J rearrangements in heavy chain DNA, Mechanism of gene rearrangement, Allelic exclusion; Generation of antibody diversity, Multiple germlineV, D and J gene segments; Combinatorial V-J and V-D-J joining; Junctional diversity; Association of heavy and light chain; Expression of Ig genes, Differential RNA processing of heavy chain primary transcripts, Expression of membrane secreted Ig, Simultaneous assembly and secretion of IgM and IgD, Synthesis, assembly and secretion of Ig; Class switching of constant regions

Module II (15 hours)

a) Cytokines: Properties of cytokines, General structure of cytokines, Function of cytokines, Cytokines related diseases, Bacterial septic shock, Bacterial toxic shock and similar diseases, Lymphoid and myeloid cancers, Chagas disease
b) Immune system in health and disease: Immune response to infectious disease; Viral infections (i) Viral neutralization by humoral antibody (ii) Cell - mediated antiviral mechanism (iii) Viral evasion of host defense mechanisms; Bacterial infections
(i) Immune responses to extracellular and intracellular bacteria (ii) Bacterial evasion of host defense mechanism; Protozoandiseases; Diseases caused by helminths.

Module III (15 hours)

a) Vaccines: Active and passive immunization; Designing vaccines for active immunization; Whole organism vaccine (i) Attenuated viral or bacterial vaccines (ii) Inactivated viral or bacterial vaccines; Polysaccharide vaccines; Recombinant vectorvaccines; DNA vaccines; Synthetic peptide vaccines; Multivalent peptide vaccines
b) Immunodeficiencies: Primary and Secondary Immunodeficiencies, lymphoid and myeloid lineage; AIDS: Structure and types,genome organization, replication, opportunistic agents and therapeutic agents

Module IV (10 hours)

a) Tumor immunology: Tumor antigen; Tumor evasion; Immune system against tumors; Therapies.
b) Transplantation immunology: Acute, hyperacute and chronic rejection; Tissue matching (HLA typing); Graft Vs host (GVH)reaction; Xenotransplantation; Immunosuppressive drugs; role of monoclonal antibodies in transplantation.

Suggested Readings

1. Kindt, T.J., Osborne, B.A., Kuby, J., Kuby Immunology
2. Kasper, D.l., Fauci, A.S., Harrison’s Infectious Diseases
3. Abbas, A.K., Lichtman, A.H.H., Pillai, S., Cellular and Molecular Immunology
4. Sell, S., Berkower, I., Immunology and Immunopathology and Immunity

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
1	L			
2		M		
3			H	
4				H

SPECIALIZATION III: FISHERY SCIENCE

ZGCP0021: CAPTURE FISHERY AND POST-HARVEST TECHNOLOGY (4 CREDITS-60 HOURS/ L-T-P: 4-0-0)

Course Outcomes

1. Explain about the capture fishery resources of the country and the managerial practices for sustainable utilization of these aquatic resources. (Understanding)
2. Develop the knowledge of cold water fishery resources of the country and their applicability in the development of future entrepreneurs in the fishery sector of the region. (Creating)

3. Explain about the various fishing gears and crafts used in various water bodies of the country. (Understanding)
4. Develop new ideas on the development of efficient fishing tools and the skill to predict the possible fish stock in the water bodies and management for sustainable utilization of the resources. (Creating)
5. Develop the skill of fish preservation and processing for long term utilization. (Creating)

Module I (20 hours)
Capture fishery: Fish catch statistics of the world with special reference to India; Riverine Fisheries River Systems in India, their ecology and fisheries (Ganga & Brahmaputra); Reservoir Fisheries: Development, Exploitation and management of Reservoirs with special reference to India–Dams and their effect On fish migration; Beel fisheries of Assam: Fish resources, problems and management;

Module II (10 hours)
Cold water fisheries: Hill stream fisheries of North East India; Mahseer fisheries: prospects and problems with special reference to NE India; Major Estuaries of India and their fisheries; Brackish water Fisheries: Chilka lake. Hilsa fishery–causes of decline and efforts for revival

Module III (10 hours)
a) Craft and Gear used in Fisheries: Traditional and mechanized boats and nets used in catching fish; Population Dynamics: Fishpopulations and factors affecting the population structures; Estimation of fish yield and control of overfishing, Yield and optimum catch; Fishing crafts and gears used in Inland capture fisheries; Destructive fishing– its impact on fish diversity.
b) Fish oils, Fish Proteins, Fish manure, Fish glue, Fish flour, Isinglass, Fishmeal, Fish Silage, Fish guano, Bone meal; Productionof fish sauce by lactic acid fermentation.

Module IV (20 hours)
Post-harvest technology and fish by-products: Preservation and processing: Methods of preservation Of both finfish and shellfish preservation(Refrigeration and freezing, Drying, Salting, Smoking, Canning, Pickling, pasting and spicing) and associated problems; Rigor mortis and post-mortem changes. Handling and packaging of fish for marketing; product stability and shelf-life. Fish by-products

Suggested Readings
1. Bal, D.V. and Veerabhadra Rao, K. Marine Fisheries. IBH Publications
2. Balakrishnan, N. N. and Thampy, D. M.A textbook of marine ecology.
3. Beaven C R Handbook of the freshwater fishes of India (Narendra Publishing House)
4. Biswas K P A Text Book of Fish, Fisheries and Technology, (Narendra Publishing House)
5. Brody , Fishery by-products technology., AVI, Westport
6. Chandy, M. Fishes, National Book Trust, India;
7. EIRI Board.Hand Book Of Fish Farming & Fishery Products
8. Gopakumar, K., Singh, B.N. and Chitranshi, V.R. Fifty Years of Fisheries Research in India, Fisheries Division Indian Council ofAgricultural Research, New Delhi.
9. Gupta S.K., Gupta P.C .General & Applied Ichthyology.S Chand & Company
10. Jayaram K. C. The fresh water fishes of India, Pakistan, Bangladesh, Burma and Sri Lanka.
11. Jhingran V. G. Fish and Fisheries of India.
12. Jobling M Environmental Biology of Fishes (Chapmen and Hall)
13. Khanna S. S. and H. R. Singh. A textbook of Fish Biology and Fisheries, Narendra Publishing House
14. Kreuzer, R., Fishery products., FAO, Fishing News Books Ltd., England
15. Krishnaveni, G., N.Veerabhadra Rao and K.Veeranjaneyulu Recent Technologies in Fish and Fisheries, Rigi Publication
16. Lagler, K.F. Ichthyology. John Wiley Publication.
17. Nikolsky, G.V. Ecology of fishes. Academic Press.
18. Pandey.Fish and Fisheries.Rastogi Publications
19. Rao, K. L. India's water wealth.
20. Ravishankar Piska. Fisheries and Aquaculture. Lahari Publications, Hyderabad.
21. Ricker, W.E. 1984.Methods for assessment of fish production in freshwaters.Blackwell Publications.
22. Rounsfell, G.A. and Everhart, W.H. Fishery Science: it 's Methods and Applications John Wiley & Sons,
23. Sachindra, N.M. & N.S. Mahendrakar. Fish Processing Byproducts: Quality Assessment And Application Studium press
24. Santhanam,R. Fisheries Science, Daya Publishing House, 1990.
25. Singh, B. A. Dey. Fish and Fisheries. Invincible Publishers
26. Srivastava, C.B.L. A Textbook of Fishery Science and Indian Fisheries, Kitab Mahal.
27. The Wealth of India, Raw Materials Vol. IV, Fish and Fisheries, CSIR, 1962

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M		
CO 2		H		
CO 3			H	
CO 4			M	
CO 5				H

ZGLF0022: LIMNOLOGY, FISHERY ECONOMICS, ORNAMENTAL FISHERY AND FISH PATHOLOGY (4 CREDITS-60 HOURS/ L-T-P: 4-0-0)

COURSE OUTCOMES (CO)

1: Explain the needs of physico-chemical factors in maintaining a proper productive aquatic ecosystem, an essentialelement in aquaculture and fishery management. (Understanding)
2: Utilize the understanding of fishery economics and laws of the country, various fishery training institutions and their roles and extension program in fishery development. (Applying)
3: Develop the skill on ornamental fish culture and aquarium preparation and maintenance. (Creating)
4: Apply the knowledge acquired on fish pathology and their prophylactic control measures. (Applying)

Module I (15 hours)
Limnology: Physico-chemical factors of fresh water habitat; Nutrients – Availability, Seasonal distribution and availability of phosphorus, Nitrogen and Silicon; Ecological classification of freshwater organisms; Plankton –Distribution, seasonal variation inspace and time, planktonic migration, cyclomorphosis

Module II (15 hours)
Fishery economics and law: Larvivorous fishes in relation to public health; Exclusive Economic Zone(EFZ) and its strategy; Fisheries co-operatives and their role in fish production and marketing; Aquaculture and rural development in India; Fishery education, training and extension; Fishery research Institutes in India; Fishery legislation and their role in fishery development.

Module III (15 hours)
Ornamental fishery: Ornamental fish culture: Ornamental aquarium fishes, Breeding and care of Freshwater aquarium fishes; Aquarium keeping—Design and construction of tanks; species-wise tank size requirement; heating, lighting, aeration and filtration arrangements; decorations; common aquarium plants and their propagation; Maintenance of Natural Colour of fishes in Aquarium.

Module IV (15 hours)
Fish pathology: Fish and Prawn/Shrimp Diseases: Types of Diseases-viral, bacterial, fungal, protozoan and other parasitic diseases; symptoms & control measures; Diagnosis-Histopathological methods; Immunoassay; Biochemical assay; Serological techniques; Role of biopesticides; Application of Monoclonal antibodies; Vaccines and immune stimulants; Drug resistance.

Suggested Readings

1. Agarwal, S.C. Limnology
2. Bond, E. Carl. Biology of fishes.
3. Datta, J. J. Datta Munshi. Fundamentals of Limnology
4. Dholakia, A.D. Ornamental Fish Culture and Aquarium Management. Daya Publishing House
5. Edward,J. Noga. Fish Disease: Diagnosis & Treatment
6. Gerald, A. Textbook of Limnology. The C.V. Morby Co.
7. Hutchinson, G.E.A. Treatise on Limnology. Vol.1. John Wiley & Sons.
8. Kumar, Arvind. Fundamentals of Limnology. APH Publishing Corporation
9. Nikolsky, G.V. Ecology of fishes. Academic Press.
10. Ricker, W.E. Methods for assessment of fish production in freshwaters. Blackwell Publications.
11. Ruttner, F. Fundamentals of Limnology. University of Toronto Press, 1968.
12. Sharma Shailendra &Pawan Kumar Bharti. Limnology and Aquatic Science. Discovery publishing house
13. Smith David J. Aquarium Keeping: Aquarium Keeping Essentials
14. Thornton Kent W., Bruce L. Kimmel, Forrest E. Payne. Reservoir Limnology: Ecological Perspectives
15. Untergasser, D. Handbook of Fish Diseases. TFH Publications
16. Welch, P.S. Limnological Methods. McGraw Hill Book Company, New York.
17. Wetzel, Robert G. Limnology: Lake and River Ecosystems. Elsevier Academic Press

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV

CO 1	H			
CO 2		H		
CO 3			H	
CO 4				H

SPECIALIZATION IV: ANIMAL ECOLOGY AND WILDLIFE BIOLOGY

ZGRE0025: WILDLIFE RESOURCE MANAGEMENT, LAWS AND TECHNIQUES IN POPULATION STUDY (4 CREDITS: 60 HOURS, L-T-P: 4-0-0)

Course Outcome

1. Explain different threatened categories and conservation history in India. (Understanding)
2. Define forestry and explain different conservation movements (Remembering)
3. Analyse the threats on different species and identify different laws for their protection (Analyzing)
4. Identify the structure and demography of wildlife population and apply different sampling techniques. (Applying)

Module I Species conservation (20 hours)

IUCN categories, criteria for allocation into different categories. Threatened animal species of India with special reference to NE India. Role of Iconic species designation in conservation. Concept and significance of conservation of Flagship (Target) species; overview of conservation problems and issues of fauna of Indian sub-continent.

Module II Natural resource management and conservation (15 hours)

a) Introduction to forestry, principles of forest management, Importance and performance of joint forest management (JFM) Role of Non-Government Organizations (NGO).

b) Conservation movement in India. Concept of stakeholders. International conservation bodies; IUCN, UNDP, Durrell WildlifeConservation trust.

c) Project Grants for Wildlife Conservation

Module III Forest and Wildlife laws of India (5 hours)

Wildlife Protection Act, 1972;The Biological Diversity Act, 2002; The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of forest Rights) Act, 2006.

Module IV Population ecology and Sampling Techniques (20 hours)

a) Demographic and life history parameters, evolution of life history parameters: r & K selection, allometry, aging and sexing,life tables, age and stage structures models, methods of estimation of life history and demographic parameters

b) Sampling designs for population estimation, population estimation methods: Mark-Recapture for Closed Population, Collection Techniques used in wildlife study.

Suggested Readings

1. Caughley G (1978). Analysis Of Vertebrate Populations. John Wiley, Chichester.
2. Hastings A (1997). Population Biology: Concepts And Models. Springer Verlag, New York.
3. Neal D (2004). Introduction to population biology. Cambridge University Press. UK
4. Ricklefs R (2010). The Economy of Nature (6 edition). W. H. Freeman
5. Tokeshi M (1998). Species Coexistence: Ecological and Evolutionary Perspectives.
6. W. J. Ecological Census Techniques Cambridge University Press
7. Patro, L. Biodiversity Conservation and Management
8. Misra, H.N. – Managing Natural Resources- Focus on Land and Water
9. Anderson, Sweeney and Williams- Wildlife and Natural Resource Management
10. Deal, K.H. Environmental Economics and Natural Resource Management
11. Kumar, R. Environmental Laws
12. Muthukrishna- Natural Resource Economics
13. Field, B.C. Economics of Environment
14. Began, M. & Mortimer, M.- Population Ecology
15. Rockwood- Introduction to population Ecology

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H	M	H	
CO2		H	M	
CO3				L
CO4				H

ZGWC0026: TECHNIQUES IN WILDLIFE STUDY WILDLIFE HEALTH, FORENSICS AND CONFLICT (4 CREDITS: 60 HOURS, L-T-P: 4-0-0)

Course Outcome

1. Define wildlife disease, identify major parasitic diseases in wild animals and assess animal health condition. (Remembering, Applying).
2. Apply different techniques of wildlife study. (Applying)
3. Discuss about wildlife forensic, various protocols for species identification and trade of wildlife products. (Creating)
4. Develop the prospects of ecotourism in Northeast India, its importance and consequences and recommend mitigation plans to reduce human animal conflict. (Evaluating, Creating)

Module I: Wildlife Health (20 hours)

a) Introduction to disease and epizootiology, Determinants of disease and disease transmission, Disease and populationdynamics.
b) Assessment of condition, health and nutritional status in free-ranging populations. Disease control operations, Planning andmanagement of wildlife health programmes.

Module II: Techniques for wildlife study, Capture and handling of wild animals (15 hours)

a) Techniques for wildlife study: Radio telemetry and acoustic analysis.
b) Capture and handling of animals - purpose, restraint techniques, different capture methods and animal barriers. Drug immobilization - drug delivery equipment and accessories.Handling and transport of wild animals, designing sledge, crate and holding enclosures.

Module III: Conservation Genetics, Wildlife Forensics and Trade (15 hours)

a) Application of genetics for wildlife conservation; Application of Molecular markers, PCR, DNA Sequencing in wildlife forensics and conservation. Loss of genetic diversity
b) Wildlife Forensics- Overview, various forensic protocols for species identification.
c) Wildlife trade: The Convention on International trade in Endangered Species of Wild Fauna and Flora (CITES)

Module IV: Human-wildlife conflict (10 hours)

a) Causes and management; Impact on ecosystem, lives and livelihood of human
b) Ecotourism: problems and prospects with special reference to northeast India.

Suggested Readings

1. Fowler- Restraint and Handling of wild and Domestic Animals
2. Briscoe, Ballou and Frankhan- Introduction to Conservation Genetics
3. Leeschcke, Temivk and Jain – Conservation Genetics
4. Frankhan, Ballou and Briscoe- Primer of Conservation Genetics
5. Cooper and Cooper- Wildlife Foresnsic Investigations
6. Huffman and Wallacw- Wildlife Forensics – Methods & Applications
7. Sahaipal, Thakar & Goyal – Forensic Examination of Hair of Protected Indian Wildlife Species
8. Linacre and Tobe- Wildlife DNA analysis
9. Rao, G. Textbook on pathology of Wildlife Diseases
10. Jani, R. Basic of Wildlife Health Care Management
11. Ayadi, D.P. Human Wildlife Conflict
12. Wang, J. Human Wildlife Conflict management: Understanding the Fundamentals of Human Wildlife Conflicts in HumanDominated Landscape

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H			
CO2	M	H		
CO3		L	H	L
CO4				H

ZGBE0027: BIOSYSTEMATICS AND EVOLUTION (4 CREDITS -60 HOURS) (L-T-P:4-0-0)

Course Outcomes

1. Explain the concept of Biosystematics and Taxonomy. (Understanding)
2. Explain the causes of evolution and natural selection. (Understanding)
3. Apply Taxonomy to solve the species problem and Identify species on the basis of taxonomic keys. (Applying)

4. Apply bioinformatics tools used for evolutionary studies. (Applying)
5. Justify the role of isolating mechanisms in speciation, estimate, construction of evolutionary trees, and measurement of genetic relationship among organisms. (Evaluating)
6. Create evolutionary trees to understand the evolution of primates. (Creating)

Module I: Biosystematics (10 hours)
Trends in Biosystematics: Chemotaxonomy, Cytotaxonomy, Numerical and Molecular Taxonomy; Dimensions of Speciation; Species Concepts: Subspecies and other intraspecific Categories; Cladistics

Module II: Taxonomy and Nomenclature (10 hours)
Taxonomic Categories. Different Kinds, Hierarchy of Categories; Taxonomic Procedures: Taxonomic collections, Preservations, Process of identification(General Idea); Taxonomic Keys: types, merits and demerits; International Code of Zoological Nomenclature (ICZN):Operative principles, interpretation and application of important rules; Formation of names of various Taxa.

Module III: Evolution (15 hours)
Micro and Macro evolution; Natural Selection-Concept of stabilizing selection, Frequency dependent selection, Balancing selection, Disruption selection; Destabilizing factors-Mutation, Genetic drift, Migration, Meiotic drive; Emergence of Non Darwinian theory of evolution, Neutral theory of evolution (Kimura).

Module IV: Speciation and Molecular basis of evolution (15 hours)
a) Isolation Mechanisms-Isolation Mechanisms and their role in speciation, Models of speciation (Allopatric, sympatric, parapatric)
b) Molecular basis of evolution-Constructing evolutionary trees, measures of genetic relationship among organisms, Molecularclock of evolution, Molecular phylogeny; Origin and
c) Evolution of Primates.

Module V: Evolutionary Bioinformatics (10 hours)
a) Concept of databases: Biological databases - Primary, secondary, composite databases; Databases for Literature, Sequenceand structure; Searching and their retrieval.
b) Bioinformatics for phylogenetic analysis. DNA and Protein sequence alignments- pairwise alignment, dot plot, global and local alignment algorithms; Multiple sequence alignment;Multiple sequence alignment based database searching–PSI-Blast
c) Homology modeling.

Suggested Readings
1. G. G. Simpson. Principle of animal taxonomy; Oxford IBH Publishing Company.
2. V.C Kapoor-Theory and practice of animal taxonomy
3. J.C. Avise. Molecular Markers, Natural History and Evolution, Chapma & Hall, New York.
4. E.O. Wilson, Biodiversity, Academic Press, Washington.
5. E. Mayer & P. Ashlock. Principles of systematic Taxonomy
6. E.O. Wilson. The Diversity of Life (The College Edition),W.W. Northem & Co.
7. Dalela and Sharma. Animal taxonomy and Museology, Jai Prashnath & company.
8. Bugs, Butterflies, Spider, snakes (1998).Kern Preston-Mafham, Nigel Marven & Roblturvey.
9. Dobzhansky,Th.,F.J.Ayala,G.L.StebbinesandJ.M.Valentine.Evolution.SurjectPublication,Delhi.
10. Futuyma,D.J.EvolutionaryBiology,Suinuae Associates,INCPublishers,Dunderland.11.Jha,
11. A.P- Genes and Evolution. John Publication, New Delhi.
12. Ashok Verma, Principles of Animal Taxonomy, Alpha Science International Ltd, Delhi.
13. Ramesh Chandra Tripathi, Biosystematics and Taxonomy, University Book House, Jaipur.
14. Avers, C.J. Evolution Process and Pattern in Evolution Oxford University, Press, New York, Oxford.
15. Ayala, F. J. and Valentine J. W. Evolving the theory and Process of Organic Evolution,
16. Brookfield,A. P. Modern aspects of Evolution. Hutchinson London, Melbourne.
17. Gallow, P. Evolutionary principles.
18. Chapman and Hall. Freeman, S. and Herron, Jon C. Evolutionary analysis Pearson Prentice Hall, New Jersey.
19. Futuyma, D. J. Evolutionary Biology, Sinauer Assoc. Inc. Pub. USA.
20. Meglitsch, P. A. Invertebrate Zoology (3rd edition),Oxford University Press.
21. Minkoff,E. C. Evolutionary Biology, Addison Wesley Pub. Co., London.
22. Wen-Hsiung Li, Molecular Evolution, Sinauer associates Inc.Pub. USA.
23. Burton S. Guttman: Evolutiona beginner 's guide, One world Publications.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	H			

CO 2		M	H		
CO 3		H			
CO 4				L	H
CO 5			L	H	H
CO 6			L	L	H

ZGCI0028: CELL BIOLOGY AND IMMUNOLOGY- THEORY AND APPLICATIONS (4 CREDITS-60 HOURS) (L-T-P:4-0-0)

COURSE OUTCOMES (CO)

1. Illustrate and summarize the organization of the cell. (Understanding)
2. Define cell division and signaling pathways. (Remembering)
3. Explain the different cellular biology with complicated biochemical and physiological processes. (Understanding)
4. Apply immunological techniques. (Applying)
5. Demonstrate molecular techniques to understand underlying cellular composition. (Analyzing)
6. Evaluate the regulation of cell cycle and its control. (Evaluating)

Module I: Cell Organisation (10 hours)

a) Biomembranes-Molecular composition and functional feature of membrane lipid, protein and carbohydrate.
b) Cytoskeletons -Structure and Organisation of Microfilament, Microtubule and Intermediate filament.
c) Cell Motility- Intercellular transport, kinesin-dynein, cilia and flagella.

Module II: Cell adhesion molecule, Cell signaling, Cell cycle (15 hours)

a) Extracellular Matrix and Cell Interaction-Cell walls, Adhesion junctions, Tight junctions, Gap junctions, Plasmodesmata; Cell- Cell Adhesion - Ca++dependent and Ca++ independent Homophilic Cell-Cell Adhesion.
b) Cell division and cell cycle regulation and control of cell cycle; Cyclins and Cyclin Dependent Kinases(CDK), Regulation of CDK-
Cyclin activity, Molecular basis of Cellular Checkpoints
c) Cell-Cell Signalling-Cell Signalling, Cell surface receptors, G-Protein coupled receptors and Second messenger

Module III: Immunology (15 hours)

a) Immune system-innate and adaptive immunity; components and characteristic features, humoral and cell-mediated immunity;
b) Cells and organs of immune system; T cells and B cells-maturation, activation and differentiation;
c) Antigens-immunological properties of antigens, factors influencing antigenicity; Immunoglobulin-structure and function, classes of Ig molecules, Antigen-antibody interactions.

Module IV: Analytical techniques (20 hours)

a) Review of principles of light microscopy; principles and applications of phase contrast and fluorescence microscopy
b) Principles and applications of Transmission and Scanning Electron microscopy
c) Spectroscopy: basic principles and types
d) Theories of Tissue fixation and staining techniques
e) Basic principles of colorimetry
f) Principles and applications of centrifugation techniques: types of centrifugation; Introduction to hydrodynamics
g) Molecular modeling
h) ELISA, RIA, Immunodiffusion

Suggested Readings

1. Cooper, G. M., Cell (A Molecular Approach)
2. Sadava D. E., Cell Biology
3. Kish V. M. and Kleinsmith L. J., Cell and Molecular Biology
4. DeRobertis & DeRobertis: Cell and Molecular Biology (Lee & Febiger, 1987)
5. Karp: Cell and Molecular Biology
6. Lodishet al: Molecular Cell Biology
7. Pollard & Earnshaw: Cell Biology
8. Verma P. S. and Agarwal V.K, Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Ltd.
9. Verma P.S. and Agarwal V.K, Cell Biology (Cytology, biomolecules and Molecular Biology),S. Chand & Company Ltd.
10. Kuby et al. : Kuby Immunology
11. H.H. Willard, L.L. Merritt Jr. and others, Instrumental Methods of Analysis.6th Edition,1986, CBS Publishers and Distributors.
12. Chatwal G and Anand, S., Instrumental Methods of Chemical Analysis,1989 , Himalaya Publishing House, Mumbai.

13. Williams, B.L. and Wilson, K. ,A Biologist ’s Guide to Principles and Techniques of Practical Biochemistry , 1975
14. B.B. Straughan and S. Walker Eds., Spectroscopy, Volume 1, Chapman and Hall Ltd.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		
CO 3	M	H	M	
CO 4			H	L
CO 5	L	L	L	H
CO 6		H		

ZGBG0029: MOLECULAR BIOLOGY AND GENETICS (4 Credits-60 hours) (L-T-P:4-0-0)

Course Outcomes

1. Define the structure of nucleic acids. (Remembering)
2. Explain gene expression. (Understanding)
3. Construct and analyze pedigree. (Analyzing)
4. Analyze the various patterns of genetic inheritance. (Analyzing)
5. Apply bioinformatics tools to archive, retrieve, and analyze biological data. (Analyzing)
6. Analyze macromolecules using electrophoretic techniques. (Analyzing)

Module I: Nucleic Acids (16 hours)

a) Nucleic acids - Molecular Structures of DNA and RNA.
b) DNAReplication-Replication in Prokaryotes and Eukaryotes, Semi conservative nature of DNA replication, Messelsons-Stahl experiment, Enzymes and proteins associated with replication, DNA polymerases, Regulation of eukaryotic genome replication.
c) DNA Damage and Repair Mechanism-Different types of DNA Damage, Direct repair system, Excision repair system, Mismatch repair system, DNA break repair.

Module II: Transcription and Translation (12 hours)

a) Transcription-Basic concept of Prokaryotic and Eukaryotic transcription, Promoters (Pribnow Box, TATAbox, CpGisland), Transcription factors, Initiation, elongation and termination of transcription in Eukaryotes.
b) Post Transcriptional Modification
c) Translation- Genetic Code, Mechanism of Initiation, Elongation and Termination.

Module III: (10 hours)

a) Organisation of genetic material-Nucleosome, Molecular anatomy of eukaryotic chromosome; Genome size and Complexity-
C value paradox, Unique and repetitive DNA, Euchromatin and Heterochromatin
b) Sex Chromosomes - Sex determination, Role of Y chromosome, Dosage Compensation in Drosophila and Human Being, X-
Chromosome inactivation, Sex chromosome anomalies
c) Human Genetics-Normal Human Karyotyping, Autosomal chromosome abnormalities, Principle and Methods of Pedigree Analysis
d) Genomic Imprinting-Imprinting of genes, Epigenetic, Epigenetic regulation by DNA methylation; Somatic Cell Genetics-Cellfusion technology, Chromosome mapping, Application of Somatic Cell Genetics.

Module IV: Genetic Inheritance (10 hours)

a) Concept of gene: Allele, multiplealleles, pseudoallele, complementation tests; Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters
b) Extra Chromosomal Inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

Module V: Bioinformatics (5 hours)

a) Gene Prediction-Finding genes in prokaryotic and eukaryotic genomes, Regulatory sequence analysis; Genome maps andmarkers, Genome variation.
b) Human genome project; Concept and Software used in Gene expression analysis and Microarray.
c) Structural biology-Protein structure prediction and classification.

Module VI: Electrophoretic Techniques (7 hours)

a) Basic principles of Electrophoresis, Agarose gel, native and SDS-PAGE

b) Isoelectric focusing, 2D-PAGE and their uses in protein research
c) Blotting Techniques

Suggested Readings

1. Gardner, Principles of Genetics
2. Strickberger, Genetics
3. Ram Mahabal, Fundamentals of Cytogenetics and Genetics
4. Brooker: Genetics: Analysis and Principles
5. Griffith et al: Modern Genetic Analysis
6. 6.Hartl & Jones: Essential Genetics: A Genomic Perspective
7. Boyer: Modern Experimental Biochemistry and Molecular biology
8. DeRobertis & DeRobertis: Cell and Molecular Biology
9. Hanes, Gel Electrophoresis of Proteins - A Practical Approach
10. Sedgewick R and WayneK.Introduction Computer Science, Princeton University [available online].
11. Blum R and LeBlanc Dee-Ann. Linux for Dummies, WILEY [available online].
12. Kanetkar YP. Let Us C [available online].

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H					
CO 2		H				
CO 3			H			
CO 4				H		
CO 5					H	
CO 6						H

ZGAP0030: ANIMAL PHYSIOLOGY (4 CREDITS-60 HOURS) (L-T-P:4-0-0)

Course Outcomes

1. Recall the physiology of digestion, different glands involved in the process, their secretions. (Remember)
2. Explain about the physiology of Respiration, interpret the Oxygen dissociation curve and to understand the regulation of respiration. (Understanding)
3. Develop a clear concept of mammalian blood chemistry, the blood clotting mechanism, musculature in vertebrates, molecular mechanism and regulation of muscle contraction, nerve physiology, and physiology of excretion. (Applying)
4. Analyze the mechanism of digestion, absorption of various biomolecules and the role of gastrointestinal hormones in digestion. (Analyzing)
5. Analyze the integration of the systems. (Analyzing)

Module I Physiology of digestion (10 hours)

a) Glands and secretion of digestives enzymes,
b) Mechanism of digestion, Gastrointestinal hormones
c) Absorption of Carbohydrates, lipids and proteins.

Module II Physiology of Respiration (10 hours)

a) Alveolar ventilation, alveolar-capillary gas exchange, Transport of O2and CO2
b) Oxygen dissociation curve and the factors influencing it,
c) Regulation of respiration.

Module III Mammalian blood chemistry (10 hours)

a) Mammalian blood chemistry and blood groups.
b) Blood clotting mechanism
c) Cardiac cycle and its regulation in mammals.

Module IV Musculature in vertebrates (10 hours)

a) Musculature in vertebrates: Types of muscles, Ultrastructure and chemical composition of skeletal muscles,
b) Molecular mechanism and regulation of muscle contraction, muscle fatigue and rigor mortis.

Module V Physiology of Excretion (10 hours)

a) Ultrastructure of nephron, mechanism of urine formation, excretion of dilute solutes and mechanism of excretion of excesssolutes, counter current mechanism
b) Osmoregulation in different animal groups (aquatic and terrestrial)

Module VI Nerve physiology (10 hours)

a) Neuron: Ultrastructure, types and function,
b) Membrane potential: Resting membrane, membrane potential, action potential, Nernst Equation, Chronaxie, Rheobase,utilization time.
c) Neural impulse induction through an axon, neurotransmitters and synaptic transmission-mode of information transferacross electrical and chemical synapses

Suggested Readings

1. Brooks and Marshall: Essentials of Endocrinology, Blackwell Science.
2. Ganong: Review of Medical Physiology, Lang Medical Publications
3. Guyton and Hall: TextBook of Medical Physiology ,W.B. Saunders
4. Hadley: Endocrinology, Prentice hall. International Edition.
5. Keel et al: Samson Wright 's Applied Physiology, Oxford Press,
6. Larson:WilliamsTextBookofEndocrinology,10thedition.W.B.SaundersCompany,Philadelphia.
7. Murray et al: Harper 's Illustrated Biochemistry, Appleton & Lange
8. Norris: Vertebrate Endocrinology. Lea & Febiger.
9. Turner and Bagnara: General Endocrinology, W. B. Saunders Company Philadelphia.
10. West: Best and Taylor 's Physiological Basis of Medical Practice, Williams and Wilkins,
11. N Arumugam and A Mariakuttikan, Animal Physiology, Saras Publication.
12. N Arumugam, Animal Physiology & Biochemistry, Saras Publication.
13. Dharmalingam, Textbook Of Endocrinology, Jaypee Brothers Medical Publisher
14. VermaP.S, Agarwal V.K and Tyagi B. S, Animal Physiology, S. Chand Publishing.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO 1	H					
CO 2		H				
CO 3			H	H	H	
CO 4	H					
CO 5	M	M	M	M	M	M

ZGEE0031: ECOLOGY AND ENVIRONMENTAL BIOLOGY (4 CREDITS - 60 HOURS) (L-T-P:4-0-0)

Course Outcomes

1. Outline the foundations of Ecology. (Understanding)
2. Explain the effects of abiotic environment on plants and animals to understand the distribution and abundance of life on earth (Understanding)
3. Develop solutions to pressing environmental problems that threaten ecological systems at every level (Creating)
4. Analyze the importance of biodiversity and threats to biodiversity. (Analyzing)
5. Design steps to protect and conserve biodiversity. (Creating)

Module I (12 hours)

a) Types of ecosystems–Salient features of aquatic and terrestrial ecosystems and their biotic communities.
b) Ecological energetic and energy flow; Measuring ecosystem productivity
c) Population Ecology-Population density, Growth rate, Natality, mortality, survivorship curves and life tables, Biotic potential

Module II (12 hours)

a) Community Ecology-Types of biotic communities, organization, carrying capacity, r and k-selection.
b) Community Development–Types of community changes, ecological succession-its causes and examples, climax community.
c) Species interactions, Competition theory, Niche, Habitat,
d) Ecological Equivalents, Character displacement; Liebig law of minimum, Shelford's law of tolerance, Significance of limiting
factors, Ecotone and Edge effect.
e) Thermoregulation: Heat balance in animals, Adaptations to temperature extremes, Aestivation, hibernation and Diapause,acclimatization, avoidance and tolerance

Module III (12 hours)

a) Eutrophication in the aquatic ecosystem, Remediation of eutrophication.
b) Acidification in aquatic and terrestrial environment, Consequences and control strategies.

c) Environmental monitoring, Environmental impact assessment and environmental management plan.
d) Biogeochemical cycles–carbon, nitrogen, sulphur cycles, impact of human activity on nutrient cycles.

Module IV (12 hours)

a) Biodegradation and Bioremediation: concept, environmental limitation for bioremediation, bioremediation of ecosystem (Air/water/soil)
b) Wastes in Ecosystem and management: Agricultural wastes and Management, Biomedical wastes and Management,Domestic waste, effects and management for purification and recirculation.
c) Environmental toxicology: Diversity and classification of environmental toxins, Air, Water and soil pollutants, Food additives and contaminants, Pesticides, Metals and Solvents, Radioactive pollution.

Module V Biodiversity (12 hours)

a) Components of Biodiversity (Genetic, Organismal and Ecological), Value of Biodiversity, threats to biodiversity, biodiversityconservation, Mega biodiversity countries, hotspots and heritage sites,
b) IUCN Red list categories. Habitat diversity of Indian wildlife, endemic and Threatened species of northeast India
c) Ethnozoology with special reference to Northeast India

Suggested Readings

1. Asthana, D.K. and Asthana, M. Environmental Problems and Solutions S. Chand and Co., New Delhi.
2. Odum : Basic Ecology (Saunders)
3. Odum : Fundamentals of Ecology (Saunders)
4. Odum. E.P. Fundamentals of Ecology. Nataraj Publishers, DehraDun.
5. Raven, Berg, Johnson : Environment (Saunders College Publishing)
6. Sharma :Ecology and Environment (Rastogi Publication)
7. Smith, R.L. Elements of Ecology. Harper and Row Publishers, New York.
8. Trivedi, P.R. and Gurdeepraj, K. Environmental Biology. Akashdeep Publishing House New Delhi
9. Turk and Turk : Environmental Science
10. VermaP.S. and Agarwal V.K, Environmental Biology(Principles of Ecology)by.,S.Chand Publishing.
11. GuptaS.R.andSinghS.P.,EcologyEnvironmentalScienceandConservation,S.ChandPublishing
12. Manju Yadav, Ecology, Discovery Publishing House
13. Rana S.V.S. ,Essentials of Ecology and Environmental Science, S.V.S. Rana. Publisher, Prentice-Hall of India
14. Anderwartha, H.G.and Birch,L.C.,The distribution and abundance of animals, University of Chicago Press, Chicago London.
15. Beeby, A., Applying Ecology Chapman and Hall Madras.
16. Begon, M.,HarperJ.L.andTownsend,C.R,Ecology–Individuals,populations and communities, Blackwell Science, Cambridge UK.
17. Brewer, R., The science of Ecology, Saunders College of Publishing, New York.
18. Chapman,J.L.andResis,M.J.,Ecology-Principles And Applications,CambridgeUniversityPress, Cambridge UK.
19. Kaeighs, S. C., Ecology with special references to animals and Man, PrenticeHall Inc.
20. Putmann, R. J. and Wratten, S. D., Principles of Ecology,
21. Crown Helm, London. Salanki,J.,Jeffery E. and Hughes G.M., Biological Monitoring of the Environment (A manual of Methods) CAB International, Wallingford UK. Singh M C: Environment Protection and the Law (Ashish Publishing House)

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	H			
CO 2			H	H	
CO 3			M	H	H
CO 4					H
CO 5			L	L	H

ZGEB0032: ENDOCRINOLOGY AND BIOCHEMISTRY (4 CREDITS-60 HOURS) (L-T-P: 4-0-0)

Course Outcomes

1. Define the various metabolic pathways and the role of hormone. (Remembering)
2. Explain the basic principles of modern analytical techniques. (Understanding)
3. Analyze the energy production and utilization. (Analyzing)
4. Explain the enzyme kinetics. (Evaluating)

Module I: Basic concepts: Hormone, action and Feedback Mechanism (5 hours)

Hormone: Classification and Chemical nature of hormones Homeostasis: Concept and Feedback system Hormone receptor and target organ concept, Mechanism of hormone action. Hypothalamo- hypophyseal axis

Module II: Endocrine glands-Structure, Hormones, Functions, Axis, Abnormalities (15 hours)

a) Structure of the pituitary gland; pituitary hormones and their functions
b) Structure of thyroid glands, thyroid hormones–biosynthesis and metabolic functions. Role of thyroid hormone in amphibianmetamorphosis
c) Structure of adrenal gland; Synthesis of adreno-cortical and medullary hormones and their functions.
d) Structure of endocrine pancreas and Hormones of Islets of Langerhans.

Module III: Reproductive Endocrinology (10 hours)

a) Testis and ovary –endocrine structure and their functions
b) Reproductive cycle- Oestrous cycle and Menstrual cycle, Role of Hormones in Implantation, Parturition and Lactation
c) Neuroendocrine regulators in insects and mammals

Module IV: Metabolism (13 hours)

a) Carbohydrate metabolism-Glycolysis, Glycogenolysis, Gluconeogenesis, TCA cycle, Cori cycle, Phosphogluconate pathway.
b) Lipid Metabolism-Oxidation of fatty acid, Cholesterol biosynthesis and metabolism, Prostaglandins.
c) Protein metabolism- Amino acid Classification, Amino acid degradation, Decarboxylation, Deamination, Ornithine Cycle.

Module V: Bioenergetics And Enzymes (10 hours)

a) Bioenergetics-Energy producing and utilizing system, Electron transfer system and Oxidative Phosphorylation.
b) Enzymes-Classification of enzymes, General properties of enzymes, Mechanism of enzyme action, Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk Equations; Enzyme inhibition.

Module VI: Basic concepts of biochemistry (10 Hours)

a) Review of concepts of acids and bases, Principle and working of pH meter, Buffer preparation
b) Principle of Laminar-air flow chamber.
c) Principles, types and applications of Chromatography
d) Gas Chromatography, GC-MS, LC – MS / MS, MALDI TOF mass spectrometer
e) Ion Exchange Chromatography, gel permeation, Affinity and reverse phase chromatography
f) HPLC and FPLC

Suggested Readings

1. Brooks and Marshall: Essentials of Endocrinology, Blackwell Science.
2. Ganong: Review of Medical Physiology, Lang Medical Publications
3. Guyton and Hall: Text Book of Medical Physiology ,W.B. Saunders
4. Hadley: Endocrinology, Prentice hall. International Edition.
5. Keel et al: Samson Wright ’s Applied Physiology, Oxford Press,
6. Williams TextBook of Endocrinology,10thedition.W.B.SaundersCompany,Philadelphia.
7. Murray et al: Harper ’s Illustrated Biochemistry, Appleton & Lange
8. Norris: Vertebrate Endocrinology. Lea & Febriger.
9. Turner and Bagnara: General Endocrinology, W. B. Saunders Company Philadelphia.
10. Berg et al.: Biochemistry, Freeman
11. Boyer: Modern Experimental Biochemistry and Molecular biology
12. DeRobertis & DeRobertis:Cell and Molecular Biology
13. Freifelder: Physical Biochemistry
14. Holme and Peck: Analytical Biochemistry, Tata McGraw Hill
15. Switzer and Garrity: Experimental Biochemistry
16. Biochemistry, Tata-McGraw Hill

Mapping COs to syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO1	L	L	L			
CO2						L
CO3			M	H	H	
CO4						H

ZGAZ0033: APPLIED ZOOLOGY (4 CREDITS-60 HOURS) (L-T-P: 4-0-0)

Course Outcomes

1: Identify methods of silkworm cultivation, maintenance of the farm, seed technology, silkworm rearing and silk reeling. (Applying)

2: Assess the basic life cycle of the honeybee and about beekeeping tools and equipment for honey production and pollination. (Evaluating)
3: Apply the latest knowledge in poultry management. (Applying)
4: Develop an overall idea of fish farming, the scientific management of different species in aquaculture, aquarium keeping and fish diseases. (Applying)
5: Identify the different types of parasites, their life cycles and the diseases caused by them. (Applying)
6: Associate the concepts in Zoology with the core principles of Sustainable Development. (Understanding)

Module I (15 hours)

a) **Sericulture:** Types of Silk Worm (Muga and Eri), their host plants, silkworm rearing and management practices. Diseases and Pest of SilkWorm and their management, Biodiversity conservation project through sericulture (Case study- 7Weaves Model)

b) **Apiculture:** Different species of honey bees, bee plants, pollen calendar, bee keeping and management practices, beeproducts, Bee enemies and diseases.

c) **Vermiculture:** species of worms, condition for efficient vermiculture (domestic and commercial level), Economics of Vermiculture

Module II (10 hours)

Aquaculture: Aquarium fish keeping: Ornamental Fishes of India special reference to North East India, common aquarium fishes; Aquarium Maintenance, Fisheries management: Composite fish culture, induced breeding and hybridization; Prawn and Pearl Culture, Exotic and Indigenous food Fishes of NE India, Fish and shellfish diseases and their control measures. Fish genetic resource conservation; Aquaphonics–prospect and future.

Module III: Poultry management (8 hours)

Poultry Rearing / Farming: Housing and equipment; Nutritional Requirements; Poultry diseases; Poultry products: Broilers, meatprocessing and meat products, Poultry by products

ModuleI IV: Parasitology (10 hours)

Introduction to Parasitology: Types of parasites, Types of Host, Zoonosis, Host-parasite Relationship, Sources of Infection, Mode of infection, Pathogenesis.
Vibrio cholera and Clostridium tetani- Life Cycle, mode of transmission, infection and treatment.
Dengue and Bird flu - Life cycle, mode of transmission, infection and treatment.

Module V: Insect pest management, Public Health and Forensic Entomology (12 hours)

a) Concept of Pest, concept of integrated pest management (IPM)

b) Mosquito (Aedes, Culex, Anopheles)-Taxonomy, Biology, Behavior and their control. Life cycle of Calliphora and Scrophaga,determination of death and causes of death.

Module VI: Sustainable Development Goals and Zoology (5 hours)

Concept of Sustainable Development, Background of SDGs, role of a zoologist, SDGs and Zoology (SDGs 1,3,5,6,8,11,12,13,14 and 15), SDG(s)-based projects/dissertations

Suggested Readings

1. Venkitaraman: Economic Zoology, Sudarsana Publishers
2. Srivastava : A Text Book of Applied Entomology, Vol. II & II.I Kalyani Publishers
3. Shukla And Upadhyaya :Economic Zoology. Rastogi Publishers.
4. Ananthakrishnan,T.N.andK.G.Sivaramakrishnan.Ecological Entomology: Insect life in an odd environment. Scientific Pub.:India
5. David, B. V and T.N. Ananthakrishnan. General and Applied Entomology. 2ndEdition. Tata McGraw-Hill Publ. Co. Ltd.: NewDelhi
6. Fenemore P G and Prakash Applied Entomology (New Age Publishers: New Delhi)
7. Packer, B. Aquaponics System: A Practical Guide to Building and Maintaining Your Own Backyard Aquaponics
8. Jayashree, K.V., C.S. Tharadevi& N. Aurumugam. Apiculture. Saras Publication
9. Chandra Girish. Apiculture & the heHoneyBee (Know About The Species Of Honey Bees, beekeeping, pollination, beehives,entomology, beekeepers, honey making
10. Arumugam,N.,T.murugan,R.RamPrabhu,J.JohnsonRajeshwar. Applied Zoology.Saras publication
11. Ganga & Chetty. Comprehensive Sericulture 2nd Edition Paperback. Oxford & IBH publication
12. Narasaiah, M.L. Problems and Prospects of Sericulture. Discovery Publishing Pvt. Ltd
13. Sharma,A.K.,K.Jaiswal &R.N. Pandey. Research and Development in Indian Sericulture. Alfa Publications
14. Singh, R.N. & C.M. Bajpeyi. Muga Culture. APH Publishing Corporation
15. Bernstein, S.Aquaponic Gardening: A Step-By-Step Guide to Raising Vegetables and Fish Together New Society Publishers

16. Jadhav and Siddiqui. Handbook of Poultry Production and Management. Jaypee Publications
17. Krishnamurthy. An Advanced Textbook On Biodiversity: Principles and Practice. Oxford & IBH Publishing
18. Johns, J. Worm Farming - Creating Compost at Home With Vermiculture. Creates pace Independent Pub
19. NPCS Board of Consultants & Engineers The Complete Technology Book on Vermiculture and Vermicompost
20. ICAR. Handbook of Integrated Pest Management (IPM) Pub: ICAR, Govt. of India
21. Metcalf, RW.H.Luckmann. IntroductionTo Insect Pest Management. Wiley India Pvt Ltd.
22. https://bloncampus.thehindubusinessline.com/case-studies/figure-out-how-7weaves-can-scale-up-and-go-global/article25933346.ece
23. https://bloncampus.thehindubusinessline.com/case-studies/7weaves-a-promising-model-for-ethical-slow-fashion/article26388043.ece
24. https://bloncampus.thehindubusinessline.com/case-studies/strong-business-model-can-creat-value-for-all/article26388095.ece
25. https://bloncampus.thehindubusinessline.com/case-studies/focussing-on-organic-growth-and-sustainability/article26389036.ece

Mapping COs to syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V	Module VI
CO1	H					
CO2		H				
CO3			H			
CO4				H		
CO5					H	
CO6						H

ZGEP0034: ETHOLOGY AND POPULATION GENETICS (4 CREDITS- 60 HOURS) (L-T-P: 4-0-0)

Course Outcomes(Co)

1. Define states and events of behaviour. (Remembering)
2. Illustrate the concept of ethology and its significance. (Understanding)
3. Elaborate fitness in terms of evolution (Creating)
4. Apply Hardy Weinberg law for studying population genetics (Applying)
5. Identify sociobiology, social hierarchy, dominance in group living animals. (Applying)
6. Construct behavioral catalog for studying animal behavior. (Creating)

Module I: Basic Concepts of Ethology (10 hours)

a) Concepts of Ethology,
b) Genes and behaviour: Selfish gene concept, Fisher’s Runaway theory
c) Evolution and development of behaviour
d) Deception, Mimicry, and Camouflage: Deimatic behaviour, Aposematic behaviour

Module II: Sociobiology (20 hours)

a) Social Behaviour:Properties And Advantages Social Grouping, social group of monkeys;
b) Fitness: Darwinian fitness, individual fitness, kin selection, group, cooperation, reciprocation, altruism, reciprocal altruism,Proximate and Ultimate causations;
c) Parental care in animals(amphibians)

Module III: Learning and Communication (10 hours)

a) Communication in animals-vocal, and aggression tactile, visual and chemical; Territoriality
b) Learning: Introduction and definition, Types-Habituation, trial and error, conditioning, cognition and imprinting; Short and long term memory, neural mechanism of learning

Module IV: Population Genetics (20 hours)

a) Gene frequencies in population - The Hardy-Weinberg principle and analysis of gene frequencies in natural population.
b) Major factors influencing gene frequencies (migration, inbreeding), Effects of selection and mutation on gene frequencies.
c) Gene flow between subpopulations

Suggested Readings

1. Drickamer & Vessey: Animal Behaviour –Concepts, Processes and Methods, Wadsworth
2. Goodenoughet al :Perspectives on Animal Behaviour, Wiley,
3. Grier : Biology of Animal Behaviour, Mosby,

4. John Alcock: Animal Behaviour, Sinauer associates
5. John Krebs, Baron Krebs: An introduction to behavioural ecology, Blackwell scientifics
6. Aubrey Manning: An introduction to animal Behaviour, Cambridge University press

Mapping COs to syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	L	L	L	
CO2	L			
CO3		H		
CO4				H
CO5		H		
CO6			H	

ZGSL0200: SERVICE LEARNING IN ZOOLOGY

Course Outcomes

1. Develop an understanding about the importance of service to community. (Understanding)
2. Identify the needs of a community. (Applying)
3. Apply skills acquired in Zoology to render service to community. (Creating)
4. Examine what can be learned from the community. (Analyzing)

Module I (5 hours)

Service learning: Definitions; Principles of Service Learning; Awareness of Community; Involvement with Community; Commitment to service

Module II (10 hours)

Aquaculture: Aquarium management - Aquarium fish keeping and breeding using local resources
Sericulture: Eri and their host plants **plantations**; indoor rearing and management practices; marketing and management of produce

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II
CO 1	H	L
CO 2	L	M
CO 3	L	H
CO 4	M	H

LABORATORY COURSES

ZGPR6004: PROJECT MANAGEMENT, REPORTING AND DOCUMENTATION (30 HOURS) (P/NP)

Course Outcomes

1. Identify qualities of a successful entrepreneur and develop competencies. (Applying)
2. Construct economically and socially sound business ideas. (Creating)
3. Analyze the potentials of a social catalyst and examine case studies. (Analyzing)
4. Assess plans for effective preparation of Detailed Project Report (DPR) and financials of a DPR. (Analyzing)
5. Develop skills for project implementation and management. (Applying)
6. Define concept of market. (Remembering)
7. Distinguish different methods of Bookkeeping and Accountancy. (Analyzing)
8. Adapt effective plans for preparing accurate project report and practicing positive documentation. (Creating)

Objective: Help the student to understand Entrepreneurship, identification of qualities of a successfulentrepreneur & how to develop it

Module I: Entrepreneurship : Concept and Functions

Who is an entrepreneur?

Entrepreneurial competencies(Initiative, Creativity and Innovation, Risk Taking and Risk Management, Problem Solving, Leadership, Persistence, Quality Performance,

Information Seeking, Systematic Planning, Persuasion and Influencing Others,

Enterprise Launching Competencies, Enterprise Management Competencies)

Functions of an entrepreneur (Promotional functions: Innovation, Risk-taking,

Organisation Building, Discovery of an idea, Detailed Investigation, Assembling the Requirements, Financing the Proposition. Managerial functions: Planning, Organizing,

Staffing, Leadership, Supervision, Communication, Motivation, Controlling.

Commercial Functions : Production, Finance, Marketing, Accounting)

Types of entrepreneur (Innovative Entrepreneur, Imitative Entrepreneur, Fabian

Entrepreneurs, Drone Entrepreneurs)

Entrepreneurship: meaning and definition; types of entrepreneurship;

entrepreneur and entrepreneurship

Difference between entrepreneur and employee

Objective: Help the students to generate various business ideas and link the best one with them

Module II: Generation of business ideas and linking

EDP: Meaning, Need, Importance of EDP

Necessity of generating ideas

Ways to generate ideas, Area Assessment Survey – Modes (Desk Research, Field

Work, Market Need Based Opportunities, Ideas from Existing Entrepreneurs)

Linking business ideas with the entrepreneur

Methodology of Opportunity Identification & Profiling Business Ideas (Preparation of Personal Profile, Development of OS (decision making) Framework, Snap Investigation of ideas generated, Evaluation in terms of OS (decision making) Framework and Short-listing of Ideas, Pre-feasibility Studies, Errors in Selection, Final Opportunity Selection)

Preparation of business project plan and business project plan execution (Summary of the Project/Project at a Glance, General Information, Details of the Proposed Project, Market Potential, Manufacturing Process, Production Programme/Sales Revenue, Cost of Manufacturing and Profitability Projections)

Objective: To impart knowledge on social entrepreneurship

Module III: Social entrepreneurship

Who is a social entrepreneur (definition and case study)

Difference between entrepreneurship and social entrepreneurship

Characteristics of social entrepreneur (Social Catalysts, Socially aware, Opportunity- seeking, Innovative, Resourceful, Accountable)

Examples and case study

Objective: To impart knowledge on preparation of DPR

Module IV: Preparation of Detailed Project Report (DPR) and financials of a DPR

Business plan : key questions

Technical arrangement & Production process (Manufacturing process, Sources of technical know how, plant & machinery, Supplier identification & supplier selection, Raw materials, packaging, land requirement, utilities and manpower, financial viability) and Location selection (Layout, built up area etc).
Product and Market (Product description, Capacity, Market study and market demand, Product mix, Branding, Channels of distribution, Advertising and Promotion etc.)
Project cost and means of finance (Land, site development, building and civil works, plant and machinery cost, other fixed assets, technical knowhow fees, preliminary and preoperative expenses, working capital margin, contingency andescalation)
Income analysis (Capital utilisation and income estimate, Expenditure estimate, Profit estimate, income tax estimate, profitability ratios : TC ratio, cash flow estimate, risk analysis, sensitivity analysis etc.)

Objective: Impart knowledge on implementing, managing and monitoring the progress of the selected project

Module V: Project implementation and management
Understanding Total Quality Management (Acceptable Quality Level, Benchmarking, Deming Wheel, ISO 9000,Pareto Analysis, Quality Circles, Measures of Central Tendency and Dispersion, Geometric Moving Average, Statistical Process Control etc.)
Goal Oriented Project Planning (Project Planning Matrix and Product Matrix)
Project Activity Planning and Implementation (Gantt Charts, the Programme Evaluation and Review Technique (PERT) andCritical Path Method (CPM) of project scheduling)
Soft skills for launching and managing a project (Creativity and Problem Solving, Interpersonal Communication, Persuasion and Use of Influence Strategy, Negotiation and Networking, Delegation of Authority and Work Effort, Efficiency Orientation As a Trait, Leadership, Concept of risk and risk taking, Legal Requirements, Types of business organisation)
Managing Business Crisis – Starting and Liquidity Crisis

Objective: To impart the Knowledge of different component of Market

Module VI: Concept of market
Traditional market
Emerging market : E commerce
Analysing the market environment 4
Researching the market and market survey
Marketing mix
Product mix
Promotion mix
Price mix, method of pricing

Objective: To impart knowledge on Book Keeping

Module VII: Bookkeeping and Accountancy
Basic concept of Accounting (Management and financial accounting)
Basic books of accounts (Journal, Purchase book, Purchase return book, Sales book, Sales return book, ledger book, Cash book etc.)
Financial statement: Meaning, Importance
Profit and loss account
Balance sheet
Depreciation and adjustment etc.
Interpretation of financial Statement (Liquidity, Current ratio, Profitability ratio, Inventory turnover ratio, Debtors turnover ratio, ROI etc)
Fund flow Analysis

Objective: To impart knowledge on Documentation and Reporting

Module VIII: Documentation and Reporting
Why to Document
What is a Documentation Report
When and How to prepare the Documentation Report
Typical format of a Documentation report
Layout of the Report
Writing a Report

Mapping COs to syllabus

Course Outcomes	Module1	Module2	Module3	Module4	Module5	Module6	Module7	Module8

CO1	H							
CO2		H						
CO3			H					
CO4				H				
CO5					H			
CO6						L		
CO7							H	
CO8								H

ZGDI6006: DISSERTATION PHASE I (4 CREDITS)

Course Outcomes

At the end of Dissertation phase I students will be able to:

1. Review and analyse scientific papers (Analyzing)
2. Design and perform experiments and prepare work plan (Applying)
3. Formulate hypotheses and choose appropriate methodologies to achieve the desired objectives (Creating)

The dissertation phase I is the preliminary stage where a student selects a research topic on interest in consultation with the assigned supervisor. In this phase the student is learns to identify research gap, formulate objectives and hypothesis, design work plan and experiments and fixes his/her methodologies to achieve the desired objectives.

ZGWP6011: INTRODUCTION TO WILDLIFE PHOTOGRAPHY (30 HOURS, L-T-P: 2-0-0) (P/NP)

Course Outcomes

1. Discuss the history of Photography, moving images and Stock photography Creating)
2. Demonstrate a brief understanding of ethics of journalism, photo journalism and sources (Understanding)
3. Assess the importance of digital technology in photography (Evaluating)
4. To define camera basics and different genres of photography (Remembering)

Learning Objective

1. Through theory and practical assignments, this class provides the students with hands on experiences in photography. Lectures, field studies, guest instructors, student presentation and group work will help you develop the analytical basisand insight to reflect upon and assess the impact of photographs on our ideas of the world.
2. By the end of this course, Students will: Be able to start their career in photography. Will be able to create picture story /Photo Essays and understand the conventions and challenges of telling stories through images
3. Gain personal leadership through challenging, intercultural assignments

Objective: This module will help to understand the students about photography basics

Module I: Introduction to photography

Camera Basics, Types of Camera, Operating a Camera, Exposure, Aperture & Shutter Speeds Light Meter, Depth of Field, Choosing Lenses, Types of lens, Lighting, Flash Photography, Filters, Steady Shooting, Composition in wildlife Photography.

Objective: *This module will help to understand the students about different types of photography in details*

Module II: Different genres of photography

Mobile Photography, **Microscopic photography**, **Macro photography, Drone photography, Wildlife Photography**

Objective: Post production is an important part of photography student will learn post-production in this module

Module III: Post Processing

Enhancing Photographs, Organizing the Picture, Quality Control, Intermediate/advanced use of post-production software like Adobe Photoshop, Lightroom etc

Objective: How to earn the livelihood from selling your images internationally

Module IV: Stock Photography

Introduction to Stock Photography, How to contribute to various stock photo agencies. Causes of rejections, Submitting Guidelines, Meta Data

Objective: This module focuses on photojournalism.

Module V: Ethics in Wildlife Photography

How to prepare for a photo tour (Dress code in wildlife photography, permissions, water bottle, notebook and other accessories) How to remain safe during shooting (How close is too close, keeping antivenom & antiallergen; leach guard, safety of gears used) Ethics in wildlife photography (knowing Schedules of animals in Wildlife (Protection) Act, 1972, not using any bait, not taking any animal out of its habitat without permission, non use of flash, not altering the habitat)

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	H	L	H	
CO 2		M			H
CO 3	H	H	H	L	M
CO 4	H	M	H	M	M

ZGDS6009: DISSERTATION PHASE II (8 CREDITS)

Course Outcomes

At the end of Dissertation phase II students will be able to:
1. Conduct experiments/ field studies using different materials and methods (Analyzing)
2. Collect various types of data and use those data for testing hypotheses (Analyzing, Evaluating)
3. Make use of several statistical tools for data analysis (Analyzing)
4. Create a scientific report based on the study (Creating)

During the dissertation phase II, a student learns how to perform experiment/field study and collect necessary data for data analysis. He/She also learns to use several statistical tools to analyze data and create a dissertation thesis based on original work done during the end semester examination.

ZGTM6010: TEACHING METHODOLOGY AND CLASSROOM MANAGEMENT (30 HOURS: P/NP)

Course Outcome (CO):
1. Define different concepts of teaching skills (Remembering)
2. Create effective teaching instruction (Creating)
3. Evaluate assessments (Evaluate)
4. Make use of ICT(Analyzing)

Module I: Introduction to Core teaching Skills. Micro- teaching.

a) Introduction to Methods, Maxims, Devices and techniques of teaching. Practice teaching on Core teaching Skills in Microteaching mode.

b) Approaches and methods of teaching Science - (i) Lecture, demonstration, explanation, Observation. (ii) Ensuring Problemsolving, laboratory, Project, Heuristic, Discussion for teaching science. (iii) Learning by discovery, group work and team teaching.
(iv) Collaborative strategies, provision in heterogeneous classroom.

Module II: Planning and designing for effective instruction in science.

a) Design of unit and lesson planning approaches to lesson planning, format of lesson plans

b) Teaching aids and laboratories in science, their necessity and importance.

c) Museum, field trips and excursion, their relevance to science. Preparation of simple aids of Science teaching.

Module III: Evaluation of Learners Progress.

a) Concept and importance of assessment & evaluation.

b) Techniques of evaluation (Theory & Practical)

c) Construction of Unit test: Design and blueprint, Item construction, Question wise analysis, Construction of Science question paper including marking scheme.

Module IV: Information and Communication Technology (ICT) Integration in Science teaching.

a) Introduction to ICT

b) Importance of ICT in Science teaching.

c) Exploring various ICT tools for Science teaching.

d) Open Education Resources (OER) and its uses in Science teaching.

e) ICT Integration in Science teaching.

f) Exploring FOSS in Science teaching

Mapping of COs to Syllabus

Course Outcomes	1	2	3	4
CO1	H	M	M	M
CO2		H		
CO3			H	
CO4				H

ZGEE6011: SPECIALIZATION LAB I – ENTOMOLOGY (2 CREDITS)

Course Outcomes

1. Explain and Identify insects of different insect orders
2. Develop the skill required to properly collect and preserve insects (Creating)
3. Compare the different types of legs, antennae and mouthparts of insects (Analysing)
4. Develop a sound knowledge on basic aspects of anatomy of different systems, physiology of internal systems like digestive system, circulatory system, reproductive system and nervous system. (Creating)
5. To Estimate haemolymph, chitin and uric acid in insects (Creating)

Syllabus

1. Insect collection and preservation
2. Different types of mouth parts
3. Different types of antenna
4. Different types of legs
5. Preparation of arolium, empodium and pollen basket
6. Preparation and identification of haemocytes, quantitative count of haemocytes.
7. Detection of chitin in insect cuticle
8. Detection of Uric acid in insects
9. Estimation of haemolymph proteins in insects.
10. Histological study of foregut, midgut and hindgut of insect.
11. Reproductive system of cockroach
12. Prothoracic gland of cockroach
13. Biosensing activity in Butterflies, Honeybees and beetles
14. Identification Of insects of forensic importance and forest defoliator

Mapping of COs to Syllabus

Course Outcomes	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14
CO1	H													
CO2	M	H												
CO3		H	H	H	H									
CO4									H	H	H	H	H	H
CO5						H	H	H						

ZGCM6012: SPECIALIZATION LAB I- CELL AND MOLECULAR BIOLOGY (2 CREDIT; 30 HRS, 0-0-2)

Course Outcome

1. To demonstrate the method to study cell morphology. (applying)
2. Demonstrating the method of preparation of histological slides. (applying)
3. Show the method of preparation to study various chromosome. And also demonstrating the pk value of buffer.(analysing)
4. To demonstrate various method of detecting concentration of an unknown sample. (applying)
5. Demonstrating the enzyme end point technoiques. (analyzing)
6. Illustrating various immunological techniques. (analysing)
7. Creating a report on the techniques observed in advanced lab. (creating)

Syllabus

1. Use of occulometer-standardization and measurements of cell height, nuclear diameters and tabular diameters
2. Histology of biological tissues and sectioning by microtome
3. Preparation of salivary gland chromosomes from Drosophila /Chironomous larva and stain with acetocarmine/aceto-orcein/fuelgen
4. Preparation of mammalian chromosomes from bone marrow or testis and stain with Giemsa stain

5. Determination of pK value of buffer
6. Determination of relationship between absorption and various concentration of a solution using a colorimeter, spectrocolorimeter/spectrophotometer.
7. Preparation of standard curve for total cholesterol
8. Quantization of enzymes: End point techniques (alkaline phosphatase), enzyme kinetics.
9. Permanent Slides: Types of cells (squamous, cuboidal, columnar epithelial cells, blood cells, nerve cells, muscle cells), connective tissues of various types, adipose tissue, mitotic & meiotic chromosomes and their different phases.
10. Preparation of emulsions- syringe method and hubbed needle method
11. Immunization routes: Intradermal, Subcutaneous, Intramuscular, Intraperitioneal, Intravenous
12. Bleeding Schedules and collection of blood: cardiac puncture, external jugular vein
13. Separation and preservation of serum: Liquid Storage using preservative and by sterilization
14. Report submission- Visit to advanced lab.

Mapping of COs to Syllabus

Course Outcomes	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14
CO1	H													
CO2		H							H					
CO3			H	H	H									
CO4						H	H							
CO5								H						
CO6										H	H	H	H	
CO7														H

ZGFS6013: SPECIALIZATION LAB I- FISHERY SCIENCE (2 CREDITS: 30 HOURS/ L-T-P: 0-0-2)

COURSE OUTCOMES (CO)

1. Identify commercially important fish species of Northeast India. (Applying)
2. Prepare fish bones using various techniques. (Analyzing)
3. Analyze various biological parameters of fish. (Analyzing)
4. Determine various indices of fish. (Evaluating)
5. Create reports on visits to fish landing centres and fish farms. (Creating)

Syllabus

1. Identification of commercially important fish species of north east India representing all fish groups
2. Fish osteology —preparation of fish skeleton (using KOH and Trypsin).
3. Biological Analysis of fish samples for gut contents, maturity stages and fecundity
4. Dissecting out the pituitary gland and preparing the extract, Weberian Ossicle.
5. Determination of length-weight analysis in fishes.
6. Determination of gonado somatic index (GSI), hepatosomatic index(HSI),condition factor(CF), and fecundity.
7. External characters, types of scales, fins, types of teeth, structure of alimentary canal, gill rakers.
8. Visit to fish landing centre and fish farms and make Reports of visit

Mapping of COs to Syllabus

Course Outcomes	E1	E2	E3	E4	E5	E6	E7	E8
CO 1	H							
CO 2		H						
CO 3				H				
CO 4			H		H	H	H	
CO 5								H

ZGAW6014: SPECIALIZATION LAB I- ANIMAL ECOLOGY AND WILDLIFE BIOLOGY [2 CREDITS: 30 HOURS, L-T-P: 0-0-2]

Course Outcome

1. Identify different flora and fauna (Applying).
2. Applying ecological sampling techniques (Applying)
3. Create and Analyse animal behavior (Analyzing, Creating)
4. Identify different successional stages (Applying)
5. Evaluate species diversity and similarity between communities (Analyzing)
6. Create field reports by studying different protected areas (Creating)

Syllabus:

1. Identification of species of butterfly, fishes, amphibia, reptilia, aves and mammalia from collection/model/photographs etc.
2. Identification of fish, amphibian and reptiles (local fauna) using Morphometric landmarks.
3. Ecological Sampling techniques: a) point transect, b) line transects, c) belt transect,
4. Behavioural study through Ethogram preparation
5. Time and Activity budgeting using Focal/Scan sampling.
6. Systematic study of common plants: Field and Herbarium techniques.
7. Study of successional stages of various forest communities.
8. Measuring diversity using Diversity:
   a) Diversity Indices: Shannon Weinner Index, Brillouin’s index, Simpson index.
   b) Similarity Indices: Morisita’s index, Sorenson's coefficient, Sorenson’s and Dice index, Jaccard index
   c) Dissimilarity indices: Bray-Curtis, Ochiai index
9. Report Submission: Study of nearby protected areas (forests and grasslands) under various management regimes and makea report

Mapping of COs to Syllabus

Course Outcomes	E1	E2	E3	E4	E5	E6	E7	E8	E9
CO1	H	H				H			
CO2			H						
CO3				H	H				
CO4							H		
CO5								H	
CO6									H

ZGEE6015: SPECIALIZATION LAB II – ENTOMOLOGY AND ENVIRONMENTAL BIOLOGY (2 CREDITS, L-T-P: 0-0-2)

Course Outcomes

1. To categorize aquatic, terrestrial and boring insects (Analysing)
2. To Identify different pests of insects, insects of forest importance and forest defoliator (Analysing)
3. To identify major vector species of insects (Analysing)
4. Demonstrate phylogenetic tree (Understanding)
5. Develop a sound knowledge on basic aspects of physiology of different systems (Applying)

Syllabus:

1. Alimentary canal of house fly with crop
2. Bacterial chamber of termite
3. Pharyngeal, labial and thoracic salivary gland of honey bee
4. Sting apparatus of honey bee
6. Identification of aquatic, terrestrial and boring insects with specific adaptive characteristics.
7. Visit to agricultural field/tea garden and forest for on spot study of pest and damage caused by them
8. Preparation of Phylogenetic tree of Insect species
9. Study of Life Cycle of Mosquito, Housefly, Drosophila
10. Collection and identification of economically important insects and various stages of their life history (using uniquerepresentatives)
11. Identification Of Pests (Tea , Jute, Paddy stored grain)
12. Identification and anatomical studies of major vector species of Anopheles, Culex and Ades

Mapping of COs to Syllabus

Course Outcomes	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11
CO1					H	H					
CO2						M			H	H	
CO3						M		L			H
CO4							H				
CO5	H	H	H	H							

ZGCM6016: SPECIALIZATION LAB II- CELL AND MOLECULAR BIOLOGY (2 CREDIT; 30 HRS; 0-0-2)

Course outcomes:

1. Demonstrating the method of separation of various cell organelles.(Understanding)

2. Illustrating the separation of nuclic acid, proteins, and amino acids. (Applying)
3. Qualitative analysis of carbohydrate, protein, lipid, nuclic acid by various methods. (Analysis).
4. Demonstration the method of lymphocyte count. (Applying)

Syllabus

1. Tissue homogenization and fractionation by differential centrifugation for isolation of mitochondria, nuclei and cytosol
2. Separation of DNA by agarose gel electrophoresis
3. Separation of proteins on Sodium dodecyl sulphate - polyacrylamide gel electrophoresis
4. Separation of amino acids by Thin Layer Chromatography.
5. Detection of Carbohydrate (a) PAS method/(b) Alcian blue method
6. Detection of Proteins (a) Mercury bromophenol blue method/(b) Ninhydrin method
7. Detection of Lipids (a) Phosphomolybic acid method/(b) Copper phthalocyanine method
8. Detection of DNA by Feulgen method and differential detection of DNA and RNA in a cell by Methyl green- Pyronin method.
9. Isolation and vital staining of lymphocytes obtained from spleen and lymph nodes of sensitized animals

Mapping of COs to Syllabus

Course Outcomes	E1	E2	E3	E4	E5	E6	E7	E8	E9
CO 1	M								
CO 2		H	H	H					
CO 3					H	H	H	H	
CO 4									H

ZGFS6017: SPECIALIZATION LAB II- FISHERY SCIENCE (2 CREDITS: 30 HOURS/ L-T-P: 0-0-2)

Course Outcomes

1. Evaluate the physicochemical parameters of water samples. (Evaluating)
2. Estimate and determine productivity of water bodies and its biotic components. (Evaluating)
3. Analyze important fish parasites. (Analyzing)
4. Develop efficient fishing tools for sustainable utilization of the resources. (Creating)
5. Create reports on the study of freshwater bodies and fish processing centre. (Creating)

Syllabus

1. Analysis of water samples for various physicochemical parameters–pH, freeCO2, dissolved oxygen, alkalinity, chloride,hardness, nitrates, phosphates, BOD, COD
2. Estimation of primary productivity by light and dark method.
3. Composition and biomass of phytoplankton, Collection, enumeration and biomass of Zooplankton
4. Identification of important fish parasites (external and internal).
5. Identification of fishing gears and fish by products.
6. Fieldwork: Visit to fresh water bodies, study of physico-chemical and biological status and make a report
7. Visit fish processing centers and make a report.

Mapping of COs to Syllabus

Course Outcomes	E1	E2	E3	E4	E5	E6	E7
CO 1	H						
CO 2		H	H				
CO 3				H			
CO 4					H		
CO 5						H	H

ZGAW6018: SPECIALIZATION LAB II- ANIMAL ECOLOGY AND WILDLIFE BIOLOGY [2 CREDITS: 30 HOURS, L-T-P: 0-0- 2]

Course Outcome:

1. Apply ecological techniques (Applying)
2. Analyze animal sign (Analyzing)
3. Make use of GPS to create habitat maps (Applying)
4. Make use of wildlife equipment (Applying)
5. Make use of software for sound analysis and species abundance data (Analyzing)
6. Explain and Perform DNA isolation (Understanding, Applying)

7. Create report on conservation practices (Creating)

Syllabus:
1. Ecological census techniques: a) mark recapture b) quadrat sampling c) plotless sampling d) pellet group count
2. Animal sign & marks analysis: Pug mark analysis; Scat/ Dung analysis: (parasite identification)
3. Mapping distribution of endangered animal fauna of Northeast India
4. Demonstration and use of equipment- camera traps, remote drug delivery equipments, tags, collars, radio tracking equipment
5. Analysis of Abundance Data
6. Extraction of DNA from biological sample, PCR amplification
7. Preparation of an area map using on field GPS data.
8. Acoustic analysis of birds /amphibians
9. Report Submission: Preparation of conservation statements-through review of literature or via field visit.

Mapping of COs to Syllabus

Course Outcomes	E1	E2	E3	E4	E5	E6	E7	E8	E9
CO1	H								
CO2		H							
CO3			H				H		
CO4				H					
CO5					H			H	
CO6						H			
CO7									H

ZGBE6019: BIOSYSTEMATICS AND ENVIRONMENTAL BIOLOGY LAB (2 CREDITS) (L-T-P:0-0-2)

Course Outcomes
1. Explain taxonomic procedures and identify various fauna. (Understanding)
2. Apply biodiversity indices. (Applying)
3. Determine parameters of the Environment. (Evaluating)
4. Application of biostatistical tools. (Applying)
5. Make use of bioinformatics softwares for genetic analysis. (Applying)
6. Demonstrate survey techniques. (Applying)

Syllabus
1. Collection, preservation, curation and identification of non-chordata and chordate species (only pest and cultured species)
2. Identification with only diagnostic features (specimen or model/diagnostic photograph) of different phyla
3. Survey and application of biodiversity indices on animal species (any one group)
4. Calculation of Pearson correlation coefficient, T-test (One sample t-test, Two sample t- test,Paired t-test); Chi square test, ANOVA, Mann-Whitney test on supplied data.
5. Preparation of Taxonomic key, study of evolution through models/charts.
6. Sequence alignments, Blastn, Blastp, Psi-Blast, Clustal Omega
7. Homology modeling
8. Phylogenetic Analysis using academic software
9. Estimation of CO_2, DO, Nitrites, total alkalinity and hardness of water sample.
10. Study of zooplanktons and its role in a pond ecosystem.
11. Analysis of physical parameters of soil.
12. Study of different types of survey techniques

Mapping of COs to Syllabus

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
CO 1	H	H			H							
CO 2			H									
CO 3				H					H		H	
CO 4						H	H	H				
CO 5												
CO 6										H		H

ZGCI6020: CELL BIOLOGY, GENETICS AND BASIC BIOINFORMATICS LAB (2 CREDITS) (L-T-P:0-0-2)

Course Outcomes

1. Demonstrate laboratory safety protocols. (Understanding)
2. Identify laboratory equipment and their uses. (Remember)
3. Interpret cell division and the stages. (Understanding)
4. Analyze macromolecules using electrophoretic techniques. (Analyzing)
5. Apply bioinformatics tools to archive, retrieve, and analyze biological data. (Analyzing)

Syllabus

1. Use and care and maintenance of common lab equipment (microscope, colorimeter/ spectrophotometer, balance, pHmeter, oven, incubator, microtome, electrophoretic apparatus, centrifuge, water bath etc.) and glass wares.
2. Identification of various stages of mitosis and meiosis from prepared slides.
3. Temporary squash preparation of onion root-tip/tadpole tail-tip cells to study stages of mitosis and Grasshopper/ Gryllotalpa testis to study meiotic stage of cell division.
4. Comparison of RBC and WBC in different groups of Vertebrate.
5. Isolation of DNA from any animal source.
6. Agarose Gel electrophoresis of isolated genomic DNA.
7. Usage of NCBI resources
8. Usage/Retrieval of sequence/structure from databases
9. Visualization of structures
10. Protein Docking and Docking of ligand receptors

Mapping of COs to Syllabus

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
CO 1	H									
CO 2		H								
CO 3			H	H						
CO 4					H	H				
CO 5							H	H	H	H

ZGDB6021: DEVELOPMENTAL BIOLOGY AND BIOCHEMISTRY LAB (2 CREDITS: 30 HOURS) (L-T-P: 2-0-0)

Course Outcomes

1. Compare the differences between developmental stages of chick embryo. (Evaluating)
2. Identify characteristic features of different phases of the mouse estrous cycle. (Applying)
3. Utilize microtomy in histological study of different tissues (Applying)
4. Determine the physiological amounts of important biological macromolecules and plant antioxidant property through various estimation methods. (Evaluating)
5. Apply Henderson-Hasselbalch Equation for preparing buffers. (Applying)

Syllabus

1. In vivo/in vitro culture and study of chick embryo.
2. Study of developmental stages of Chick embryo from permanent slides.
3. Study of different stages of estrous cycle in mice.
4. Tissue processing, sectioning, staining, analysis of histological tissues
5. Preparation buffers of different pH using Henderson-Hasselbalch Equation and Its Verification using pH meter.
6. Quantitative estimation of amino acid using ninhydrin reagent.
7. Quantitative estimation of total protein by Lowry method.
8. Estimation of glucose in serum by glucose oxidase peroxidase method/tissue by Anthrone reagent
9. Determination of in vitro antioxidant property (of plants extracts).

Mapping COs to syllabus

	E1	E2	E3	E4	E5	E6	E7	E8	E9
CO1	H	H							
CO2			H						
CO3				H					
CO4						H	H	H	H
CO5					H				

ZGEP6022: ETHOLOGY AND POPULATION GENETICS LAB (2 CREDITS: 30 HOURS) (L-T-P: 0-0-2)

Course Outcomes
1. Compare different types of behavior and analyze the methods of behavior sampling. (Evaluating)
2. Identify characteristic features of social organization in primates and analyze inclusive fitness. (Applying)
3. Construct gene frequencies using Hardy Weinberg Law. (Creating)
4. Determine food preferences in fish or insects. (Evaluating)
5. Distinguish behavioral changes in zooplanktons in relation to temperature and chemicals. (Analyzing)

Syllabus
1. Identification of different behavioral types (States and Events) in any group of animals.
2. Preparation of behavioral catalog (Ethogram)
3. Behavioral sampling Techniques: Scan animal Sampling, Focal animal sampling
4. Time and activity budgeting
5. Social organisation in primates
6. Analysis of gene frequencies using Hardy Weinberg Law using case studies.
7. Thermotactic behaviour in Zooplanktons/ Earthworm
8. Chemotactic behaviour in Zooplanktons/ Earthworm
9. Food preference in Tribolium / fish.
10. Study of Deimatic behaviour/ Aposematic behaviour in any group of animals.
11. Analysis of inclusive fitness.

Mapping COs to syllabus

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11
CO1	H	H	H	H						H	H
CO2					H						
CO3						H					
CO4									H		
CO5							H	H			

SERVICE LEARNING IN ZOOLOGY PRACTICAL

Course Outcomes
1. Demonstrate aquaculture practices and techniques. (Applying)
2. Demonstrate techniques in Sericulture. (Applying)
3. Examine what can be learned from the community. (Analyzing)

Syllabus
1. Identification of local potential aquarium fishes
2. Aquarium making and management
3. Preparation and setting up of aquarium
4. Rearing of Eri silkworm
5. Identification of silkworm pests

Mapping of COs to Syllabus

	E1	E2	E3	E4	E5
CO 1	H	H			
CO 2			H	H	
CO 3	M	M	L	H	M

FOUNDATIONS OF SERVICE LEARNING PRACTICAL (2 CREDITS)(L-T-P: 0-0-2)

Course Outcomes
1. Demonstrate waste management practices. (Applying)
2. Demonstrate proper health and hygiene practices. (Applying)
3. Examine what can be learned from the community. (Analyzing)

Syllabus
1. Identification and segregation of waste in designated bins
2. Composting of biodegradable waste
3. Visit to nearby school and demonstration of personal hygiene habits

4. Awareness Programme on breeding grounds
5. of vectors and their control.

Mapping of COs to Syllabus

Course Outcomes	1	2	3	4
CO 1	H	H		
CO 2			H	H
CO 3	L	M	L	L

SCHOOL OF HUMANITIES AND SOCIAL SCIENCES

DEPARTMENT OF ECONOMICS
MASTER OF ARTS IN ECONOMICS
Course Structure of MA Programme

SEMESTER I						
TYPE	**CATEGORY**	**COURSE CODE**	**COURSE TITLE**	**L-T-P**	**CREDITS**	**PAGE**
Theory	Core Course	ENML0046	Microeconomic Analysis	4-0-0	4	854
Theory	Core Course	ENMY0047	Macroeconomic Analysis	4-0-0	4	854
Theory	Core Course	ENFE0067	Financial Economics	4-0-0	4	873
Theory	Core Course	ENMM0048	Mathematical Methods in Economics	4-0-0	4	855
Theory	Department Elective (DE)	ENMB0050	Money and Banking	3-0-0	3	857
Theory	School Elective (SE)	ENIP0051	Indian Economic Development	3-0-0	3	858
Theory	Service Learning	ENSL0200	Service Learning	2-0-0	2	
			Total Credits		**22**	
SEMESTER II						
TYPE	**CATEGORY**	**COURSE CODE**	**COURSE TITLE**	**L-T-P**	**CREDITS**	**PAGE**
Theory	Core Course	ENSM0052	Statistical Methods in Economics	4-0-0	4	859
Theory	Core Course	ENEO0049	Economics of Development			856
Theory	Core Course	ENPS0054	Public Economics	4-0-0	4	861
Theory	Core Course	ENDV0055	Indian Economic Development and Policy	4-0-0	4	862
Theory	School Elective (SE)	ENPB0056	Public Finance	3-0-0	3	862
			Total Credits		**23**	
SEMESTER III						
TYPE	**CATEGORY**	**COURSE CODE**	**COURSE TITLE**	**L-T-P**	**CREDITS**	**PAGE**
Theory	Core Course	ENRM0057	Research Methodology in Economics	4-0-0	4	863
Theory	Core Course	ENES0058	Environmental Economics and Sustainability	4-0-0	4	864
Theory	Core Course	ENDI6003	Dissertation Phase I	2-0-0	2	876
Theory	Discipline Specific Elective (DSE) (Any one)	ENEG0059	Agriculture Economics - Issues and Management	4-0-0	4	865
Theory		ENBE0070	Behavioural Economics			874
Theory	Discipline Specific Elective (DSE) (Any one)	ENHE0061	Health Economics	4-0-0	4	867
Theory		ENOR0065	Operations Research			871
			Total Credits		**18**	
SEMESTER IV						
TYPE	**CATEGORY**	**COURSE CODE**	**COURSE TITLE**	**L-T-P**	**CREDITS**	**PAGE**
Theory	Core Course	ENIN0063	International Economics	4-0-0	4	868
Theory	Core Course	ENPE0064	Population Economics	4-0-0	4	870
Theory	Core Course	ENDI6004	Dissertation Phase II	4-0-0	4	877
Theory	Discipline Specific Elective (DSE) (Any one)	ENNE0071	Economy of North East Region	4-0-0	4	875
Theory		ENLE0069	Labour Economics			873
Theory		ENEI0062	Economics of Industry			868
Theory	Discipline Specific Elective (DSE) (Any one)	ENEM0053	Econometric Methods			860
Theory		ENGE0066	Gender Economics			871
Theory		ENED0060	Economics of Education			866
			Total Credits		**20**	
			Total Programme Credits in BA Economics		**83**	

MA Economics - LIST of VALUE ADDED COURSES

SEMESTER II						
TYPE	**CATEGORY**	**COURSE CODE**	**COURSE TITLE**	**L-T-P**	**CREDITS**	**PAGE**
Practical	Value-added Course	ENDA6005	Data Analysis with SPSS/STATA	0-0-2	2	

DEPARTMENT OF EDUCATION
MASTER OF ARTS IN EDUCATION
Course Structure of MA Programme

SEMESTER I					
Type of Course	Category	Course Code	Course Title	Credits	Page No.
Theory	DC	EDFE0035	Philosophical Foundations of Education	4(4-0-0)	897
	DC	EDEP0036	Fundamentals of Educational Psychology	4(4-0-0)	898
	DC	EDTE0013	Emerging Trends in Education	3(3-0-0)	880
	DC	EDDE0014	History and Development of Education in India	3(3-0-0)	882
	Elective Group I				
	DE	EDET0015	Educational Technology	3(3-0-0)	883
	Elective Group II				
	DE	EDLR0007	Leadership and Social Responsibility	3(3-0-0)	880
Practicum	DC	EDJG6002	Journaling – A Technique for Personal and Academic Growth	3(3-0-0)	903
Total Credits				23	
SEMESTER II					
Theory	DC	EDSF0038	Sociological Foundations of Education	4(4-0-0)	900
	DC	EDRM0034	Research Methodology in Education	4(4-0-0)	896
	Specialisation Courses: One area of Concentration to be opted (Educational Leadership/Educational Psychology)				
	DC	EDEL0019	Developing Educational Leadership	3(3-0-0)	884
	DC	EDDL0020	Human Development and Learning	3(3-0-0)	885
	Elective Group I				
	-	-	-	3(3-0-0)	
	Elective Group II				
	DE	EDPC0037	Peace Education and Conflict Management	3(3-0-0)	899
Practicum	DC	EDES6003	Educational Seminar I	2	903
	SE	SWCA6010	Computer Applications for Social Sciences (Lab)	2	907
	DC	EDSV6004	School Visits	2	904
	Total Credits			23	
SEMESTER III					
Theory	DC	EDCI0039	Curriculum Development and Instruction	3	901
	DC	EDTP0022	Principles and Techniques of Teaching and Pedagogy	3	886
	DC	EDTE0023	Teacher Education	3	887
	DC	EDME0024	Measurement and Evaluation in Education	3	888
	SPECIALIZATION COURSES				
	Educational Leadership				
	DC	EDOC0029	Organisational Communication	3	892
	DC	EDFM0026	Financial Management and Accounting	3	889
	Educational Psychology				
	DC	EDLE0027	Life Span Development and Education	3	890
	DC	EDLI0028	Learning and Individual Differences	3	891
Practicum	DC	EDDI6005	Dissertation Phase I	2	904
	DC	EDES6009	Educational Seminar II	2	906
	DC	EDTP6010	Teaching Practice	2	907
		Total Credits		24	
SEMESTER IV					
Theory	**SPECIALIZATION COURSES**				
	Educational Leadership				

	DC	EDEA0030	Educational Administration	3	893
	DC	EDSR0031	Ethics and Social Responsibility in Education	3	894
	Educational Psychology				
	DC	EDSP0032	Counselling Skills for Educational Psychologists	3	895
	DC	EDCA0033	Child and Adolescent Mental Health	3	896
Practicum	DC	EDDI6007	Dissertation Phase II	4	905
	DC	EDIN6008	Internship	3	906
	Total Credits			13	
	TOTAL PROGRAMME CREDITS			83	

LIST OF VALUE ADDED COURSES						
Course Type	**Category**	**Course Code**	**Name of Paper**	**L-T-P**	**Credits**	**Page No.**
Theory & Practicum	Value Added	EDES6011	Education for Sustainable Development	1-0-1	2	911
		EDTT6012	Teacher and Teaching Skills	1-0-1	2	912
		EDHW6013	Education for Health and Wellness	1-0-1	2	912
		EDWE6014	Women Empowerment	1-0-1	2	914
		EDFL6015	Family Life Education	1-0-1	2	913

DEPARTMENT OF ENGLISH

MASTER OF ARTS IN ENGLISH

Course Structure of MA Programme

SEMESTER I					
TYPE	COURSE CODE	COURSE TITLE	CATEGORY	CREDITS	PAGE
Theory	EGEP0001	Chaucer to Elizabethan Period – Poetry, Drama and Romance	DC	4	916
	EGLS0002	Literary and Social History of England - Chaucer to Elizabethan Period	DC	3	917
	EGSD0029	Shakespearean Drama	DC	4	939
	EGRP0004	Rhetoric and Prosody		2	918
	Elective I One course to be chosen				
	EGTS0005	T.S. Eliot	DE	3	918
	EGTH0006	Thomas Hardy	DE		919
	Elective II One course to be chosen				
	MCML0027	Media Literacy	SE	3	946
	EDLR0007	Leadership and Social Responsibility	DE		880
	SWGS0039	Gender studies	SE		1039
	EGET0007	English Language Teaching	SE		920
Seminar	EGSM6001	Seminar and Presentation I	DC	1	935
Orientation	EGSL0200	Service Learning-Language Communication			934
Total Credits				20	
SEMESTER II					
Theory	EGRR0008	Restoration to Romantic Period – Poetry and Drama	DC	4	920
	EGLC0028	Literary Criticism – Plato to F.R. Leavis and Select Twentieth Century Perspectives	DC	4	933
	EGIL0030	Introduction to Linguistics	DC	4	940
	EGAL0011	Approaches to Language and Literary Research	DC	3	922
	Elective I One course to be chosen				
	EGTR0012	Classics in Translation	DE	3	922
	EGIW0013	Indian Women Writers	DE		923
	Elective II One course to be chosen				
	SWEM0038	Environment studies and Disaster Management	SE		1038
	EDPC0037	Peace Education and Conflict Management	SE		899
	PCSP0006	Introduction to Social Psychology	SE		974
	EGNE0014	North-East Indian Literature in English	DE		924
Seminar	EGSP6002	Seminar and Presentation II	DC	1	935
Theory	EGSL0200	Service Learning-Language Communication			934
SEMESTER III					
Theory	EGVP0015	Victorian to Post-Modern Period – Poetry, Drama & Fiction	DC	4	924
	EGPL0016	Post-Colonial Literature – Poetry, Drama & Fiction	DC	3	925
	EGAL0017	American literature – Poetry, Drama & Fiction	DC	3	926
	EGLT0018	Literary and Critical Theory	DC	4	927
	EGGN0019	Gender and Literature	DC	2	927
	Specialisation Course: Language and Linguistics				
	EGLS0020	Linguistics and Stylistics I	DC	3	928
	Specialization Paper: European Literature				
	EGIM0021	Introduction to Modern European Literature I	DC	3	928
	Specialization Paper: African Literature				
	EGAL0022	Colonial and Post- Colonial African Literature I	DC	3	929
Project	EGPP6003	Project Phase I	DC	3	936
Practical	EGSL0200	Service Learning-Language Communication(Community Engagement)			934

Total Credits				21	
SEMESTER IV					
Theory	EGIW0023	Indian Writing in English – Poetry, Drama & Fiction	DC	4	930
	EGSA0024	South-Asian Literature	DC	4	931
	Specialization Paper: Language and Linguistics				
	EGLS0025	Linguistics and Stylistics II	DC	3	931
	Specialization Paper: European Literature				
	EGEL0026	Introduction to Modern European Literature II	DC	3	932
	Specialization Paper: African Literature				
	EGPC0027	Colonial and Post- Colonial African Literature II	DC	3	933
Project	EGPP6004	Project Phase II- Dissertation	DC	8	937
Practical	EGSL0200	Service Learning-Language Communication(Community Engagement)			934
Total Credits				19	
Total Programme Credits				80	

VALUE ADDED COURSES						
CourseType	**Category**	**Course Code**	**Name of Paper**	**L-T-P**	**Credits**	**PageNo**
Theory & Practical	Value Added	EGES0138	Effective Communication Skills	1-0-1	2	938
		EGML0028	Myths in Literature	2-0-0	2	939

DEPARTMENT OF MASS COMMUNICATION

MASTER OF ARTS IN MASS COMMUNICATION

Course Structure of MA Programme

Type	Category	Course Code	Name	Credits	Page No.
SEMESTER - I					
Theory	DC	MCHD0028	History and Development of Communication Media	3	946
	DC	MCPC0029	Philosophy of Communication	3	947
	DC	MCTC0030	Theoretical Perspectives of Communication	4	948
	DC	MCPJ0031	Principles and Practices of Journalism	4	948
	Elective 1: One Course to Be Opted				
Theory	SE	PCEC0013	Eastern Approaches to Psychology and Counselling	3	974
	SE	EDET0015	Education Technology	3	883
	SE	SWEM0038	Environment and Disaster Management	3	
	Elective 2: One Course to Be Opted				
Theory	DE	MCML0027	Media Literacy	3	946
	SE	EDLR0007	Leadership and Social Responsibility	3	880
	SE	SWGS0039	Gender Studies	3	
	SE	EGET0007	English Language Teaching	3	920
Practicum	DC	MCTP6015	Techniques of Photography and Image Editing	2	964
Practicum	DC	MCJG6016	Journaling	1	964
Theory	Service Learning	MCLS0100	Community Media	2	971
			Total Credits	26	
SEMESTER - II					
Theory	DC	MCID0032	Investigative and Data Driven Journalism	3	949
Theory	DC	MCTS0033	Theories of Development Communication and Social Change	4	950
Theory	DC	MCRM0034	Media and Communication Research Methodology	4	951
Theory	DC	MCDM0035	Digital Media	3	952
	Elective 1: One Course to Be Opted				
Theory	SE	SWDS0044	Introduction to Disability Studies	3	
Theory	SE	PCPD0007	Personality Development		
Theory	DE	MCRC0026	Rural Communication		945
	Elective 2: One Course to Be Opted				
Theory	SE	PCSP0006	Introduction to Social Psychology	3	974
Theory	SE	EDPC0037	Peace Education and Conflict Management		
Theory	SE	SWEM0038	Environment and Disaster Management		
Theory	SE	LSNE0020	North-East Indian Literature in English		
Practicum	DC	MCDI6017	Dissertation Phase - I	2	965
Practicum	DC	MCAV6018	Audio-Video Production	2	965
			Total Credits	21	
SEMESTER- III					
Theory	DC	MCML0037	Media Laws, Ethics and Social Responsibility	3	952
Theory	DC	MCAM0038	Advertising, Marketing and Public Relations	3	953
Practicum	DC	MCDP6019	Dissertation Phase - II	2	966
	Specialization: Electronic Media				
Theory	DC	MCAV0039	Audio-Video Editing	3	954
Theory	DC	MCTV0040	Television and Video Production	4	955
Theory	DC	MCSM0041	Sound for Media	4	956
	Specialization: Print Media				
Theory	DC	MCPC0042	Political Communication	3	956
Theory	DC	MCNR043	News Reporting and Editing	4	957
Theory	DC	MCHE0044	Health and Environmental Communication	4	958
	Specialization: Communication for Development				

Theory	DC	MCPM0045	Programme Management	3	959
Theory	DC	MCSA0046	Situation Analysis for Communication Strategy	4	959
Theory	DC	MCCA0047	Planning Models and Communication Approaches	4	960
			Total Credits	19	
SEMESTER - IV					
Theory	DC	MCMC0048	Media and Cultural Studies	3	961
Practicum	DC	MCIP6020	Internship	5	966
	Specialization: Electronic Media				
Theory	DC	MCFA0049	Film Appreciation	3	962
Project	DC	MCFP6021	Final Project	5	966
	Specialization: Print Media				
Theory	DC	MCBJ0050	Business Journalism	3	963
Project	DC	MCFP6021	Final Project	5	966
	Specialization: Communication for Development				
Theory	DC	MCPM0051	Project Monitoring and Evaluation	3	963
Project	DC	MCFP6021	Final Project	5	966
			Total Credits	16	
			TOTAL PROGRAMME CREDITS	82	

LIST OF VALUE-ADDED COURSES

Course Type	Course Code	Name of Paper	T-L-P	Credits	Page No.
Theory & Practicum	MCCS6122	Communication Skills	1-0-1	2	968
Theory & Practicum	MCCW6123	Creative Writing	1-0-1	2	968
Theory & Practicum	MCEM6124	Event Management	1-0-1	2	969

DEPARTMENT OF PSYCHOLOGY
MASTER OF SCIENCE PSYCHOLOGY (Clinical/Counselling Psychology)
Course Structure

Type of Course	Category	Course Code	Course Title	Credits	Page No.
SEMESTER I					
Type of Course	Category	Course Code	Course Title	Credits	Page No.
Theory	Core Course	PCTP0020	Theories of Personality	4	975
		PCMH0021	Concepts of Mental Health and Illness-I	4	976
		PCRM0022	Research Method and Statistics in Social Sciences	4	977
		PCCP0023	Cognitive Psychology	3	978
	Elective 1: One Course to Be Opted				
	SE	PCEC0013	Eastern Approaches to Psychology and Counselling	3	974
	SE	EDET0015	Education Technology	3	883
	SE	SWEM0038	Environment and Disaster Management	3	
	Elective 2: One Course to Be Opted				
	DE	MCML0027	Media Literacy	3	946
	SE	EDLR0007	Leadership and Social Responsibility	3	880
	SE	SWGS0039	Gender Studies	3	
	SE	EGET0007	English Language Teaching	3	920
	SE	PCGP0024	General Psychology	3	979
Practicum	DC	PCPP6026	Psychological Assessment-I (Practicum-I)	2	996
Practicum	DC	PCPG6018	Personal Growth	P/NP	992
		Total Credits		23	
SEMESTER II					
Theory	DC	PCCM0025	Concepts of Mental Health and Illness-II	4	980
	DC	PCBP0026	Bio- psychology	3	981
	DC	PCPT0027	Psychological Testing	4	982
	Elective 1: One Course to Be Opted				
	SE	PCHT0028	Health Psychology	3	983
	SE	SWDS0044	Introduction to Disability Studies		
	DE	MCRC0026	Rural Communication		945
	Elective 2: One Course to Be Opted				
	SE	PCSP0006	Introduction to Social Psychology	3	974
	SE	EDPC0037	Peace Education and Conflict Management		
	SE	SWEM0038	Environment and Disaster Management		
	SE	LSNE0020	North-East Indian Literature in English		
Practicum		PCPP6027	Psychological Assessment-II (Practicum-II)	2	997
Field Work		PCFW6028	Field Work	2	998
	DC	PCFA6019	Psychological First Aid	P/NP	993
		Total Credits		21	
SEMESTER III (COUNSELLING PSYCHOLOGY SPECIALIZATION)					
Theory	DC	PCFP0029	Foundations of Counseling Psychology	4	983
	DC	PCCY0030	Child and Youth Counseling	3	984
	DC	PCDR0031	Disability Studies and Rehabilitation Psychology	4	985
Practicum	DC	PCRP6020	Research Project Phase-I	4	993

	DC	PCPR6029	Practicum-III (NO TITLE)	2	998
	DC	PCSI6021	Supervised Internship Phase-I	4	993
	DC	PCIP6022	Summer Internship	P/NP	994
	DC	PCST6023	Study Tour	P/NP	995
		Total Credits		21	
SEMESTER IV (COUNSELLING PSYCHOLOGY SPECIALIZATION)					
Theory	DC	PCAT0032	Addiction and Trauma Counselling	3	986
	DC	PCMF0033	Marriage and Family Counselling	4	987
Practicum	DC	PCPR6030	Practicum-IV (NO TITLE)	2	999
	DC	PCSI6024	Supervised Internship Phase-II	8	995
	DC	PCRP6025	Research Project Phase-II	6	996
		Total Credits		23	
SEMESTER III (CLINICAL PSYCHOLOGY SPECIALIZATION)					
Theory	Core Course	PCFC0034	Foundations of Clinical Psychology	4	988
		PCPG0035	Psychodiagnostics	4	989
		PCRP0036	Forensic Psychology	3	989
Practicum		PCRP6020	Research Project Phase-I	4	
		PCPR6029	Practicum-III (NO TITLE)	2	
		PCSI6021	Supervised Internship Phase-I	4	
Practicum		PCIP6022	Summer Internship	P/NP	
		PCST6023	Study Tour	P/NP	
		Total Credits		21	
SEMESTER IV (CLINICAL PSYCHOLOGY SPECIALIZATION)					
Theory	Core Course	PCPC0037	Psychotherapy	4	990
		PCNP0038	Neuropsychology	3	991
Practicum	Practicum	PCPR6030	Practicum-IV (NO TITLE)	2	
		PCSI6024	Supervised Internship Phase-II	8	
		PCRP6025	Research Project Phase-II	6	
		Total Credits		23	
		TOTAL PROGRAMME CREDITS		88	

LIST OF ELECTIVES COURSES – MSc Psychology					
Course Type	Category	Course Code	Name of Paper	L-T-P	Page No
Theory	Elective – I (Semester I)	PCEC0013	Eastern Approaches to Psychology and Counselling	3-0-0	974
Theory	Elective – II (Semester II)	PCSP0006	Introduction to Social Psychology	3-0-0	974

LIST OF VALUE-ADDED COURSES – MSc Psychology				
Course Type	Course Code	Name of Paper	L-T-P	Page No
Theory & Practicum	PCWO6033	Working for Diversity	2-0-0	
Theory & Practicum	PCSO6034	School Psychology	2-0-0	1000
Theory & Practicum	PCCO6035	Community Mental Health	2-0-0	1001
Theory & Practicum	PCLS6036	Life Skills Education	2-0-0	1002

DEPARTMENT OF PUBLIC ADMINISTRATION
MA PUBLIC ADMINISTRATION
(With Specialisations in Human Rights-HR/ International Relations -IR/ Public Policy-PP)

Course Structure

<table>
<tr><th colspan="6">SEMESTER I</th><th></th></tr>
<tr><th>Type of Course</th><th>Category</th><th>Course Code</th><th>Course Title</th><th>Credits</th><th>Page No.</th></tr>
<tr><td rowspan="9">Theory</td><td>DC</td><td>PASE0001</td><td>State and its Elements</td><td>3</td><td>1006</td></tr>
<tr><td>DC</td><td>PAIA0002</td><td>Introduction to the Public Administration</td><td>3</td><td>1006</td></tr>
<tr><td>DC</td><td>PACD0003</td><td>Comparative and Development Administration</td><td>3</td><td>1007</td></tr>
<tr><td>DC</td><td>PAPP0004</td><td>Public Policy</td><td>3</td><td>1008</td></tr>
<tr><td colspan="5">Elective Paper</td></tr>
<tr><td>DE</td><td>PAEP0005</td><td>Engaged Policy and Governance</td><td>3</td><td>1008</td></tr>
<tr><td></td><td></td><td>Elective Group I</td><td></td><td></td></tr>
<tr><td>DE</td><td>PAHR0024</td><td>Introduction to Human Rights (HR)</td><td rowspan="2">3</td><td>1021</td></tr>
<tr><td>DE</td><td>PAIR0025</td><td>Introduction to International Relations (IR)</td><td>1022</td></tr>
<tr><td>Orientation</td><td>Mandatory Course</td><td>PASL0200</td><td>Service Learning</td><td></td><td>1020</td></tr>
<tr><td></td><td></td><td colspan="2">Total Credits</td><td>18</td><td></td></tr>
<tr><th colspan="6">SEMESTER II</th></tr>
<tr><td rowspan="10">Theory</td><td>DC</td><td>PAAP0007</td><td>Administrative Theory and Principles</td><td>3</td><td>1009</td></tr>
<tr><td>DC</td><td>PAIA0008</td><td>Indian Administration</td><td>3</td><td>1010</td></tr>
<tr><td>DC</td><td>PAPP0009</td><td>Public Personnel Administration</td><td>3</td><td>1011</td></tr>
<tr><td>DC</td><td>PARM0010</td><td>Research Methodology</td><td>3</td><td>1012</td></tr>
<tr><td colspan="5">ELECTIVE GROUP I</td></tr>
<tr><td>DE</td><td>PAIC0026</td><td>Issues in Contemporary International Relations (HR/IR)</td><td rowspan="2">3</td><td>1023</td></tr>
<tr><td>DE</td><td>PAPF0027</td><td>Policy Formulation- Structures and processes (PP)</td><td>1024</td></tr>
<tr><td colspan="5">ELECTIVE GROUP II</td></tr>
<tr><td>DE</td><td>PALM0028</td><td>Labour Migration, Citizenship and Governance (HR/IR)</td><td rowspan="2">3</td><td>1024</td></tr>
<tr><td>DE</td><td>PAOB0012</td><td>Organizational Behaviour (PP)</td><td>1012</td></tr>
<tr><td>Value Added Course - I</td><td>Mandatory</td><td>PAEP0021</td><td>Environmental Policy and Administration</td><td></td><td></td></tr>
<tr><td>Theory</td><td>Service Learning</td><td>PASL0200</td><td>Service Learning</td><td></td><td></td></tr>
<tr><td></td><td colspan="3">Total Credits</td><td>18</td><td></td></tr>
<tr><th colspan="6">SEMESTER III</th></tr>
<tr><td rowspan="7">Theory</td><td>DC</td><td>PABF0013</td><td>Budget and Financial Administration in India</td><td>3</td><td>1013</td></tr>
<tr><td>DC</td><td>PASW0014</td><td>Social Welfare Administration</td><td>3</td><td>1014</td></tr>
<tr><td>DC</td><td>PAEG0015</td><td>Environmental Governance</td><td>3</td><td>1014</td></tr>
<tr><td>DC</td><td>PACA0016</td><td>Citizens and Administration</td><td>3</td><td>1015</td></tr>
<tr><td colspan="5">ELECTIVE GROUP I</td></tr>
<tr><td></td><td>PASE0029</td><td>India in South East Asian Politics (HR /IR)</td><td rowspan="2">3</td><td>1025</td></tr>
<tr><td></td><td>PAPP0030</td><td>Public policy in India (PP)</td><td>1026</td></tr>
<tr><td>Project</td><td>DC</td><td>PADP6001</td><td>Dissertation – Phase I</td><td>3</td><td>1017</td></tr>
<tr><td>Value Added Course - II</td><td></td><td>PADV0031</td><td>Data Management and Visualisation</td><td></td><td>1026</td></tr>
<tr><td>Value Added Course -</td><td></td><td>PAIG0023</td><td>Innovation in Governance</td><td></td><td></td></tr>
</table>

III					
Practical	Service Learning	PASL0200	Service Learning-(Community Engagement)		1020
			Total Credits	18	
		SEMESTER IV			
Theory	DC	PADL0017	Decentralization and Local Governance	3	1016
	DC	PAEG0018	E-Governance	3	1017
		ELECTIVE GROUP I			
	DE	PAIO0032	International Organisations and National Interest (HR/IR)	3	1027
	DE	PAPI0033	Policy Implementation (PP)		1027
		ELECTIVE GROUP II			
	DE	PACG0034	China and the Global System (HR/IR)	3	1028
	de	PAPO0035	Policy Analysis (PP)		1029
Project	DC	PADP6005	Dissertation – Phase II	6	1018
Practical	Service Learning	PASL0200	Service Learning-(Community Engagement)		1020
			Total Credits	**18**	
			Total Programme Credits	**72**	

VALUE ADDED COURSES					
Course Type	**Category**	**Course Code**	**Name of Paper**	**Credits**	**Page No.**
Theory & Practical	**Value Added**	PAEP0021	Environmental Policy And Administration	2	1019
		PAIG0023	Innovation In Governance	2	1019
		PADV0031	Data Management and Visualisation	2	1019

DEPARTMENT OF SOCIAL WORK
MASTER OF SOCIAL WORK

Course Structure of MSW Programme

SEMESTER I						
TYPE	**CATEGORY**	**COURSE CODE**	**COURSE TITLE**	**L-T-P**	**CREDITS**	**PAGE**
Theory	Departmental core	SWHI0035	History, Ideologies and fields of Social Work	3-0-0	3	1034
Theory	Departmental core	SWGD0036	Human Growth and Development	2-0-0	2	1035
Theory	Departmental core	SWIS0037	Introduction to Indian Society, Polity and Economics	2-0-0	2	1036
Theory	Departmental core	SWCS0070	Social Work with Communities and Social Action	3-0-0	3	1037
Theory	School Elective	SWEM0038	Environment and Disaster Management	3-0-0	3	1038
Theory	Departmental Elective	SWGS0039	Gender Studies	3-0-0	3	1039
Practicum	Departmental Core	SWFR6008	Concurrent Field Work	0-0-16	6	1076
SEMESTER II						
TYPE	**CATEGORY**	**COURSE CODE**	**COURSE TITLE**	**L-T-P**	**CREDITS**	**PAGE**
Theory	Departmental core	SWPF0040	Social Work Practice with Individuals and Families	3-0-0	3	1040
Theory	Departmental core	SWPG0041	Social Work Practice with Groups	3-0-0	3	1041
Theory	Departmental core	SWRS0042	Social Work Research and Statistics	3-0-0	3	1042
Theory	Departmental core	SWWA0043	Social Welfare Administration	3-0-0	3	1043
Theory	Departmental Elective	SWDS0044	Introduction to Disability Studies	3-0-0	3	1044
Theory	Departmental Elective	SWEM0038	Environment and Disaster Management	3-0-0	3	1038
Practicum	Departmental Core	SWFW6009	Concurrent Field Work II	0-0-16	6	1076
Practicum	Departmental Core	SWSL0200	Participatory Service Learning – Rural Practicum	30-0-50 in 10 days	2	1078
SEMESTER III						
TYPE	**CATEGORY**	**COURSE CODE**	**COURSE TITLE**	**L-T-P**	**CREDITS**	**PAGE**
Theory	Departmental core	SWSJ0045	Social Justice, Human Rights & Para-legal Education	3-0-0	3	1045
Theory	Departmental core	SWES0046	Emerging Social Work Perspectives and Integrated Approach	3-0-0	3	1046
Theory	Departmental core	SWCA0047	Computer Applications for Social Sciences (Lab)	0-0-2	2	1076
Theory	Departmental Elective	SWRT0048	Community Development: Rural, Tribal and Urban	3-0-0	3	1047
Theory	Departmental Elective	SWGC0049	Governance and Community Development	3-0-0	3	1048
Theory	Departmental Elective	SWCS0050	Family Centered Social Work Practice	3-0-0	3	1049
Theory	Departmental Elective	SWPC0051	Social Work Practice with Children	3-0-0	3	1050
Theory	Departmental	SWMS0052	Medical Social Work	3-0-0	3	1051

	Elective					
Theory	Departmental Elective	SWHS0053	Mental Health and Social Work	3-0-0	3	1052
Theory	Departmental Elective	SWOD0054	Organisational Structure, Behaviour and Development	3-0-0	3	1053
Theory	Departmental Elective	SWDO0055	Policies for Development Organisations - Urban, Rural and Tribal Communities	3-0-0	3	1054
Theory	Departmental Elective	SWCP0056	Introduction to Child Psychology and Development	3-0-0	3	1055
Theory	Departmental Elective	SWRC0057	Rights of the Child – Legal Framework, National And International Instruments	3-0-0	3	1056
Project	Departmental Elective	SWRP6020/ - /SWCP6022	Research Project Phase I/ SWAYAM Course 1/ Community Development Project I	2-2-2/3-0-0/2-2-2	3	1078-1079
Internship	Departmental Core	SWFW6010	Continuous Field Work I	0-0-200 In one month	6	1077
SEMESTER IV						
TYPE	**CATEGORY**	**COURSE CODE**	**COURSE TITLE**	**L-T-P**	**CREDITS**	**PAGE**
Theory	Departmental core	SWSP0058	Social Development and Social Policy	3-0-0	3	1057
Theory	Departmental core	SWPM0059	Project cycle Management and Resource Mobilisation	3-0-0	3	1058
Project	Departmental Elective	SWRP6021/ - /SWCP6023	Research Project Phase II / SWAYAM Course 2/ Community Development Project II	2-2-2/3-0-0/2-2-2	3	1078-1079
Theory	Departmental Elective	SWHP0060	Community Health and Population Management	3-0-0	3	1059
Theory	Departmental Elective	SWDC0061	Community Development Practice with Disempowered Communities	3-0-0	3	1060
Theory	Departmental Elective	SWWE0062	Development Concerns and Women Empowerment	3-0-0	3	1061
Theory	Departmental Elective	SWSN0063	Families With Special Needs	3-0-0	3	1062
Theory	Departmental Elective	SWPW0064	Psychiatric Social Work	3-0-0	3	1063
Theory	Departmental Elective	SWCH0065	Community Health and Services	3-0-0	3	1064
Theory	Departmental Elective	SWHR0066	Human Resource Management: Social Work Perspective	3-0-0	3	1065
Theory	Departmental Elective	SWCI0067	Corporate Social Responsibilities - Concepts & Ideologies	3-0-0	3	1066
Theory	Departmental Elective	SWSP0068	Children with Special Needs	3-0-0	3	1067
Theory	Departmental Elective	SWRP0070	Child Rights and Child Protection	3-0-0	3	1068
Internship	Departmental Core	SWCF6012	Continuous Fieldwork II	0-0-200 In one month	6	1077
Internship	Departmental Core	SWIN6013	Internship	0-0-200 In one month	P/NP	1078
VALUE ADDED COURSES						
TYPE	**CATEGORY**	**COURSE CODE**	**COURSE TITLE**	**L-T-P**	**CREDITS**	**PAGE**
Theory &	Value Added	SWRB6014	Results Based Management of	15-0-15	2	1070

Practicum			Projects and programmes			
Theory & Practicum	Value Added	SWAW6015	Academic Writing, Research Proposal Development and Dissertation Writing Course	15-0-15	2	1070
Theory & Practicum	Value Added	SWWD6016	Working with Diversity	15-0-15	2	1071
Theory & Practicum	Value Added	SWLS6017	Life skills for competency development	15-0-15	2	1072
Theory & Practicum	Value Added	SWFT6018	Family Therapy	15-0-15	2	1073
Theory & Practicum	Value Added	SWCD6019	Introduction to Communication for Development (C4D) for Social Work	15-0-15	2	1074

Note: Mandatory Course EDPC0201: Indian Polity and Constitution

SCHOOL OF HUMANITIES AND SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS

VISION
To envision excellence in quality education and moulding intellectually competent persons in economics for creating novelideas through innovative teaching and research contributing to the modern society.

MISSION
- Empower the students with critical understanding of economic theory, analytical treatment and empirical interpretations of economic issues.
- Make the students aware of recent and ongoing developments in the field of economics.
- Enhance the skill and efficiency of the students for better employability in competitive job markets.

Programme Outcomes – MA Economics
PO 1: **Critical Thinking**: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO 2: **Effective Communication**: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

PO 3: **Social Interaction**: Elicit views of others, mediate disagreements and help reach conclusions in group settings.

PO 4: **Effective Citizenship**: Demonstrate empathetic social concern and equity centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO 5: **Ethics**: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

PO 6: **Environment and Sustainability**: Understand the issues of environmental contexts and sustainable development.

PO 7: **Self-directed and Life-long Learning**: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.

Programme Specific Outcomes – MA Economics
PSO 1: **Knowledge of Economic Structure:** Ability to understand theories of basic economic structure and enhanced policy making. It also provides detailed knowledge of Indian Economy especially in post independence period.

PSO 2: **Applications of Mathematical and Econometric Methods:** To acquaint with the basic and applied mathematical and econometric methods to solve real economic problems. This develops skills required for empirical research.

PSO 3: **Growth and Sustainable Development Outlook:** To acquaint with in-depth knowledge of growth and sustainable development policies and strategies.

PSO 4: **Understanding of Trade and Financial Policies:** To equip with the fundamental strategies and principles governing trade and relations across countries.

PSO 5: **Perspective of Sectoral Knowledge:** To equip with the knowledge of sectoral behaviour, sector specific theories and policies.

PSO 6: **Population and Behavioural Studies:** To understand the principles of population and human decision making behaviour guided by cognitive skills.

MAPPING OF COURSES TO POS/PSOS – MA ECONOMICS

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
1.1	H						M	H		M			M
1.2	H		M					H		M		L	
1.3	M	M						M	H				M
1.4	M			M	L					H	M	H	
1.5		M					M			M	H	L	
1.6			M			H		H		H		M	
2.1	M						M		H		M		H
2.2	H						M	M	H				H
2.3		M			M			H		M		L	
2.4	M		M			H	M		H			M	
2.5			H	M				L			M	H	
2.6		M	H						H				M

3.1		H	M		H		H		M	H			L
3.2	L			H		H				H	H	M	
3.3		H	M		M				M				H
3.4	M		H			M		H		M		H	
3.5		M	M		H			M				H	H
3.6			H	M		M				M		H	M
3.7		M				H			M	H		H	
4.1	H	M			M			H		M	H		
4.2			M	M		L	H			H		M	H
4.3		H	M		M				H				M
4.4	H						M		H				M
4.5			M		H	L				M		H	H
4.6	L	M						H		M	H		
4.7				M		M	M		M	H		H	
4.8			H		M			M		H		M	
4.9	H				M		L			M		H	H

DETAILED SYLLABUS – MA ECONOMICS

THEORY COURSES

ENML0046: MICROECONOMIC ANALYSIS (4-0-0)

COURSE OUTCOMES

1. Describe the detail concepts of microeconomics (Remembering)
2. Illustrate the behaviour of economic agents as well as the behaviour of the firms (Understanding)
3. Apply microeconomic concepts and theories to analyse real-life situations (Applying)
4. Illustrate the interactions of Microeconomics with other branches of Economics (Analyzing)
5. Elucidate the effects of economic policies on microeconomic behaviour and thus on the overall economic activities (Evaluating)
6. Develop ideas and critical insights for analysing real-life economic problems (Creating)

Module I: Choice under Risk and Uncertainty (12 hours)
The von-Neumann-Morgenstern Axioms; Expected Utility Theory; Risk Aversion; Certainty Equivalent and Risk Premium; Reducing Risk – Diversification, Insurance, Information; Comparative Risk Aversion; The Demand for Risky Assets; The State Preference Approach to Choice under Uncertainty

Module II: Imperfect Market Structure: Oligopoly (15 hours)
Basic Market Structure; Non-collusive Oligopoly – Cournot, Bertrand, Stackelberg, Paul Sweezy; Collusive Oligopoly – Cartels, Price Leadership, Single Basing-point Price; The Mark-up Rule

Module III: Factor Pricing and Income Distribution (15 hours)
Review of Factor Pricing under Perfectly Competitive Markets; Factor Pricing Under Imperfectly Competitive Markets; Monopolistic and Monopsonistic Powers; Labour Union and Collective Bargaining; Bilateral Monopoly; Elasticity of Factor Substitution; Technological Progress and Factor Share; Pricing of Fixed Factors – Rents and Quasi Rents

Module IV: The Theory of Public Choice (10 hours)
Pareto Optimality; Social Welfare Functions – Bergson & Samuelson, Arrow; Maximisation of Social Welfare; Compensation Criteria; Arrow's Impossibility Theorem; The Theory of Second Best; Social vs. Private Costs and Benefits

Module V: Market Failures (8 hours)
Externalities and Inefficiency; A Simple Bilateral Externalities; Public Goods and Free Riders Problems; Imperfect Markets; Asymmetric Information and Markets for Lemons; Moral Hazard; Adverse Selection; Signaling

Suggested Readings

1. A. Koutsoyinnis, Modern Microeconomics, International Edition, Macmillan Press Ltd
2. Baumol, W.J., Economic Theory and Operations Analysis, 1982.
3. C. Snyder & W. Nicholson, Fundamentals of Microeconomics, Cengage Learning (India), 2010
4. D. Salvator, Principles of Microeconomics, 5th Edition, OUP
5. Hal R. Varian, Intermediate Microeconomics, a Modern Approach, W.W. Norton and Company/Affiliated East-West Press(India), 8th Edition, 2010
6. Karl E. Case & Ray C. Fair, Principles of Economics, Pearson Education Inc., 8th Edition, 2007.
7. N. Gregory Mankiw, Economics: Principles and Applications, India edition by South Western, a part of Cengage Learning,Cengage Learning India Private Limited, 4th Edition, 2007.
8. R. S. Pindyck, D. N. Rubinfeld & P. L. Meheta, Microeconomics, 7th Edition, Pearson, New Delhi

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO1	M				
CO2		H		H	
CO3	H				M
CO4				M	
CO5		H			
CO6			H		H

ENMY0047: MACROECONOMIC ANALYSIS (4-0-0)

COURSE OUTCOMES

1. Describe the detail concepts of macroeconomics and its related terms. (Remembering)
2. Identify the behaviour of macroeconomic variables and their interdependences in a closed as well as in an openeconomy. (Understanding)
3. Apply macroeconomic variables and concepts in examining the real-life situation (Applying)
4. Evaluate the role of macroeconomic variables in smooth functioning of an economy and its dynamics. (Analyzing)
5. Elucidate the effects of macroeconomic changes and policies on overall growth and development of an economy. (Evaluating)
6. Formulate and develop macroeconomic models and tools for analyzing real-life macroeconomic situations. (Creating)

Module I: Consumption and Investment Functions (12 hours)
Theories of Consumption – Absolute Income, Relative Income, Life Cycle, Permanent Income; Theories of Investment – The Present Value Criterion for Investment, Marginal Productivity of Capital, The Marginal Efficiency of Capital and Investment, Financial Theory of Investment; Lags in Investment; Portfolio Disequilibrium and the Transmission Mechanism

Module II: Money Demand, Inflation and Unemployment (15 hours)
Post-Keynesian Theories of Demand for Money – Friedman, Patinkin, Baumol, Tobin; Determinants of Money Supply; Patinkin's Real Balance Effect; Theories of Inflation; Inflation and Unemployment – Phillips Curve Analysis; Trade-off vs. No Trade-off – Tobin, Friedman; The Inflationary Pressure Curve; Adaptive and Rational Expectations; Okun's Law; Keynesianism vs. Monetarism

Module III: New-Classical Macroeconomics (10 hours)
Main Features of New-Classical Model; Rational Expectation – Barrow's View; Rational Expectations and the Real Business Cycles – Kydland, Prescott; Expectations of Future Variables – Sargent, Muth; Macroeconomic Imbalances; Lucas Aggregate Supply Function; The Rational Expectations Hypothesis and its Critique

Module IV: Cyclical Fluctuation (8 hours)
Characteristics of Cyclical Fluctuation; Business Cycle in Market Economies; Short-Term vs. Long-Term Growth Trend; Theories of Business Cycles – Samuelson, Hicks, Kaldor, Schumpeter; Impact of Recession on Trade Imbalances

Module V: Open Economy Macroeconomics (15 hours)
IS-LM Analysis in Open Economy; Mundell-Fleming Model; Marshall-Lerner Condition; Interest-Rate Differentials; Inflation and Unemployment in the Open Economy; Fiscal Policies with Exchange Rate and Inflation; Floating Exchange Rates with Zero and Perfect Capital Mobility; Exchange Rate Expectations; Exchange Rate Overshooting

Suggested Readings

1. Andrew B. Abel & Ben S. Bernanke, Macroeconomics, Pearson Education, Inc., 7th Edition, 2011
2. Dornbusch, Fischer and Startz, Macroeconomics, McGraw Hill, 11th Edition, 2010.
3. Errol D'Souza, Macroeconomics, Pearson Education, 2009.
4. N. Gregory Mankiw, Macroeconomics, Worth Publishers, 7th Edition, 2010.
5. Olivier Blanchard, Macroeconomics, Pearson Education, Inc., 5th Edition, 2009.
6. Paul R. Krugman, Maurice Obstfeld & Marc Melitz, International Economics, Pearson Education Asia, 9th Edition, 2012.
7. Richard T. Froyen, Macroeconomics, Pearson Education Asia, 2nd Edition, 2005.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO1		H			
CO2	M			H	
CO3			H		H
CO4	H				
CO5		H		M	
CO6			H		

ENMM0048: MATHEMATICAL METHODS IN ECONOMICS (4-0-0)

COURSE OUTCOMES

1. Identify the body of basic mathematics that enables economic analysis (Remembering)
2. Explicate the usage of the concepts of mathematics in Economics (Understanding)
3. Apply mathematical techniques to elucidate economic problems (Applying)
4. Assess the role of economic theory and draw inference in context of mathematical techniques (Analysing)
5. Explain the solution concepts for economic problems with a variety of economic applications (Evaluating)

6. Develop or build mathematical models to analyse real economic problems (Creating)

Module I: Optimization with Equality Constraint (12 hours)
Solving Equality Constrained Optimization without Lagrange Multiplier; Lagrange Characterization – Single and Multi- constraint Cases; Complementary Slackness Condition; Sensitivity Analysis; Income Expansion Path

Module II: Optimization with Inequality Constraint and Input-Output Model (13 hours)
Binding and Non-binding Constraints; Solution with One and Two Inequality Constraints; Kuhn-Tucker Method; Mixed Constraints – Solution with Equality and Inequality Constraints; Basic Structure of Input-Output Model; Open and Closed Model; Hawkins-Simon Condition; Static and Dynamic Model

Module III: Difference and Differential Equations (15 hours)
Solution of First Order Difference Equations; Economic Applications; Solution of Second Order Difference Equations – Homogeneous and Non-Homogeneous Equations; Economic Applications of Second Order Homogenous and Non-Homogeneous Equation – Cobweb Market Model, Market Model with Inventory, Determining Dynamic Market Equilibrium Price; Plotting Differential Equation – Phase Diagram

Module IV: Basic Game Theory (20 hours)
Appraisal of Normal Form Games; Games with Perfect Information – Strategic Games, Nash Equilibrium and Existence Properties, Application to Market Equilibrium and Pricing; Extensive Form Games with Perfect Information – Pure Strategy and Nash Equilibrium, Sub-game Perfect Equilibrium, Backward Induction, Bargaining Game (Split-the-Pie); Extensive Form Games with Imperfect Information – Principles for the Equivalence of Extensive Games, Mixed and Behavioural Strategies, Nash Equilibrium; Repeated Games – Finitely Repeated Games and Backward Induction, Infinitely Repeated Games; Dependent Strategies

Suggested Readings
1. Allen, R.G.D., Mathematical Analysis for Economists, Macmillan and Co Ltd.
2. Chiang A.C. & K. Wainwright, Fundamental Methods of Mathematical Economics, McGraw Hill International Edition
3. Hoy, L., Mckenna, Rees & Stengos, Mathematics for Economics, Prentice Hall, 2004.
4. J. M. Henderson and R. E. Quandt, Micro-economic Theory – A Mathematical Treatment
5. K. Sydsaeter & P. Hammond, Mathematics for Economic Analysis, Pearson Educational Asia: Delhi, 2002.
6. T. Yamane, Mathematics for Economist: An Elementary Survey, 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	M			
CO2	M			
CO3				H
CO4	H			M
CO5			H	
CO6		M	H	

ENEO0049: ECONOMICS OF DEVELOPMENT (4-0-0)

COURSE OUTCOMES
1. Define the key aspects of economic development. (Remembering)
2. Explain the role of various measurement of economic development. (Understanding)
3. Identify the various theories and approaches to economic development. (Applying)
4. Analyse the uses of various development theories of growth. (Analyzing)
5. Explain the importance of development theories. (Evaluating)
6. Discuss the various key aspects of dualistic development theories and its applicability. (Creating)

Module I: Measurement of Economic Development (10 Hours)
Measurement of economic development – National Income/GDP and Per Capita Income as an Index of Development; Alternative Measures of Development Gap: HDI, GDI and related indices; Structural Changes in the Development Process – Kuznets

Module II: Theories and Approaches to Economic Development (17 Hours)
Evolution in the Concept of Economic Development – Growth to Sustainable Development; Approaches to Development – Income Approach and Criticism; Sen's Capability Approach; Establishment Space in Economic Development; Theories of Economic Development – Karl Marx and Development of Capitalist Economy; Theory of Social Change; Surplus Value and Profit

Module III: Theories of Growth (15 Hours)
Summary of Classical Growth Models – Structural Model and Limitations; A Brief Review of Neo-classical Growth Models – Production Function in Neo-classical Growth; Instability of Growth; Solutions of Instability Problem; The Convergence Debate; Endogenous Growth Models – Arrow, Uzawa-Locus, Romer; The New Economic Geography – Krugman

Module IV: Development Strategies and Dualistic Pattern of Development (18 Hours)
Big Push – Rosenstein-Rodan; Balanced Growth – Nurkse; Unbalanced Growth – Hirschman; Critical Minimum Efforts – Leibenstein; Structural Change Models - Lewis, Fei-Renis; Rural-Urban Migration– The Harris-Todaro Model; Core- Periphery Models; The Process of Cumulative Causation – Myrdal; Neo-Colonial Dependence Model

Suggested Readings

1. Barro & Salai-Martin, Economic Growth, Prentice Hall of India.
2. Basu, K., Analytical Development Economics: Oxford Economic Papers.
3. Meier, G.M., Leading Issues in Economic Development, Oxford Economic Papers.
4. Roy, D., Development Economics, Oxford Economic Papers.
5. Thirlwal, A. P., Growth and Development, Palgrave.
6. Todaro, M.P., Development Economics, Pearson.
7. UNDP, Human Development Reports, Oxford Economic Papers.
8. World Bank, World Development Reports, Oxford Economic Papers.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1		M		
CO2	M	H		
CO3				H
CO4			H	
CO5				H
CO6			H	

ENMB0050: MONEY AND BANKING (3-0-0)

COURSE OUTCOMES
1. Learn basic ideas of monetary theory and the effects of monetary variables on the macroeconomic system.(Remembering)
2. Understand the working of non-banking financial institution and international financial institutions. (Understanding)
3. Develop the ability to understand the role of monetary forces and real forces and their interconnection in shaping and influencing the monetary and related policies both at the national and international levels. (Applying)
4. Understand the working of Indian baking system and the inter connectivity of the banks. (Analyzing)
5. Enable to evaluate the trend of financial reform in the field of financial inclusion. (Evaluating)
6. Understand the various determinant of demand and supply of money and its role in balancing the growth of theeconomy. (Creating)

Module I: Supply and Demand for Money (11 hours)
Money Supply – Theoretical and Empirical Attempts to Define Money; Components of Money Supply; Money Creation by the Banking System; High Powered Money and Money Multiplier; Measures of Money Supply and Liquidity in India; Balance Sheet of Central Bank; Demand for Money; Interest Sensitivity of Demand for Money – A Review of Classical, Keynesian and Monetarist Theories of Demand for Money

Module –II: Theories in Rate of Interest (12)
Term Structure of Interest Rates; Expectations Theory; Liquidity Premium Theory; Structure of Interest Rates in India; Monetary Policy – Targets, Goals and the Trade Offs among Alternate Goals; Lags in Operation; Keynesian and Monetarist Views on Transmission Mechanism; Rules vs. Discretion

Module-III: Banking Structure in India (11 hours)
Central Banking – Main Functions; Policy Tools, Recent Monetary Policy of RBI; Money Aggregates Targeting; Interest Targeting and Inflation Targeting Approaches of RBI; Autonomy of RBI; Commercial Banking – Types of Commercial Banks in India; Credit Creation Process; Major Developments in Commercial Banking in India since Reforms (including Mergers); Recent Developments on Financial Inclusion; Performance of Private and Public Banks

Module –IV: Non-Banking Financial Institutions (11 hours)
Role, Growth and Structure of Non-Banking Financial Institutions (NBFIs) in India; Types and Control of Non-Banking Financial

Companies (NBFCs); International Monetary System: IMF as provider of International Liquidity; Constituents of International Money and Capital Markets

Suggested Readings

1. Bhole, L.M., Financial Institutions and Markets. Tata Mcgraw Hill. 2016.
2. Bofinger, P., Monetary Policy: Goals, Institutions, Strategy and Instruments. Oxford University Press, 2001.
3. Dennis Geoggrey, E.J., Monetary Economics, Longman, 1981.
4. Desai, V., The Indian Financial System and development, Himalaya Publishing House, 2019.
5. Diulio, A. E., Theory and Problems of Money and Banking, International Edition (Schaum's Outline Series), 1987.
6. Fabozzi, F. J. & Franco, Capital Markets Institutions and Instruments, (4th ed.), New Jersey: Prentice Hall, Modigliani, 2009.
7. Gordon, E. & Natarajan, K., Financial Markets & Services, Himalaya Publishing House, 2019.
8. Handa. J., Monetary Economics, 2nd Edition, Routledge, London, 2009.
9. Howells, P. & Bain, K., The Economics of Money, Banking and Finance, Prentice Hall, Pearson Education Ltd., 2002.
10. Khan, M.Y., Indian Financial System, Tata Mcgraw Hill, 2017.
11. Kulkarni, G., Modern Monetary Theory, New Delhi: Macmillan, 1999.
12. Mankiw, N.G., Macro-economics. New York: Macmillan, Worth Publishers, 2008.
13. Mohan, R., Monetary Policy in a Globalized Economy – A Practitioner's View, Oxford University Press concerned, 2009.
14. Walsh, Carl E., Monetary Theory and Policy, Third Edition, The MIT Press Cambridge Massachusetts, 2010.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H			
CO2			M	
CO3		H		
CO4			H	
CO5		M		H
CO6				H

ENIP0051: INDIAN ECONOMIC DEVELOPMENT (3-0-0)

COURSE OUTCOMES

1. Learn the key issues related to the Indian economy. (Remembering)
2. Understand the economic reforms and its impact on Indian economy. (Understanding)
3. Identify the policies and performance in different sector (Applying)
4. Evaluate the impact of various development policies in Agriculture and Industry in the Indian Scenario. (Analyzing)
5. Explain the economic reform and its impact in Indian economy. (Evaluating)
6. Discuss their understanding of the usefulness of various development policies. (Creating)

Module I: Indian Economic Development: An Overview (10 hours)

Growth and Structure of the Indian Economy – Planned Economic Development, Development Strategy after Independence; Economic Growth, Distribution and Structural Change since Independence; Critical Evaluation of Trendand Issues in Demography – Education, Health, Poverty, Inequality, Unemployment

Module II: Economic Reforms (12 hours)

Economic Reforms Since 1991 – Liberalization, Privatization, Globalization; Major Developments in Post EconomicReforms Period; Critical Evaluation of the Changing Structure of the Indian Economy – Pre and Post-reform Eras

Module III: Sectoral Development (13 hours)

Issues and Concern in Indian Agriculture – Land Reform, Green Revolution, Agricultural Price Policy; Agriculture and WTO; Industrial Development in India – Industrial Growth since 1991, New Industrial Policy and its Impact; Trends in Exports and Imports – Foreign Trade Policy; Assessment of Performance of Service Sector in India in the Contemporary Period

Module IV: Macroeconomic Policies and their Impact in Indian Economy (10 hours)

Financial Sector Reform and Impact of Monetary Policy; Reforms in Banking Sector; Capital Market and its Reform; Reforms in fiscal Policy – Fiscal Responsibility and Budget Management (FRBM) Act; Reform in Indian Labour Market inPost-liberalization Period

Suggested Readings

1. Kapila, U., Economic development and policy in India, Academic Foundation, 2009.

2. Rakesh Mohan, India's Financial Sector and Monetary Policy Reforms, in Shankar Acharya and Rakesh Mohan, Editors,
3. India's Economy: Performances and Challenges: Development and Participation, Oxford University Press, 2010.
4. Pulapre Balakrishnan, The Recovery of India: Economic Growth in the Nehru Era, Economic and Political Weekly, November, 2007.
5. Pulapre Balakrishnan, Ramesh Golait & Pankaj Kumar, Agricultural Growth in India Since 1991, RBI DEAP Study No. 27,2008.
6. Rakesh Mohan, India's Financial Sector and Monetary Policy Reforms, in Shankar Acharya and Rakesh Mohan, editors,
7. India's Economy: Performances and Challenges: Development and Participation, Oxford University Press, 2010.
8. A. Ahsan, C. Pages & T. Roy, Legislation, Enforcement and Adjudication in Indian Labour Markets: Origins, Consequences and the Way Forward, in D. Mazumdar and S. Sarkar, Editors, Globalization, Labour Markets and Inequality in India, Routledge, 2008.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H			
CO2		H		
CO3			H	
CO4				H
CO5			H	
CO6				L

ENSM0052: STATISTICAL METHODS IN ECONOMICS (4-0-0)

COURSE OUTCOMES

1. Explain in detail the measures and approaches of various statistical tools and techniques (Remembering)
2. Express the notion of pre-specified ideas about statistical parameters and methods for hypothesis testing.(Understanding)
3. Explicate the idea statistical estimation and analytical techniques (Applying)
4. Gain computational skills to put into practice various statistical inferential approaches (Analysing)
5. Evaluate the underlying assumptions of various analysis tools and techniques (Evaluating)
6. Analyze the results and suggest recommendations to the decision making processes (Creating)

Module I: Distribution Theory (15 hours)

Review of Distribution Theory – Discrete and Continuous Distribution; Truncated Distribution – Poisson Only; Compound Distribution – Binomial, Poisson; Random Vectors; Joint Distributions; Variance-covariance Matrix; Transformations of Bivariate Random Variables; Bivariate Normal Distributions

Module II: Probability Theory (15 hours)

Review of Axiomatic Approach to Probability and Baye's Theorem; Expectations of Functions of Random Variables; Moment Generating Functions; Conditional Expectation and Distribution; Conditional Variance; Applications; Characteristic Function of a Random Variable

Module III: Sampling Techniques (15 hours)

A Brief Review of Random Sampling and Estimates of a Population Mean; Ratio Method Estimation – Concept, Bias; Ratio Estimators in Simple Random Sampling and Stratified Random Sampling; Regression Method of Estimation – Concept, Bias; Regression Estimators in Simple Random Sampling and Stratified Random Sampling; Cluster Sampling – Estimation with Equal and Unequal Clusters; Sub Sampling (Two-Stage only)

Module IV: Statistical Inference (15 hours)

Methods of Constructing Estimators; Theory of Hypothesis Testing – Test Function, Randomized and Non-randomized Tests; Interval Estimation – Confidence Intervals; Relationship with Tests of Hypotheses; Inference on Population Mean – Comparing two Population Means; Inference on Variance – Comparing two Population Variance; Likelihood Ratio Tests and their Properties; Large Sample Theory – Delta Method; Derivation of Large Sample Standard Error

Suggested Readings

1. Johnson N. L. & Kotz. S., Distributions in Statistics Vol-I, II and III, John Wiley and Sons, New York, 1996
2. Rohatgi, V. K., Introduction to Probability Theory and Mathematical Statistics
3. Larsen, R., Marx, M. An introduction to mathematical statistics and its applications, Prentice Hall, 2011.
4. Miller, I., & Miller, M., J. Freund's mathematical statistics with applications, 8th ed, Pearson, 2017

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H	M		
CO2	M		H	
CO3		M		H
CO4			H	
CO5			M	
CO6				H

ENEM0053: ECONOMETRIC METHODS (4-0-0)

COURSE OUTCOMES

1. Define the basic concepts of econometrics and statistics. (Remembering)
2. Explain the concepts of simple linear regression and its associated topics. (Understanding)
3. Apply the regression models estimating regression parameters using OLS. (Applying)
4. Analyse the results of regression models with hypothesis testing and different statistical tests. (Analysing)
5. Evaluate the regression models along with diagnostics and model specification. (Evaluating)
6. Create and design hypothesis of economic problems and advance regression models with qualitative variables.(Creating)

Module I: Linear Regression and Diagnostic Analysis (18 hours)

Overview of the Classical Linear Regression Models - Simple and Multiple; Methods of Estimation-Methods of Moments, Method of Least Squares, Maximum Likelihood Method; Properties of Estimator; Goodness of Fit - R Square and Adjusted R Square; Hypothesis Testing for Regression Coefficients; Analysis of Variance (ANOVA); Problems with Linear Regression - Specification Bias, Autocorrelation, Heteroscedasticity, Multicollinearity; Outliers – Leverage and Influence; Tests for Outliers; Test for Linearity; Tests of Omitted Variables

Module II: Advanced Models in Regression (12 hours)

Use of Instrumental and Dummy Variables; Models with Qualitative Dependent Variables – Probit, Logit and Tobit Probability Models; Simultaneous Equation Models – Nature and Problems; Simultaneity Bias; Structural, Reduced-form and Recursive Models; Identification Problem – Rank and Order Conditions; Identification and Multicollinearity; Over Identified Linear Model – Generalised Method of Moments

Module III: Estimation of Simultaneous Equation Models (10 hours)

Indirect Least Squares (ILS); Method of Instrumental Variables (IV); Two Stage Least Squares (2SLS); Limited-Information Maximum Likelihood Method; Exogeneity and Causality – Weak and Strong Exogeneity, Tests for Exogeneity, Granger Causality

Module IV: Dynamic Econometric Models (10 hours)

Lagged Variables – Meaning and Importance; Distributed Lag Models – Koyck and Almon Approaches; Autoregressive Models – Partial Adjustment Model and Adaptive Expectation Models

Module V: Basics of Time Series Analysis (10 hours)

Stationary and Nonstationary Time Series; Box-Jenkins Approach; Unit Roots Tests – Null and Alternative Hypotheses under Unit Root Tests; Cointegration and Cointegrating Regression

Suggested Readings

1. Dougherty, C., Introduction to Econometrics, 4th ed., Oxford University Press, 2011.
2. Gujarati, D., & Porter, D., Essentials of Econometrics, 4th ed., McGraw-Hill, 2010.
3. Kmenta, J., Elements of Econometrics, Khosla Publishing House, 2008.
4. Maddala, G., & Lahiri, K., Introduction to Econometrics, 4th ed., Wiley, 2009.
5. Maddala, G.S., Introduction to Econometrics, 3rd Ed, Wiley India, 2009.
6. Madnani, G.M.K., Introduction to Econometrics: Principles and Applications, CBS Publishers & Distributors, 2009.
7. Wooldridge, J., Introduction to Econometrics: A Modern Approach, 5th ed., Cengage Learning, 2014.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	M				M
CO 2				H	
CO 3	H			M	
CO 4		H	M		H
CO 5	H		H		
CO 6		H			

ENPS0054: PUBLIC ECONOMICS (4-0-0)

COURSE OUTCOMES

1. Define the main concepts in public economic policies. (Remembering)
2. Explain the concepts of public goods, public expenditures and taxation. (Understanding)
3. Identify the main issues of budgeting and fiscal policies. (Applying)
4. Evaluate economic concepts of income redistribution. (Analyzing)
5. Explain the evaluation of public investment projects and decision making in the public sector. (Evaluating)
6. Discuss their understanding of the usefulness and problems related to government subsidies and income support (Creating)

Module I: Government Activity and Public Economic Policies (15 hours)

Efficiency, Markets and Governments – Markets, Prices, Efficiency Conditions; Market failure – A Preview of the Basis for Government Activity and the Functions of the Government; Equity vs. Efficiency – Positive and Normative Analysis; Externalities and Government Policy – Market Failures, Externalities and Efficiency; Public Choice Theory – Meaning, Outcomes of Collective Choice; The Choice Process – Unanimity, Majority Rule, Cyclical Voting and the Voting Paradox, Arrow's Theorem

Module II: Theories of Public Goods, Public Expenditures and Taxation (15 hours)

The Theory of Public Goods; Provision of Private Goods and Public Goods – Markets and Government; The Demand for a Pure Public Good; Efficient Output of a Pure Public Good – Partial and General Equilibrium Analysis; Individual Action; Voluntary Cooperation and Efficiency; Local Public Goods; Voting Models of Public Goods; The Theory of Public Expenditure –Tiebout, Samuelson, Buchanan; Theories of Taxation; Tax Neutrality; Direct vs. Indirect Taxes and Equity; Buoyancy and Elasticity Estimates of Taxation; Tax Efforts; The impact of Taxes on Market Prices and Efficiency

Module III: Budgeting, Fiscal Policies and Income Redistribution (15 hours)

Program Budgeting – It's Application; Zero-Based Budgeting; Budgeting Policies; Theory of Fiscal Policy; Fiscal Policy with Special Reference to Under-developed Countries; Federal-Fiscal Relation in India; Income Redistribution – Taxes, Government Expenditures and the Distribution of Income, Welfare, Social Security and the Social Safety Net; Demographic Changes and the Future of Social Security; The Impact of Social Security on Savings and Work Incentives; Government Subsidies and Income Support – The Basis and Trade-off

Module IV: Public Investment Projects and the Public Sector (15 hours)

Public Utilities and Project Evaluation – Cost-Benefit Analysis; Distributional and Political Considerations; Problem of Government Failure – Privatization, Devolution, Rules vs. Discretion; Citizen Decision Making; Public and Private Sectors – Lack of Residual Claimant, Citizens and Rational Ignorance, Collective vs. Individual Consumption, Lack of Revealed Preference; Measuring and Valuing Public/Private Output

Suggested Readings

1. Buiter, W.H., Principles of Budget and Fiscal Policy, MIT Press, 1990.
2. Browning E K & Browning J M, Public Finance and the Price System, Pearson Education, Singapore.
3. Hyman D N, Public Finance: A Contemporary application of Theory to Policy,Thomson South Western
4. Jha, Raghbendra, Modern Theory of Public Finance, Wiley Eastern, Delhi, 1987.
5. Ulbrich, H., Public Finance in Theory and Practice, Thompson South Western.
6. Mukherjee, S., Ghose, A. & Nag, N. N., Analytical Public Finance. Public Economics – Public Choice - Public Policies, NewCentral Book Agency (P), Kolkata
7. Musgrave, Richard A., The Theory of Public Finance, Tata McGraw Hill, N.Y., 1959.
8. Ghosh A & Ghosh C, Public Finance, PHI Learning Private Limited, Delhi.
9. Musgrave & Musgrave., Public Finance in Theory and Practice, McGraw Hill, Singapore.
10. Cullis, John & Jones, Philip, Public Finance and Public Choice, McGraw Hill.
11. Ursula, H., Public Finance, James Nisbet and Co., London, 1968.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	M			
CO2		H	H	
CO3		M		M
CO4			H	
CO5			M	
CO6				H

ENDV0055: INDIAN ECONOMIC DEVELOPMENT AND POLICY (4-0-0)

COURSE OUTCOMES

1. Understand the recent economic reforms in Indian economy since 1991. (Remembering)
2. Explain the sector wise reform ranging from agriculture to service sector and foreign trade as well. (Understanding)
3. Identify the main issues of reform and policy debate and its performance in Indian Economy. (Applying)
4. Evaluate the impact of various development policies in Agriculture and Industry in the Indian Scenario. (Analyzing)
5. Explain the trends and performance in service sectors. (Evaluating)
6. Discuss their understanding of the usefulness of various development policies. (Creating)

Module I: Economic Reforms Since 1991 (14 hours)
Indian Economy During Reforms – An Assessment; Main Aspects of New Economic Policy and its Relevance; Recent Issuesof Indian Economy – National Institution for Transforming India (NITI Aayog), Demonetization, Goods and Service Tax (GST), The Insolvency and Bankruptcy Code (IBC), Digital India, Make in India

Module II: Sectoral Development and Recent Reforms (18 hours)
Issues and Concern in Indian Agriculture – Agriculture Price Policy, Farm Law, Indian Agricultural Industry Reform; Industrial reform – MSME Development, Impact of Financial Reforms on Industrial Sector; Foreign Trade – Current Position of Balance of Payments of India, Export-Import Policy (EXIM); Foreign Direct Investment (FDI); Service Sector –Reasons for Rapid Service Sector Growth, Information and Communications Technology (ICT), India's Information Technology (IT) and ITES Industry

Module III: Major Issues of Indian Economy (15 hours)
Poverty, Inequality and Inclusive Growth – A Critical Assessment; Employment and Unemployment – Policy Implications;Rural Development – Role of Cooperatives, Agriculture Diversification, Organic Farming; Sustainable Economic Development; Privatization and Disinvestment Debate; Regional Imbalances

Module IV: Performance of Indian Economy (13 hours)
Indicators of Development – Physical Quality of Life Index (PQLI), Human Development Index (HDI), Gender DevelopmentIndices (GDI); Inequality-Adjusted Human Development Index Indicators of India's Economic Performance – Fiscal and Financial Sector Reforms and Recent Changes in the Policy; Recent Changes in Monetary Policy in India and its Impact; Centre State Finance Relations; Finance Commission in India

Suggested Readings

1. Dutt Rudder & K.P.M Sunderam, Indian Economy. S Chand & Co. Ltd. New Delhi, 2017.
2. Mishra S.K & V.K Puri, Indian Economy and – Its Development Experience. Himalaya Publishing House, 2017.
3. Kaushik Basu, The Oxford Companion to Economics of India, Oxford University Press, 2007.
4. Kapila U, Indian economy since independence, Academic foundation, New Delhi
5. Government of India, Economic Survey (Annual), Economic Division, Ministry of Finance, New Delhi.
6. Ahluwalia, I.J. & I.M.D. Little (Eds.), India's Economic Reforms and Development (Essays in honour of Manmohan Singh),
7. Oxford University Press, New Delhi, 1999.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H			
CO2		M		
CO3	M		H	
CO4				H
CO5		H	H	
CO6				M

ENPB0056: PUBLIC FINANCE (3-0-0)

COURSE OUTCOMES

1. Know about Indian tax system and its type and reforms over the years (Remembering)
2. Discuss the various types of grants available and the mechanism of availing those grants (understanding)
3. Develops analytical framework that facilitates the evaluation of public policy and subsequently inform the publicdebate. (Applying)
4. Evaluate the process of budget allocation and discuss the trend of government expenditure (Analyzing)
5. Examining the working of various international financial institution in the context of globalization (Evaluating)
6. Develop administrative skill with the knowledge of government fiscal policy (creating)

Module I: Taxation and Budget: (13 hours)
Indian Tax System; Revenue of the Union; Major Taxes in India; Base of Taxes; Direct and Indirect Taxes; Reforms in Direct and Indirect Taxes; Taxes on Goods and Services – GST; Analysis of Central and State Government Budgets; Kinds of Budget; Different Concepts of Budget Deficits; Lack of Flexibility in Central and State Budgets; Shrinking Size of Development Finance Through Budgets; Trends in Public Expenditure; Non Plan Expenditure; Growth of Subsidies Public Debt; Trends in Internal and External Debt; Crowding out of Private Investment and Activity; Devolution of Resources and Grants; Reports of Finance Commissions in India; Transfer of Resources from Centre and State to Local Bodies; PanchayatiRaj Finances

Module II: Government expenditure and Theories of Public Expenditure (11 hours)
Public Policy and Expenditure Allocation of Resources; Provision of Public Goods; Voluntary Exchange Models; Demand Revealing Schemes for Public Goods; Contributions of Clarks; Groves and Leyard; Tiebout Model; Stabilization Policy; Keynesian Case for Stabilization Policy; Wagner's Law of Increasing State Activities; Wiseman-Peacock Hypothesis; Pure Theory of Public Expenditure; Structure and Growth of Public Expenditure; Criteria for Public Investment; Social Cost- benefit Analysis

Module III: Deficit Financing: Concept and its Relation with Inflation (10 hours)
Deficit Financing in India; Issues Relating to Public Debt; Debt Burden Analysis and Management of Public Debt; Domar's concept of Debt Sustainability; Public Debt in India; Need for Rule Based Fiscal Consolidation; Fiscal Responsibility and Budget Management (FRBM) Act 2003; Recent Amendments to FRBM Act

Module IV: Intergovernmental Grants in Theory and Practice (11 hours)
Growth and Decline of Federal Grants; Purposes of Grants; Correcting Spatial Externalities; Redirecting Priorities; Types of Grants – General Purpose vs. Categorical, and Project grant. Lump-sum or Matching, Open-ended vs. Close-ended, Matching Grants; Various Classification; Efficiency and Equity Effects of Grants; Indifference Analysis of Grants;

Suggested Readings

1. Aronson, J.R., Public finance, New York: McGraw-Hill International, 1985.
2. Atkinson, A.B., & Stiglitz, J.E., Lectures on public economics. New Jersey: Princeton University Press, 2007.
3. Basu, K., & Maertens, A., The new Oxford companion to economics in India, New York: Oxford University Press, 2012.
4. Bhatia, H. L., Public Finance, Vikas Publishing House Private Ltd., 2006.
5. Brown, C.V., & Jackson, P. M., Public Sector Economics, United Kingdom: Wiley-Blackwell, 1990.
6. Buchanan, J. M., & Musgrave, R. A., Public Finance and Public Choice: Two contrasting visions of the state, Cambridge,Massachusetts: MIT Press, 1990.
7. Cullis, J., Jones, P., & Jones, P.R., Public Finance and Public Choice: Analytical perspectives, New York: Oxford University Press, 2009.
8. Musgrave, R.A., & Musgrave, P.B., Public Finance in Theory and Practice, New York: McGraw Hill Book Company, 1989.
9. Rao, M.G., & Sen, T. K., Fiscal Federalism in India: Theory and Practice, Macmillan India, 1996.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1		M		
CO2	H			
CO3		H		
CO4			H	
CO5	H			M
CO6				H

ENRM0057: RESEARCH METHODOLOGY IN ECONOMICS (4-0-0)

COURSE OUTCOMES
1. Describe the different types of research and the needs of research in Economics (Remembering)
2 Identify the essential conditions helpful for the formulation of research hypothesis (Understanding)
3. Evaluate the various tools and techniques of sampling to collect data (Applying)
4. Gain knowledge of statistical software for analysing data (Analysing)
5 Assess the relative importance of various analytical tools and techniques (Evaluating)
6. Formulate logical arguments for a research problem (Creating)

Module I: Basics of Research (10 hours)
Meaning, Types, Characteristics and Scope of a Scientific Research; Steps Involved in Scientific Research; Literature Review and Identification of a Research Gap; Formulation and Types of Hypothesis and/or Research Questions; Objectives; Research Design; Reference and Documentation; Limitations and Ethical Issues in Research

Module II: Sample Design and Data Processing (12 hours)
Nature and Sources of Data; Types of Data – Cross Sectional, Time Series, Pooled; Accuracy of Data; Types of Sampling, Determination of Sample Size, Sampling Procedure; Choice of Sampling Technique; Errors in Sampling; Processing of Data; Validation of Field Work; Editing and Coding; Classification and Presentation

Module III: Data Analysis (15 hours)
Qualitative and Quantitative Analysis; Univariate and Multivariate Analysis; Descriptive and Inferential Analysis; Testing of Hypotheses – Single and Multiple Comparison; Non-Parametric Tests; Test for Randomness; Advanced Data Analysis Techniques; Multidimensional Scaling

Module IV: Report Writing and Interpretation of Results (10 hours)
Types of Report; Importance of Report; Steps in Report Writing; Citation Styles; Footnotes and Bibliography; Presentation and Interpretation of Results; Research Findings and Suggested Recommendations

Module V: Statistical Software for Data Analysis (13 hours)
Basics of Computer and its use in Research; Introduction to Different Software (Excel, SPSS, STATA, EVIEWS, etc.); Entering Data in Software; Defining and Recoding Variables; Computing new Variables; Data Analysis with Statistical Software (Use Practical Examples)

Suggested Readings
1. Krishnaswamy, O.R., Research Methodology in Social Science, Himalaya Publishing House, Bombay, 2002.
2. Jerry W. Willis, Foundations of Qualitative Research: Interpretive and Critical Approaches, Sage
3. Tandon, B.C., Research Methodology in Social Sciences
4. Subramanian, N., Introduction to Computers
5. Bruce, B. & Howard, L., Qualitative Research Methods for the social sciences, London: Pearson, 2014.
6. Flick, U., An Introduction to Qualitative Research, Sage Publications, 2014.
7. Bryman Alan, Social Research Methods, Oxford University Press, Oxford

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO1	H				
CO2		M		H	
CO3	H				H
CO4			M		
CO5		H		M	
CO6			H		H

ENES0058: ENVIRONMENTAL ECONOMICS AND SUSTAINABILITY (4-0-0)

COURSE OUTCOMES
1. Define the basic concepts of environmental economics, including its key principles and methods. (Remembering)
2. Understand the environmental issues in relation to the theory of externalities, public goods, and welfare. (Understanding)
3. Apply environmental principles concerning the choice of instruments for controlling pollution and the relative strength and weaknesses of environmental policies based on command-and-control and market-based instruments.(Applying)
4. Analyze environmental problems using various economic techniques and to assess various environmental policies and issues. (Analysing)
5. Evaluate and examine the methods developed for valuing environmental goods and services for sustainabledevelopment. (Evaluating)
6. Develop and design various approaches to examine issues in the contemporary environmental discourse from and economists' point of view. (Creating)

Module I: Economics of Resources (12 hours)
Economics of Natural Resources; Resources and its Management; Optimal use of Renewable Resources; Common Property Resources and Open Access; Tragedy of Commons; Non-renewable Resources – Economic Issues Relating to use of Non-renewable Resources; Optimal Depletion; Backstop; Exploration and Technological Progress

Module II: Environmental Issues and Regulation (13 hours)
Problems of Market Failure - Public Bads and Externalities; Environment Degradation as Market Failure; Externality – Environmental Damage as Negative Externality; Social Choice of Optimum Pollution; Pigouvian Tax; Coase Theorem; Property Rights; Pollution – Environmental Pollution as a Public Bad; Optimal Pollution; Pollution Control – Market Based Instruments, Emission Fees, Tradable Pollution Permits, Hybrid Instruments, Double Dividend Hypothesis; Environmental Policies in India

Module III: Valuation of Environmental Goods (15 hours)
Ordinary Goods vs. Environmental Goods; Use and Non-use Values; Willingness to Pay and Willingness to Accept; Valuation Methods for Environmental Goods; Direct Methods or Stated Preference Methods – Contingent Valuation;Indirect or Revealed Preference Methods – Hedonic Pricing Method, Travel Cost Method

Module IV: Global Environmental Concerns and Sustainable Development (20 hours)
Climate Change, Loss of Biodiversity, Ozone Depletion, Pollution Havens; Sustainable Development – Concept, Notions and Different Approaches to Sustainability; Measurement of Sustainability; Sustainable Accounting – United Nations' System of Environmental and Economy Accounting; Brundtland Commission; Sustainable Industrialization; EnvironmentalImpact Assessment; Meaning of Resource Conversation; Material Substitution; Recycling – Optimum Recycling; Waste Management; Micro Planning for Eco-preservation – Watershed and Joint Forest Management, Wildlife Management; Role of International Organizations – IPCC, UNEP, Earth System Governance Project

Suggested Readings

1. Bhattacharya, Rabindra N., Environmental Economics: An Indian Perspective, New Delhi: Oxford University Press, 2002.
2. Hanley, N., J.F. Shogren & B. White, Environmental Economics in Theory and Practice, Macmillan, 1997.
3. Kolstad, Charles D., Environmental Economics, Oxford University Press, New Delhi, 1999.
4. Lewis, Lynne, & T. H. Tietenberg, Environmental Economics and Policy, Routledge, 2020.
5. Pearce, DW & R. Turner, Economics of Natural Resource Use and Environment, John Hopkins Press, Baltimore, 1991.
6. Seneca, Joseph J., & Michael K. Taussig, Environmental Economics, New Jersey: Prentice-Hall, 1984.
7. Shankar, U., Environmental Economics, Oxford University Press, New Delhi, 2001.
8. Tietenberg, T., Environmental Economics and Policy, Harper Collins, New York, 1994.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	M			
CO 2				
CO 3	M		H	
CO 4		M		M
CO 5		H		
CO 6				H

ENEG0059: AGRICULTURE ECONOMICS – ISSUES AND MANAGEMENT (4-0-0)

COURSE OUTCOMES

1. Draw distinctive features of agriculture which can influence the whole economy (Remembering)
2. Recognize limited resources available in the economy and realize the need of their efficient allocations throughimproved production techniques (Understanding)
3. Identify the new investment opportunities in agriculture to challenge economic problems like unemployment,inequality etc. (Applying)
4. Assess the role of agricultural policies to achieve harmonious development (Analysing)
5. Explain the trade-off between agriculture and non-agriculture to achieve sustainable agricultural development and in sensitizing overall development (Evaluating)
6. Use of economic theories in optimizing the production and distribution of agricultural products (Creating)

Module I: Agricultural Resources and Production (15 hours)
Resources in Agriculture; Land as a Resource; Land Capability; Issues in Utilization of Land; Competition for Agricultural Land; Effects of Urbanization; Land Degradation; Water as a Resource; Institutional Arrangements and Issues in Water Allocation; Managing Disasters – Drought, Flood, Famine; Production Function in Agriculture; Substitutability of Factors; Farm Size and Laws of Return

Module II: Agricultural Markets and Pricing (20 hours)
Supply Response in Agriculture; Issues Relating to Specification of Supply Response Function – Distributed Lags; Rigidities in Farm Supply Response – Supply Response of Individual Crops and Aggregate Production; Market Supply of Subsistence and Perennials Crop; Barriers to Internal Trade; Marketing Reforms; Behaviour of Agricultural Prices – Cobweb Cycles and Demand and Supply of Agricultural Products; Marketed and Marketable Surplus; Terms of Trade between Agriculture and Non-agriculture

Module III: Agricultural Finance (13 hours)
Role of Agencies; Inter-linked Markets; Subsidy and Taxation in Agriculture; Regulated Markets;

Crop and Livestock Insurance; Food Security and Public Distribution System; Infrastructural Development; Rural Creditand Rural Indebtedness; Need for State Intervention

Module IV: Farm Management (12 hours)
Farm Management Analysis – Production Function Approach, Farm-budgeting Approach; Farm Efficiency Measurements; Farm Efficiency Indicators; Productivity and Farm Size Debate; Crop Protection – Weed Control, Pest and Disease Control

Suggested Readings

1. Acharya, S.S. & Agarwal, N.L., Agricultural Marketing in India. New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd., 2012.
2. Johl, S.S. & Kapur, T.R., Fundamentals of Farm Business Management, Kalyani Publishers, Ludhiana, 2006.
3. Kahlon, A.S. & Singh, K., Managing Agricultural Finance: Theory and Practice, Allied Publisher Ltd., New Delhi, 1984.
4. Lekhi, R. K. & Singh, J., Agricultural Economics: An Indian Perspective, Ludhiana: Kalyani Publishers, 2015.
5. Penson, Capps, Rosson & Woodward, Introduction to Agricultural Economics, 7th Edition
6. R. S. Despandey & Arora, S., Agrarian Crisis and Farmer Suicide, (eds.), Sage India Publications, 2010.
7. Reddy, S.S. & Ram, P.R., Agricultural Finance and Management, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2000.
8. Reddy, S.S., Ram, P.R., Sastry, T.V.N, & Devi, I.B., Agricultural Economics, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India, 2015.
9. Soni, R., Leading Issues in Agricultural Economics, New Delhi: Vishal Publishing, 2004

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H			
CO2		H		
CO3	M			H
CO4				
CO5		H	M	
CO6		H		M

ENED0060: ECONOMICS OF EDUCATION (4-0-0)

COURSE OUTCOMES
1. Know Understand the concept of welfare economics and its applicability in education sector (Remembering)
2. Understand the educational financing from the point of view of Economics (Understanding)
3. Gain policy level understanding for improvement of health sector from economics prospective. (Applying)
4. Explore approaches of economic theory to health sector. (Analyzing)
5. The students can evaluate the investment pattern in education and also understand the direct and indirect benefits of education in development of society. (Evaluating)
6. Get an idea on various scopes to do research on education and health sector by applying the different economicstheories. (Creating)

Module I: Economics of Education (15 hours)
Human Capital – Types, Components; Human Capital Theory; Education as an Instrument for Economic Growth; Demand for Education; Supply of Education; Determinants of Demand for Education; Costs of Education – Private Costs, Social Costs; Benefits of Education – Direct, Indirect, Social; Wastage and Stagnation in Education – Causes and Measures; Manpower Planning –Meaning, Techniques of Forecasting

Module II: Education and Budget Allocation (15 hours)
Measurement and Trends; Correlation between Alternative Measures of Wellbeing; The Concept of Knowledge Economy – The Spread of Education across the World; Budgetary Allocations across Space and Time; Institutional Design;Alternative Systems for Service Delivery; The Role of Imperfect Information, Incentives and Contracts

Module III: Education and Planning (15 hours)
Approaches to Educational Planning – Production Function Models, Manpower Requirement Approach, Input-Output Model, Gender Based Approach; Educational Planning in Developing Countries with Special Reference to India; Vocational Education in India; New Education Policy

Module IV: Discrimination and Inequality in Education (15 hours)
Models of Preference-based and Statistical Discrimination; Effective Policies to Address Historical Inequalities; Evaluating Policy Impact – The Estimation of Treatment Effects in Randomized Experiments and in Observational Data

Suggested Readings

1. Banerjee, A. & Somanathan, R., The Political Economy of Public Goods, 2007.

2. Becker G.S., Human Capital (2nd Edition), National Bureau of Economic Research, New York, 1974.
3. Becker, G., Investment in Human Capital: a Theoretical Analysis, The Journal of Political Economy, 70(5), 9-49, 1962.
4. Benabou, R., Workings of a City, Quarterly Journal of Economics, 108(3), 619-652, 1993.
5. Cohn E. & T. Gaske, Economics of Education, Pergamon Press, London.
6. Galanter, M., Competing Equalities: Law and the Backward Classes in India, University of California Press, 1984.
7. McMohan, W.W., Education and Development: Measuring the Social Benefits, Oxford University Press. 1999.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H			
CO2		H		
CO3			H	
CO4		H		
CO5			H	M
CO6				H

ENHE0061: HEALTH ECONOMICS (4-0-0)

COURSE OUTCOMES

1. Learn the detail concepts of health economics and application of economic concept in the health sector.(Remembering)
2. Develop ideas and critical understanding on the health system in the context of Indian scenario. (Understanding)
3. Identify the demand and supply gap in healthcare system to suggest healthcare professionals and policymakers. (Applying)
4. Assess the role of government in health care delivery system and identifying the scope of health financing. (Analyzing)
5. Evaluate the health care programmes and policy to provide decisions concerning the allocation of resources. (Evaluating)
6. Develop or build economic perspective for research problem in health sector. (Creating)

Module I: Basics of Health Economics (18 hours)
Concepts, Definition of Health Economics; Measures of Health Status; Topics in Health Economic Theory – Production Function of Health, Grossman's Model of Demand for Health; Supply-side Health Economics; Theory of Health Behavior;Market of Health Insurance

Module II: Economic Evaluation in Healthcare (18 hours)
Economic Evaluation in Healthcare – Concepts, Importance; Types of Economic Evaluation in Healthcare – Cost Minimization Analysis, Cost Effectiveness Analysis, Cost Benefit Analysis, Cost Utility Analysis; Health TechnologyAssessment – Basic Concept, Importance of HTA in Health Economics

Module III: Public Policy on Health (12 hours)
Public Policy in Health Care Delivery – Role of State, Rationale for Government Intervention in the Health Sector – Publicand Private sector; Health Financing; Concept and Calculating Methods of HALE, QALYs and DALYs

Module IV: Health Sector in India (12 hours)
Overview of Health Care in India; Health System of India – Post Reform Scenario; Health Outcomes; Socio-economic Determinants of Health; Different Dimension of Health - Poverty, Malnutrition, Gender Perspectives in Indian context

Suggested Readings

1. Henderson, J. W., Health Economics & Policy, (3e), Thomson South-Western, Latest Edition, 2007.
2. David Wonderling, Reinhold Gruen & Nick Black, Introduction to Health Economics, Open University Press, 2005.
3. Sherman Folland, Allen Goodman & Miron Stano, Economics of Health and Health Care, Routledge, 8th edition, 2017
4. Jack, W., Principles of Health Economics for Developing Countries, Washington, D.C.: The International Bank for Reconstruction and Development/The World Bank, 1999.
5. World Health Organisation, The economics of the social determinants of health and health inequalities: A resource book.World Health Organisation, 2013.
6. Stephen Morris, Nancy Devlin, David Parkin & Anne Spencer, Economic Analysis in Healthcare, 2nd Edition, Wiley, 2012.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H			
CO2	M			
CO3		M	H	
CO4				H
CO5		H		H

CO6			M	

ENEI0062: ECONOMICS OF INDUSTRY (4-0-0)

COURSE OUTCOMES

1. Recall the concepts of micro economics concepts of price, market type, business motives (Remembering)
2. Understand basic models of the behaviour of firms and industrial organization and how they can be applied to policyissues (Understanding)
3. Assess economic situations – particularly those determining the relationships among firms within an industry and the strategies that each firm can adopt –, relate them to concrete problems and provide policy recommendations. (Applying)
4. Understand the minimal cost input factor quantities for a firm and optimal selling prices, supply quantities andresulting profits of firms in different market structures (Analyzing)
5. Discuss the need of competitive environment and the degree competition for a healthy functioning of a market. (Evaluating)
6. Develop the ability to calculate market concentration with different index and understand the relation between competition level and market concentration. (Creating)

Module I: Exploring the Subject Matter of Industrial Economics (15 hours)
Meaning, Scope, Need and Significance of the Study of Industrial Economics; Types and Choice of form of Organization; Business Motives – Alternatives Types of Motives/Goals; Industrial Profile – Private Sector, Large, Medium and Small Scale Industries; Integration; Industrial Combinations – Causes, Mergers and Amalgamations, Diversification

Module II: Theories of Industrial Location (15 hours)
Approaches to Industrial Location Analysis – Alfred Weber's Theory, Sergant Florence's Theory, Market Area Theory,Central Place Theory of Losch; Industrial Imbalances – Causes and Remedies; Government Policy and Approach for Backward Regions in India

Module III: Industrial Efficiency, Productivity and Pricing (15 hours)
Economic Efficiency – Meaning; Factors Determining Efficiency; Productivity – Norms and Measurement; The Competitive Environment; Market Concentration – Meaning and Measurement; Pricing in Practice – Cost-plus Pricing, Variable Cost Pricing, Target Rate of Return Pricing, The Going Rate Pricing, Transfer Pricing

Module IV: Indian Industrial Growth and Finance (15 hours)
Industrial Policy in India- Role of Public and Private Sectors; Trends in Indian Industrial Growth after 1991 Industrial Policy;Role of MSME in India; Sources of Industrial Finance – GDR, ADR; Disinvestment as a Sources of Finance; Choice of Funding – External vs. Internal Sources, Financial Statements – Balance Sheet; Profit and Loss Account; Analysis of Financial Ratios; Project Appraisal and Capital Budgeting

Suggested Readings

1. Barthwal, R.R., Industrial Economics, Wiley Eastern limited, New Delhi, 1985.
2. Cherunilam, F. Industrial Economics: Indian Perspective (3rd Edition), Himalaya Publishing House, Mumbai, 1994.
3. Desai, B., Industrial Economy of India, Himalaya Publishing House, Mumbai, 1999.
4. Divine, P.J. & R.M. Jones et. al., An Introduction to Industrial Economics, George Allen and Unwin Ltd., London, 1976.
5. Government of India, Economic Survey (Annual).
6. Hay, D.A. & Morris D.J., Industrial Economics: Theory and Evidence, Oxford University Press, New Delhi, 1979.
7. Mishra & Puri (latest edition), Indian economy, Himalaya publisher
8. Seth R., Industrial Economics, Ane Books Pvt Ltd.
9. Singh, A & A.N. Sandhu, Industrial Economics, Himalaya Publishing House, Mumbai, 1988.
10. Sivaya, K.V. & Das, V.B.M., Indian industrial economy, Sultan Chand, Latest edition.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	M			
CO2	H	M		
CO3			H	
CO4		H		
CO5			M	H
CO6				H

ENIN0063: INTERNATIONAL ECONOMICS (4-0-0)

COURSE OUTCOMES

1. Know the key concepts and practical applications of international economics including international trade and international finance. (Remembering)
2. Understand the key principles and models of international economics and know the country's position regarding international trade, terms of trade, international debt and balance of payments and foreign exchange. (Understanding)
3. Apply the theories and models of international trade for economic growth and global welfare and critically commenton international economic policy. (Applying)
4. Analyse the links between trade, international finance, economic growth and globalization, with a particular emphasison the experiences of developing countries. (Analysing)
5. Evaluate international trade policies regarding increase in exports, international debt, and international institutions to solve domestic problems like inflation, unemployment and value of currency etc. (Evaluating)
6. Design and develop economists' arguments and models concerning international trade policies and its analysis for various issues of the day surrounding globalization. (Creating)

Module I: International Trade Theory (18 hours)

The Law of Comparative Advantage; Production Frontier with Increasing Costs; Gains from Trade with Increasing Costs; Offer Curves; Terms of Trade; Factor Endowments and the Heckscher-Ohlin Theory; Economies of Scale, Imperfect Competition and International Trade; Stolper-Samuelson Theorem; Specific Factors Model, Leontief Paradox; Technological Gap Model; Product Cycle Theory; The Gravity Model

Module II: International Trade Policy (12 hours)

Trade Restrictions – Tariffs, Partial and General Equilibrium Analysis of a Tariff, Optimum Tariff, Tariff structure; Nontariff Trade Barriers and the New Protectionism; Economic Integrations – Free Trade Areas, Customs Unions, Common Markets, Optimum Currency Area, Economic Union, Political Union; Dumping; Retaliation Against Dumping; International Cartels

Module III: Balance of Payments and Foreign Exchange Markets (10 hours)

Balance of Payments – Current and Capital Account; Foreign Exchange Markets – Types and Functions; Exchange Rates – Exchange Rate and the Balance of Payments, Spot and Forward Rates, Currency Swaps, Futures, and Options; Foreign Exchange Risks – Hedging, Speculation, Interest Arbitrage

Module IV: International Exchange Rate Determination (10 hours)

Exchange Rate Determination – Absolute Purchasing Power Parity Theory, Relative Purchasing-Power Parity Theory; Monetary Approach to Balance of Payments and Exchange Rate – Fixed Exchange Rates, Flexible Exchange Rates; Portfolio Balance Model and Exchange Rates; Exchange Rate Dynamics

Module V: International Resources Movements and Managements (10 hours)

International Capital Flows - Foreign Portfolio Investment (FPI), Foreign direct investment (FDI); Its determinants and benefits; International Labor Migration – Motives, Welfare Effects; International Monetary System – Classic Gold Standard, Bretton Woods System, WTO and International Trade; International Debt Crisis; Recycling of Petro-Dollars; Causes of Debt Crisis; Secondary Market for Debt of Developing Countries

Suggested Readings

1. Bhagwati, Jagdish N., International Trade: Selected Readings, Cambridge, Mass: MIT Press, 1987.
2. Chacholiades, M., International Trade: Theory and Policy, McGraw Hill, 1988.
3. Cherunilam, F., International Economics, McGraw Hill India, 5th Edition, 2008.
4. Kindleberger, C.P., International Economics, R.D. Irwin, Homewood, 1963.
5. Krugman, Paul R., & Maurice Obstfeld, International Economics. Harlow: Pearson Education, 2011.
6. Mannur, H.G., International Economics, Vikas Publishing, New Delhi, 2010.
7. Reinert, Kenneth A., An introduction to international economics: new perspectives on the world economy, CambridgeUniversity Press, 2020.
8. Salvatore, D., International Economics, Wiley, 11th Edition, 2013.
9. Sodersten, Bo, & Geoffrey Reed, International Economics. Basingstoke: Macmillan, 2004.
10. Sodersten, International Economics, Basingstoke: Palgrave Macmillan Limited, 1999.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	M				
CO 2		M		M	
CO 3	M		H		M
CO 4		H		H	
CO 5					H

CO 6				H	

ENPE0064: POPULATION ECONOMICS (4-0-0)

COURSE OUTCOMES

1. Highlight various policies on population control measures (Remembering)
2. Develop the knowledge of the different models, theories about the relationship between population growth and development (Understanding)
3. Develop the ability to relate the changes in social and political economy due to demographical changes. (Applying)
4. By the end of the course the students are expected to learn the two important concepts of Fertility and Mortality and relate the factors for change in population in a particular region. It gives an idea about calculation of different rates of fertility and mortality. (Analyzing)
5. The students will be in a position to narrate the international and internal migration of India. Identify the factors responsible for internal and international Migration. (Evaluating)
6. Discuss the models of population projection and help in focusing the future policy measures (Creating)

Module I: Population and Development (15 hours)

Demography –Meaning and Scope; Evolution of Population Policy in India – The Shift in Policy from Population Control to Family Welfare, to Women Empowerment; Family Planning Strategies and their Outcomes; Measures of Population Change; Population Structure; Population Distribution; Theories of Population – Malthus, Optimum Theory of Population; Theory of Demographic Transition – Views of Meadows, Enke and Simon; Population and Development – Demographic Dividend

Module II: Distributional Pattern of Population (15 hours)

Population Trends in the Twentieth Century; Population Explosion and its Dynamics; Pattern of Age and Sex Structure in Developed and Less Developed Countries; Determinants of Age and Sex Structure; Demographic Effects of Sex and Age Structure; Economic and Social Implications; Age Pyramids Projections

Module III: Fertility, Nuptiality and Mortality (15 hours)

Fertility – Emerging Issues in Fertility Control; Fertility Analysis; Social Structure and Fertility Change; Nuptiality Concept and Analysis of Marital Status – Single Mean Age at Marriage, Synthetic Cohort Methods, Trends in Age at Marriage; Mortality – Death Rates, Crude Age-specific; Mortality at Birth and Infant Mortality Rate; Sex and Age Pattern of Mortality; Levels and Trends of Mortality rate in Developed and Less Developed Countries; Life Table Construction and Uses; Concepts of Stable Population; Methods of Population Projection

Module IV: Migration and Urbanization (15 hours)

Internal and International Migration Flows; Internal Migration its Effect on Population Growth and Pattern; Factors Affecting Migration; Theories of Migration Related to Internal Migration; International Migration Flows; Dynamics of the International Migration Process; Urbanization Growth and Distribution of Rural-urban Population in Developed and Developing Countries; Population Growth, Employment and Housing in Mega Cities in Developing Countries; Gravity Model

Suggested Readings

1. Amsden, A.H., The Economics of Women and Work, Penguin, Harmondsworth, 1980.
2. Baud, I.S.A., Form of Production and Women's Labour, Gender Aspects of Industrialization in India and Mexico, Sage, N.D.1992,
3. Bhole, L.M. Financial Institutions and Markets, Tata Mcgraw Hill, 2016.
4. Bogue, D.J., Principles of Demography, John Wiley, NY, 1971.
5. Boserup, E. Women's Role in Economic Development, George Allen and Unwin, London, 1970.
6. Chenery, H. & N. Srinivasan (eds.), Handbook of Development Economics, Vol. I & II, Elsevier, Amsterdam, 1989.
7. Chiang, C.L., Life Tables and Mortality Analysis, W.H.O., Geneva, 1974.
8. Coale, A.J. & E.M. Hoover, Population Growth and Economic Development in Low Income Countries: A Case Study of
9. India's Prospects, Princeton University Press, Princeton, 1958.
10. John, R. W., Population: An Introduction to Concepts and Issues, (7th ed.), New York: Wadsworth Publishing Company,2002.
11. King, M. & M.A. Hill (eds.), Women's Education in Developing Countries: Barriers, Benefits and Politics, John Hopkins,
12. Baltimore, 1993.
13. Shryock, H. S. et. al., The Methods and Materials of Demography, New York: Academic Press, 1976.
14. Srinivasan, K., Basic Demographic Techniques and Applications, New Delhi: Sage Publications, 1998.
15. Thompson, W. S. & Lewis, D. T., Population Problems, New Delhi: Tata McGraw Hills Publishing Co., 1976.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H			
CO2		H		
CO3	H			
CO4		M		M
CO5			H	L
CO6				H

ENOR0065: OPERATIONS RESEARCH (4-0-0)

COURSE OUTCOMES

1 Familiar with basic ideas, characteristics and different phases of Operations Research (Remembering)
2. Describe the basic concepts of convex sets and linear programming method (Understanding)
3. Identify situations where linear and non-linear programming problem can be applied (Applying)
4. Perform sensitivity analysis to assess the magnitude of change of a linear programming (Analysing)
5. Develop strong analytical skills and logical argument to work on with complex issues (Evaluating)
6. Formulate linear programming model of a real-world problem and demonstrate the solution process (Creating)

Module I: Basics of Operations Research (10 hours)
Meaning and Definition; Phases of an Operations Research Study; Importance and Scope; Limitations of Operations Research; Operations Research in Decision Making; Application of Operations research

Module II: Assignment and Transportation Problems (15 hours)
Assignment Problem – Concept, Nature, General Formulation; Solution of Assignment Problems – Hungarian Method; Transportation Problem – Concept, Nature, General Formulation; Solution of Transportation Problems – North West Corner Method; Dual Transportation Model; Difference between Transportation and Assignment Problem

Module III: Network Analysis (15 hours)
Basic Concepts; Classic and Modern Network Models – PERT and CPM; Drawing of Network Activity; Critical Path;Determination of Floats – Total Float, Free Float and Independent Float; Social Networking Problems; Pivotal Agents in Social Networks

Module IV: Linear Integer Programming and Models of Inventory (20 hours)
Modeling with Integer Variables; Canonical and Standard forms; Branch and Bound Methods; Applications – Production Planning, Scheduling; Algorithms for Integer Optimization – Cutting Plane Methods, Approximation Algorithms; Problem of the Economic Order Quantity; Problem with Price Breaks; Static Multi-commodity Model with Limited Capacity of the Stock; Dynamic Problems – Basic Concepts

Suggested Readings

1. A. Ravindran, D. T. Phillips & James J. Solberg, Operations Research- Principles and Practice, John Wiley & Sons, 2005.
2. A.M. Natarajan, P. Balasubramani & A. Tamilarasi, Operations Research, Pearson
3. Avriel, Mordecai, Nonlinear Programming: Analysis and Methods, Dover Publishing, 2003.
4. Bazaraa, Mokhtar S. & Shetty, C. M., Nonlinear programming. Theory and algorithms, John Wiley & Sons, 1979.
5. F.S. Hillier & G.J. Lieberman, Introduction to Operations Research- Concepts and Cases, 9th Edition, Tata Mc-Graw Hill,2010.
6. J. K. Sharma, Operations Research Theory and Applications, Macmilan
7. Martin J. Osborne, An Introduction to Game Theory, Oxford University Press
8. Ravindran, A., Phillips, D. T., & Solberg, J. J., Operations Research- Principles and Practice (2nd Ed.). New Delhi: Wiley India, 2007.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H			
CO2		M		
CO3	M		H	
CO4		H		M
CO5			M	
CO6			H	M

ENGE0066: GENDER ECONOMICS (4-0-0)

COURSE OUTCOMES

1. Relate the demography concepts to understand the demography of female population (Remembering)
2. Articulate connections between global, regional and local issues and their relation to women's experiences and to human rights. (Understanding)
3. Examine the various gender indices to understand the framework of policy relating to gender issues. (Applying)
4. Explore the factors responsible for gender discrimination in India (Analyzing)
5. Evaluate the role of technology and institutions in addressing the problem of gender inequalities. (Evaluating)
6. Analyze interconnection between good governance, gender budgeting, Democratic decentralization and women empowerment. (Creating)

Module I: Concept and Importance of Gender Economics (15 hours)

Importance of Gender Economics; Women in Patriarchal and Matriarchal Societies and Structures; Gender Bias in the Theories of Values; Distribution and Population; Demography of Female Population; Causes of Declining Sex Ratios and Fertility Rates in LDCs and Particularly India; Women and their Access to Nutrition, Health, Education and Community Resources and their Impact in Female Mortality and Fertility; Gender Planning Frameworks and Tools; Gender Inequality Indices – GII,MPI, WEIA, SIGI, GDI, GEM; Gender Inequalities in India; Gender and National Planning; Theories of Gender Inequality

Module II: Decision Making, Economic Activity and Women (15 hours)

Factors Affecting Decision Making by Women; Property Rights; Access to and Control Over Economic Resources and Assets; Power of Decision Making at Household, Class, Community Level; Economic Status of Women and its Effect in WPR, Income Level, Health and Education in Developing Countries; Concept and Analysis of Women's Work – Visible and Invisible Work, Economically and Socially Productive Work; Female Contribution to National Income

Module III: Labour Market, Technology, Environment and Women (15 hours)

Factors Affecting Female Entry in Labour Market; Supply and Demand for Female Labour in Developed and Developing Countries; Studies of Female work Participation in Agricultural and Non-agricultural Rural Activities; Wage Differentials in Female Activities; Determinants of Wage Differentials – Gender, Education, Skill, Productivity, Efficiency, Opportunity; Structure of Wage Across Regions and Economic Sectors; Impact of Technological Development and Modernization on Women's Work Participation; Women and Environment – Female Activities and Environmental Concerns; International Agreements

Module IV: Social Security, Gender Planning and Development Policies (15 hours)

Effectiveness of Collective Bargaining; Review of Legislation for Women's Entitlement Protection of Property Rights; Schemes for Safety net for Women; Need for Female Labour Unions; Affirmative Action for Women and Improvement in their Economic and Social Status; Gender Mainstreaming in Development Policies; Gender Sensitive Governance – Gender Budgeting, Democratic Decentralization (Panchayats) and Women's Empowerment in India; The Kudumbashree Experience in Kerala, A comparative assessment on Gender policies between developed and developing countries (with special reference to Asian countries); Gender and technology based education institution in development and developingcountries.

Suggested Readings

1. Agarwal, Bina, A Field of One's Own: Gender and Land Rights in South Asia, Cambridge; Press, Cambridge, 1994.
2. Amsden, A.H., The Economics of Women and Work, Penguin, Harmondswosrth, 1980.
3. Beneria, L. & M. Roldan, The Crossroads of Class and Gender, University of Chicago Press, Chicago, 1987.
4. Beneria, Lourdes, GunseliBerik, and Maria Floro, Gender, Development and Globalization: Economics as if all People Mattered, Second Edition, Routledge, London, 2015.
5. Bonnie G Smith, Women's Studies: The Basics, Routledge, London, 2013.
6. Borerup, E., Women's Role in Economic Development, George Alle and Unwin, London, 1970.
7. Government of India, Towards Equality - Report of the Committee on the Status of Women in India, Department of Social Welfare, Ministry of Education and Social Welfare, New Delhi, 1974.
8. Government of India, Shram Shakthi, Report of the National Commission on Self employed Women and Women works in the Informal Sector, Ministry of Human Resource Development, New Delhi, 1987.
9. Irene Tinker, Persistent Inequalities: Women and world development, New York: Oxford University Press, 1990.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	M			
CO2	H			
CO3				H
CO4		H		
CO5		L	H	
CO6				H

ENFE0067: FINANCIAL ECONOMICS (4-0-0)

COURSE OUTCOMES

1. Learn the key concepts of financial economics. (Remembering)
2. Understand the fundamental concept and application of financial field. (Understanding)
3. Identifying the current financial issues and problems to provide better decision-making to investors. (Applying)
4. Illustrate the trading in the stocks market and analyze the complexities of the derivative market. (Analyzing)
5. Evaluate the financial policy and programme to provide financial advice to policymakers. (Evaluating)
6. Use of financial economics concept in solving real life problems.(Creating)

Module I: Investment Theory and Portfolio Analysis (18 hours)
Overview of Investment Evaluation Methods and Evaluation Criteria; Fixed-income Securities; Bond Prices; Spot Prices; Discount Factors; Arbitrage; Yield-to-maturity; Price Sensitivity; Interest Rate Sensitivity and Duration; The Term Structure of Interest Rates; Yield Curves; Spot Rates and Forward Rates; Portfolios of Assets – Measurement of Return and Risk; Effects of Diversification; Optimal Portfolio Choice; Mean-variance Frontier of Risky and Risk-free Asset; Portfolio Weights

Module II: Options and Derivatives (15 hours)
Options and other Derivatives – Concepts, Definitions; Interest Rate Futures; Futures and Hedging; Hedging Strategies; Option Markets – Call and Put Options; Bounds for Option Prices; Put-call Parity; Option Pricing Formula – Binomial Approach; Factors Affecting Option Prices; Option Trading Strategies; Option to Expand; Valuation of Real Option; Pricing of other Derivatives; Numerical Problems for Derivative Pricing

Module III: Corporate Finance (12 hours)
Types of Corporate Financing – Owner's Funds, Debt Funds; Strategy of Corporate Financing and Corporate Value; The role of Capital Market in Explaining Corporate Performance; Portfolio for Corporate Bonds; Corporate Debt and DividendPolicy, The Modigliani-Miller Theorem; Capital Asset Pricing Model and its Use in Corporate Finance

Module IV: Valuation of Financial Assets (15 hours)
Concept of Value; The Time Value of Money and Asset Pricing – The Valuation of Debt Instruments; The Equilibrium Priceand Quantity of Bonds – Loanable Fund Approach, Demand and Supply Approach; Valuing Stock and other Assets – Income Stocks and Growth Stocks; Equilibrium Price and Value of Stock Transactions

Suggested Readings

1. David G. Luenberger, Investment Science, Indian Edition, 2012.
2. Basu, Sankarshan, Hull, John C., Options Futures and Other Derivatives, Pearson Education, Inc, 8th Edition, 2013.
3. Brealey, Richard A., Myers, Stewart, C., Allen, Franklin, & Mohanty Pitabas, Principles of Corporate Finance, Tata McGraw-Hill Education, 10th Edition, 2013.
4. William Sharpe, Gordon Alexander & Jeffery Bailey, Investments, Prentice Hall of India, 6th Edition, 2003.
5. Stephen A. Ross, Randolph W. Westerfield & Bradford D. Jordan, Fundamentals of Corporate Finance, McGraw-Hill, 7thEdition, 2005.
6. Thomas E. Copeland, J. Fred Weston & Kuldeep Shastri, Financial Theory and Corporate Policy, Prentice Hall, 4th Edition,2003.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H			
CO2	M	H		
CO3			H	
CO4		H		M
CO5			M	
CO6				H

ENLE0069: LABOUR ECONOMICS (4-0-0)

COURSE OUTCOMES

1. Define the main concepts related to labour economics. (Remembering)
2. Explain the analytical grasp of labour demand and supply. (Understanding)
3. Identify the main issues of wage determination. (Applying)
4. Analyse the theoretical issues in labour economics. (Analyzing)
5. Explain the practical applicability of theories related to labour productivity and labour mobility. (Evaluating)
6. Discuss the key issues of Indian labour market and measures to solve the problems in labour market. (Creating)

Module I: Introduction to Labour Economics (10 Hours)
Concept, Nature and Scope of Labour Economics; Labour Market – Concept, Labour Supply, Labour Demand; Measuring the Labour Force, Workers Preferences, Time and Budget Constraints, Hours of Work Decision; Production Function; Imperfections in the Labour Market – Job Search and Job Matching, Imperfect Information in Labour Market; Labour Flexibility

Module II: Theories of Wage Determination (15 hours)
Theories of Wage – Classical, Neo-classical, Modern; Employment Decision in the Short Run and Long Run; Long Run Demand for Labour; Labour Market Equilibrium – Equilibrium in a Single Competitive Labour Market, Competitive Equilibrium Across Labour Markets, Non-competitive Labour Markets; Wage Determination in Organized and Unorganized Sector; Human Capital Theory of Wage

Module III: Wage Differentials, Labour Efficiency and Discrimination (15 Hours)
Homogenous Workers and Jobs; Heterogeneous Workers and Jobs; The Hedonic Wage Function; Alternative Pay Schemes and Labour Efficiency; Theory of Optimal Fringe Benefits; Labour Efficiency – Education in the Labour Market, Schooling Model; Efficiency Wage Models; Segmentation and Discrimination in Labour Market – Race and Gender in the Labour Market, The Crowding Model, Employer and Employee Discrimination; Measuring Discrimination – The Oaxaca Decomposition; Relation between Wage and Employment; Impact of Trade Union and Collective Bargaining on Employers

Module IV: Labour Productivity, Unemployment and Migration (10 Hours)
Labour Productivity – Concept, Measurement; Wages, Prices and Employment; Unemployment – Frictional, Structural, Demand-deficient Unemployment; Measurement of Unemployment – The Stock-Flow Model; Reducing Unemployment – Public Policies; Labour Mobility; Migration as an Investment in Human Capital; Determinants of Migration; Consequences of Migration; The Economic Benefits of Immigration

Module V: Issues in Indian Labour Market (10 Hours)
Features of Indian Labour Market – Size and Composition in the Organized and Unorganized Labour Market; Major issues in the Indian Labour Market; Labour Productivity in India; Labour Turnover and Absenteeism in India; Women and Child Labour in India; Agricultural and Rural Labour; Labour Market Institutions of Minimum Wage; Employment and Wage Policy in India; Informal Labour and Social Security Measures; Globalization and Labour Market; Labour Statistics in India

Suggested Readings
1. Ashenfelter, Orley & Richard Layard, The Handbook of labour Economics. Vol. 1 and 2, New York: North-Holland, 1986, Vol.3A, 3B and 3C, 1999.
2. Butler, A.D., Labor Economics and Institutions, American Publishing Company, ND, 1972.
3. Datt, G., Bargaining Power, Wages and Employment: An Analysis of Agricultural Labour Market in India.
4. George J. Borjas, Labour Economics, McGrawhill, New York, 2000.
5. Government of India, Reports on The National Commission on Labour.
6. Marshall, F.R., V.M. Briggs, & A.G. King, Labour Economics, Richard D. Irwin Inc., Homewood, Illinois, 1984.
7. McConnell, C.R., S.L. Brue & D.A. Macpherson, Contemporary Labour Economics, McGraw Hill, NY, 2009.
8. Michael Hopkins, Labour market planning revisited, Palgrave Macmillan, 2002.
9. Rees, A., Economics of Work and Pay, Harper and Row, NY, 1973.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO1	**H**				
CO2	**M**				
CO3		**M**			
CO4				**H**	M
CO5			**M**	**H**	
CO6			H		H

ENBE0070: BEHAVIOURAL ECONOMICS (4-0-0)

COURSE OUTCOMES
1. Learn the principles and methods of Behavioural Economics (Remembering)
2. Identify the systematic departures of economic behaviour from the prediction of the neoclassical model(Understanding)
3. Get the idea of how behavioural principles have been applied to economic problems (Applying)
4. Understand the principles behind the behavioural approach for the development of analytical tools in Economics (Analysing)
5. Incorporate psychologically motivated assumptions into economic models (Evaluating)

6. Interpret how behavioural models change the predictions for equilibrium behaviour and their implications for optimal policy (Creating)

Module I: Introduction to Behavioural Economics (10 hours)
Behavioural Economics Meaning, Definitions; Behavioural Economics and the Standard Economic Models; Scope and Methodology of Behavioural Economics; Applications

Module II: Decision-making under Risk and Uncertainty (13 hours)
Preferences and Choice; Anomalies in Expected utility Theory; Alternatives to Expected Utility Theory – Disappointment, Decision-Weighting, Rank-dependent Utility; Role of Reference; Dependent Preference in Risky and Risk Free Choices

Module III: Intertemporal Decision-making (13 hours)
Discounted Utility Model; Alternative Choice Models – Time Preferences, Time Inconsistent Preferences; Utility and Consumption Independence; Independence of Discounting from Consumption

Module IV: Behavioural Game Theory (13 hours)
Nature and Equilibrium of Behavioural Game Theory; Mixed Strategies and Iterated Games; Modelling of SocialPreferences; Inequality Aversion Model; Reciprocity Model

Module V: Basic Behavioural Macroeconomics (11 hours)
Neo-Keynesian Rational Expectation Model; Rational Expectation and Attainment of Business Cycle and Labour Market Equilibrium; Determination of Asset Price; Stability Analysis of Macroeconomic Models

Suggested Readings
1. Peter Diamond & Hannu Vartiainen, Introduction to Behavioural Economics and Its Applications, Princeton UniversityPress, 2012.
2. BD Bernheim, S Della Vigna & D Laibson, Handbook of Behavioural Economics-Foundations and Applications - NorthHolland, 2019.
3. Sanjit Dhami, The foundations of Behavioural Economics, Oxford, 2020.
4. N. Wilkinson & M. Klaes, An Introduction to Behavioral Economics, Palgrave Macmilla, 2012.
5. Paul De Grauwe & Yeumei Ji, Behavioural Macro Economics -Theory and Policy, Oxford University Press, 2019.
6. G. Akerlof, Behavioural Macroeconomics and Macroeconomic Behaviour, Nobel Prize Lecture, 2001.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO1	H				
CO2		M			
CO3			M		H
CO4	M			H	
CO5				H	
CO6			H		H

ENNE0071: ECONOMY OF NORTH EASTERN REGION (4-0-0)

Course Objectives:
This course is designed to expose the students to the overview of North East Economy. It explains the trend and performance of agriculture, industry and service sector in the context of North East scenario. It also includes the evaluation of various developmental policies for structural transformation of the region.

Course/Learning Outcomes
At the end of the course the students would be able to:
1. Define and understanding of macroeconomics policies and their impact of North East Economy. (Remembering)
2. Explain the policies and Performance in Agriculture. (Understanding)
3. Identify the policies and performance in Industry. (Applying)
4. Evaluate the impact of various development policies in Agriculture and Industry in the Indian Scenario. (Analyzing)
5. Explain the trends and performance in service sectors and the scope of growth of enterprises in the North Eastern region and the role of various policies in it. (Evaluating)
6. Discuss the usefulness of various development policies and the different development initiatives in the North Eastern region along with some of the reasons for its failure. (Creating)

Module I: Overview and Characteristics of North East Economy (20 hours)

North Eastern Region as an economy; Characteristics of the economy; Trend and Pattern of GDP growth in NER; Demographic features of the NE economy; Poverty and Inequality in NER comparison with the Indian economy; Trends of Employment and Unemployment; Recent developments in human resource.

Module II: Agriculture in North East Economy (15 hours)
Agriculture: features and challenges; Growth of Agricultural Sector in NE; Agricultural Finances-Sources and Limitations; Agricultural Policies of NE States; Agriculture-Industry linkage especially in NER, Problems of Agricultural Marketing in NE.

Module III: Industry and Service Sectors in North East Economy (20 hours)
Industry: growth, composition and challenges, Growth of Micro Small and Medium Enterprises (MSME); North East Industrial and Investment Promotion Policy (NEIIPP) 2007 & 2015; Services sector; Trends, growth and challenges; Rural economy, Diversification of rural employment; Infrastructure and regional economic development, Nature and characteristics of Public finance for NER trends and challenges.

Module IV: Structural Transformation and Institutions in North East (20 hours)
Institutions and economic Development; Governance and development-government failure and its correction; Local self-government and development; Community participation and development, community failure; Role of DONER and NEC; New development initiatives in NER, Vision Document 2020 and Act East Policy

Suggested Readings:

1. Banerjee and Kar (1999): Economic Planning and Development of North-Eastern States, Kanishka, ND.
2. Deb, B.J & B. Dutta Ray (2006): Changing Agricultural Scenario in North-East India, Concept Publication, New Delhi
3. Dikshit, K. R and J K Dikshit (Eds.) (2014): North East India Land People and Economy, Springer
4. Maithani, B.P. (1997): Local Self-Government in North-East India: An Appraisal, NIRD, Hyderabad
5. Menon, S. (Ed.) (2007): India's North East Economy-Problems and Prospects, ICFAI Univ. Press, Hyd.
6. Mishra, B. (2006): Fiscal Policy in North-East India, Akansha Publishing House, ND.
7. Nayak. P. (Ed.) (2010): Growth and Human Development in North- East India, Oxford University Press.
8. RBI (2006): Report of the Committee on Financial Sector Plan for North Eastern Region, RBI.
9. World Bank (2007): Development and Growth in Northeast India The Natural Resources, Water, and Environment Nexus

ENDI6003: DISSERTATION PHASE-I (2-0-0)

Course Description:
The MA students would be required to do project work and submit dissertation. The project work is to be related to the specialization area chosen by the student. Dissertation submitted by the students would be evaluated by External Examiners appointed by the University. The work for the MA dissertation is spread over Semester III and Semester IV as Dissertation Phase-I and Dissertation Phase-II respectively. The total dissertation grades are distributed between the two semesters i.e. 2 credits in Semester III and 4 credits in Semester IV equaling 6 credits in total.

Course Objectives:
The aim of the course is to equip the students with presentation skills and develop academic writing skill. Moreover, the students will also be able to apply the statistical research training acquired in the taught element of the program by designing an appropriate research strategy and research methodology to carry out the research.

The Structure of the Course:
In Dissertation Phase-I, the students have to independently think of a research idea and, by the end of the semester, has to defend a research proposal based on the idea i.e. need to present the Synopsis by the end of the third semester. The total credit in Dissertation Phase-I equals to 2 credits.

Structure of Dissertation Phase-I

Sl. No.	Tentative Stages to be completed	Tentative Duration
1.	Research idea or concept note, i.e., Statement of the Problem	First month
2.	Review of Literature	Second month
3.	Research Methodology Sampling, Sample size determination, Selection of sample, Analytical tools to be used, Questionnaire preparation, Preliminary exploration of data i.e. Pilot Survey	Third month andFourth month (3/4 common classes)
4.	Synopsis Presentation Submission of Modified Synopsis to the Head of the Department	Before the commencement of the end semester examination (date will be notified later) Evaluation by the end of Third Semester

		(Based on Synopsis)
5.	Students have to collect all the required data during the semester break (between 3rd and 4th semester)	

ENDI6004: DISSERTATION PHASE-II (4-0-0)

Course Descriptions:
The MA students would be required to do project work and submit dissertation. The project work is to be related to the specialization area chosen by the student. Dissertation submitted by the students would be evaluated by External Examiners appointed by the University. The work for the MA dissertation is spread over Semester III and Semester IV as Dissertation Phase-I and Dissertation Phase-II respectively. The total dissertation grades are distributed between the two semesters i.e. 2 credits in Semester III and 4 credits in Semester IV equalling 6 credits in total.

Course Objectives:
The aim of the course is to fine-tune the dissertation he/she working in the Phase-I and during the work, the students will also learn how to apply the statistical and econometric tools in their own research.

The Structure of the Course:
In Dissertation Phase-II, the student has to carry out data analysis and write the dissertation and defend it by the end of the fourth semester. The dissertation will include original research question(s) if any, critical review of the relevant literature, analytical tools employed in response to the research questions, data analysis and interpretation. Finally, the students need to submit the dissertation to the university authority maintaining all instructions provided by the university. Under the process, the students will be guided by an assigned supervisor of the department to do the work. The total credit in Dissertation Phase-II equals to 4 credits.

Structure of Dissertation Phase-II

Sl. No.	Tentative Stages to be completed	Tentative Duration
1.	Validation of data, data entry and preliminary analysis of data(drawing graphs, trend lines, etc.)	First month
2.	Main data analysis	Second month
3.	Dissertation writing and Proof reading	Third and fourth month
4.	Submission and Viva Voce	Evaluation by the end of Fourth Semester

DEPARTMENT OF EDUCATION

VISION:
To build a pool of intellectually competent educational leaders and teacher educators leading on the process of education in general and teacher education in particular which nurtures individual autonomy and social development by ensuring quality with peace across the globe

MISSION:
The Mission of the Department is to facilitate the expression of leaders hidden within the students, developing sound cognitive, affective and psychomotor abilities and making them a sound citizen of the country and world as a whole.

PROGRAM OUTCOMES - MA EDUCATION

PO 1: **Critical Thinking:** To inculcate critical thinking among the students.
PO 2: **Effective Communications:** To generate an ability among the students to communicate their thoughts and ideas from one end to another clearly for making others comfortable in understanding.
PO 3: **Scientific Temper:** To inculcate scientific temper among the students to be judicious and logical in their thinking and presentation.
PO 4: **Effective Citizenship:** To enable the students to possess the qualities of a good citizen and prove to be a productive member of the society.
PO 5: **Ethics:** To create ethical values among the students to be a righteous individual.
PO 6: **Environment and Sustainability:** To create environmental awareness among the students lashing with the sense of sustainability.
PO 7: **Gender Sensitization and social commitment:** To sensitize the students about the gender variability and its utility in harmonious ways of life.
PO 8: **Self-directed and life -long learning:** To create a positive attitude among the learners to havethe zeal for self-directed and life- long learning.

PROGRAM SPECIFIC OUTCOMES - MA EDUCATION

PSO 1: **Educational Foundations and Educational Leadership:** To equip the PG students with foundations of education and inculcating educational leadership among the students.
PSO 2: **Skill Based Competence: To** inculcate some skills relating to teaching, research, leadership,management computer etc.
PSO 3: **Curriculum and Pedagogical Issues:** To make the PG students well aware of the curriculum planning and designing and pedagogy to transact the curriculum effectively and testing the students.
PSO 4: **Ethics and Social Responsibility in Education:** To produce morally upright PG students whoare to contribute in environmental sustainability and social development.

MA List of Courses

1.1 Philosophical Foundations of Education	3.2 Principles and Techniques of Teaching and Pedagogy
1.2 Fundamentals of Educational Psychology	3..3 Teacher Education
1.3 Emerging Trends in Education	3.4 Measurement and Evaluation in Education
1.4 History and Development of Education in India	3.5 Educational Law and Government Policy
1.5 Educational Technology	3.6 Financial Management and Accounting
1.6 Leadership and Social Responsibility	3.7 Life Span Development and Education
1.7 Journaling – a Technique for Personal and Academic Growth	3.8 Learning and Individual Differences
2.1 Sociological Foundations of Education	3.9 Dissertation Phase I
2.2 Research Methodology in Education	3.10 Educational Seminar II
2.3 Knowledge and Curriculum	3.11 Teaching Practice
2.4 Developing Educational Leadership	4.1 Organisational Communication
2.5 Human Development and Learning	4.2 Educational Administration
2.6 Peace Education and Conflict Management	4.3 Ethics and Social Responsibility in Education
2.7 Educational Seminar I	4.4 Counselling Skills for Educational Psychologists
2.8 Computer Applications for Social Sciences (Lab)	4.5 Child and Adolescent Mental Health
2.9 School Visits	4.6 Dissertation Phase II
3.1 Curriculum Development and Instruction	4.7 Internship

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4
1.1 Philosophical foundations of Education	H	H	H	L	M	M	M	H	H	H	H	H
1.2 Fundamentals of Educational Psychology	H	H	H	M	L	M	L	H	H	H	H	H
1.3 Emerging Trends in Education	H	M	H	M	M	M	M	H	H	H	H	M
1.4 History and Development of Education in India	H	M	M	M	L	L	M	H	H	H	H	H
1.5 Educational Technology	H	M	H	M	H	H	M	H	H	H	H	H
1.6 Leadership and Social Responsibility	H	H	H	H	H	H	H	H	H	H	H	H
1.7 Journaling	H	H	M	M	H	L	H	H	H	H	H	H
2.1 Sociological Foundations of Education	H	L	H	H	M	M	H	H	H	H	H	M
2.2 Research Methodology and Statistics in Social Sciences	H	H	H	H	H	M	H	H	M	H	M	H
2.3 Knowledge and Curriculum	H	L	M	M	M	L	M	H	M	H	H	H
2.4 Developing Educational Leadership	M	H	M	H	H	M	H	H	H	H	H	H
2.5 Human Development and Learning	M	H	M	M	M	M	H	H	M	H	H	H
2.6 Peace Education and Conflict Management	M	H	H	H	H	H	M	H	H	H	H	M
2.7 Educational Seminar-I	H	H	H	M	H	M	H	H	H	H	H	H
2.8 Computer Application for Social Sciences (Lab)	H	H	H	M	H	H	L	H	H	H	H	H
2.9 School Visits	M	H	M	H	H	H	H	H	H	H	H	H
3.1 Curriculum Development and Instruction	M	M	H	M	M	L	L	H	H	H	H	H
3.2 Principles and Techniques of Teaching and Pedagogy	H	H	H	H	H	H	H	H	H	H	H	H
3.3 Teacher Education	H	H	H	H	H	M	H	H	H	H	H	H
3.4 Measurement and Evaluation in Education	H	M	H	M	H	M	H	H	M	H	H	H
3.5 Educational Law and Government Policy	M	L	M	H	H	M	M	H	H	H	H	H
3.6 Financial Management and Accounting	M	L	L	L	H	L	M	H	L	H	L	H
3.7 Life Span Development and Education	H	L	H	H	M	M	H	H	H	H	H	H
3.8 Learning and Individual differences	H	H	H	M	M	H	H	H	M	H	H	H
3.9 Dissertation Phase-I	H	H	H	H	H	M	H	H	H	H	H	H
3.10 Educational Seminar-II	H	H	H	M	H	M	H	H	H	H	H	H
3.11 Teaching Practice	H	H	H	H	M	L	H	H	H	H	H	H
4.1 Organisational Communication	H	M	M	M	L	M	H	H	H	H	H	
4.2 Educational Administrati on	M	M	H	L	L	M	H	H	H	H	H	
4.3 Ethics and Social Responsibility in Education	H	M	H	H	H	H	H	H	H	H	M	
4.4 Counselling Skills for Educational Psychologists	H	M	H	L	L	M	H	M	H	H	H	
4.5 Child and Adolescent Mental Health	H	H	M	H	H	M	M	H	H	H	H	M
4.6 Dissertation Phase-II	H	H	H	H	H	M	H	H	H	H	H	H
4.7 Internship	H	H	H	H	M	M	H	H	H	H	H	H

DETAILED SYLLABUS
MA EDUCATION DETAILED SYLLABUS

EDLR0007: LEADERSHIP AND SOCIAL RESPONSIBILITY (3-0-0)

COURSE OUTCOMES

1. State the meaning of leadership and the qualities of a true leader. (Remembering)
2. Discuss the concept of leadership and management and the different theories and stylesof leadership. (Understanding)
3. Analyze the role of individual social responsibility and the social responsibility ofeducators. (Analysis)
4. Identify the role of leadership in the decision-making process and find out thetechniques that improves decision making process. (Application)
5. Discuss the role of leadership in policy formulation and find out the effect of leadership in social entrepreneurship. (Application)

Module I: Leadership and Management (13 Lectures)
Understanding Leadership; Its need and function; Styles and Theories of Leadership Styles of leadership (Autocratic, Democratic, Laissez Faire) and Theories of Leadership (Great Man Theory, Trait Theory, Fiedler's Contingency Theory, Hersey and Blanchard's Situational Theory, Tannenbaum and Schmidt Leadership Continuum); Changing roles of Leadership; Concept of Management, functions of Management, Leadership and Management issues; Discipline in Leadership, Leadership-A bridge to improved practice, Ways to improve Staff Achievement; Staff motivation, Performance and Personal Organization .

Module II: Social Responsibility (10 Lectures)
Concept of Social Responsibility, Types of Social Responsibility, Its need, Changing role; Social Engagement; Individual Social Responsibility and Corporate Social Responsibility, Social Responsibility of the Educators.

Module III: Leadership and Decision Making (12 Lectures)
Decision Making process; Types of Decision Making, Key steps in Decision Making, techniques of effective Decision Making; Barriers towards Decision Making, Ways of mitigating Barriers in Decision Making; Importance of Decision Making in Educational Institution, Organisational Behaviour, Leadership and Decision Making.

Module IV: Leadership Implementation and Implantation (10 Lectures)
Leadership and implantation; Leadership roles in Policy Formulation; Complexity of joint actions; Economic theory and program implementation; Implantation as exploration; Volunteerism; social entrepreneurship.

Suggested Readings

1. Bass, B. M. Transformational leadership: Industry, military, and educational impact, Mahwah,NJ: Erlbaum (1998).
2. David, B. Leadership in Organizations There Is a Difference between Leaders and Managers, New York: University Press of America (2009).
3. Friedman, A. A. Beyond mediocrity: transformational leadership within a transactional framework. International Journal of Leadership in Education, 7(3), 203-224 (2004). doi:10.1080/1360312042000213877.
4. Fullan, M. Leadership and sustainability. New Delhi: Sage publication Ltd. (2005).
5. Kouzes, J.M., & Posner, B.Z. The leadership challenge. San Francisco, CA: Jossey- Bass. (2002).
6. Lee G. & Bolman,T. Deal Reframing Organizations Artistry, Choice, and Leadership. San Francisco: Jossey- Bass.(2008).
7. Rogers, C. Transition, self-regulation, independent learning and goal theory. Psychology of Education Review, 36(2), 26-31 (2012).
8. Starratt, R. Ethical Leadership. San Francisco: Jossey- Bass (2004).
9. Williams, M. Leadership for leaders. New Delhi: Vinod Vasishtha (2006).

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	H	H	H
CO 2	H		M	
CO 3		H		
CO 4	M		H	
CO 5		M		H

EDTE0013: EMERGING TRENDS IN EDUCATION (3-0-0)

COURSE OUTCOMES

1. Recall contemporary issues, techniques in education. (Remembering)

2. Explain/ identify/ classify the contemporary issues and techniques in education.(Understanding)
3. Use the new techniques of teaching in practice. (Application)
4. Appraise the present educational institutions regarding the challenges and hurdlesfaced. (Evaluation)
5. Formulate actionable strategies to prevailing problems in the educational system.(Creation)

Module I: Recent Pedagogical and Delivery Techniques (10 Lectures)
Distance Education – Purposes, functions, organization and management of Distance Education Programme; e-learning – Nature, Characteristics, Styles, Arrangement for e-learning in an educational institution; Virtual Classrooms – Modus operandi, Advantages and Limitations. Teleconferencing and; Video conferencing – Meaning, types, Educational Advantages.

Module II: Recent Techniques in Education (10 Lectures)
Language laboratory - Need, Types, Functioning, Uses and Applications; Team Teaching-Meaning, Definition, Objectives, Principles, Types, Organization, Procedure and steps, Advantages and Limitations; Co-operative learning and collaborative learning-Key elements-Implementing the elements.

Module III: Autonomy, Accountability and Accreditation (8 Lectures)
Autonomy-Meaning, Need; Academic, Administrative and Financial Autonomy, Objectives, Salient Features, Advantages of Autonomous colleges; Accountability and Accreditation; Accreditation process, Assessment and Accreditation –NAAC, NBA-ISO, Accreditation and Certification.

Module IV: Challenges in School Education (10 Lectures)
Current student related Challenges: Parental Involvement, Drugs and Violence, School safety. Current Teacher related challenges: Diverse learning needs, Quality and expectations, Pupil- Teacher ratio. Teacher mentee /mentor programs. Current School related challenges- Technology issues, Bullying, harassment and ragging.

Module V: Learning Environment in Educational Institutions (7 Lectures)
The concept of Institutional environment, The classroom learning environment- Disciplinary problems, The effects of the Institutional environment on Academic performance, Punishment and its effects. Creating Trustworthy school environments; Guidance and Counselling.

Suggested Readings
1. Associates, A. F. Leading Academic Change: Essential Roles for Departmental Chairs. San Francisco: Jossey -Bass Publishers (2000).
2. Associates, H. D. Higher Education in the Era of Digital Competition – Choice and Challenges (2000).Modison: WI Atwood Publishing.
3. Association of Indian Universities. Privatization of Higher Education (2003)
4. Association of Indian Universities: Accountability and Autonomy in Higher Education. (1998).
5. Association of Indian Universities: Excellence in Achieving Social Relevance in Higher Education (1993).
6. Chauhan, S.S Innovations in Teaching Learning Process. New Delhi, Vikas Publication (2004).
7. Gandhi, M.M . Autonomy and Accountability in Higher Education- An Indian Perspective. IOSR Journal of Research and Method in Education (2013). Vol. 3, Issue 5 (Nov-December) pp. 33-37. Retrieved from http://www.iosrjournals.org/iosr-jrme/papers/Vol-3%20Issue-5/F0353337. pdf?id=7370.
8. Govindasamy, T. Successful implementation of e-learning: Pedagogical considerations. The internet and higher education (2001), 4(3), 287-299.
9. Haynes, N. M. Creating safe and caring school communities: Comer school development program schools. Journal of Negro Education (1996), 308-314.
10. Hernes, G and Martin, M. (eds) . Accreditation and the global Higher education market (2008). UNESCO: International Institute for Educational Planning. Retrieved from http://unesdoc. unesco.org /images/0016/001635/163514e.pdf. Accessed on 19 July, 2016.
11. Holmberg, B. . Theory and Practice of Distance Education. 2nd Edition. Routledge (2005).
12. Mangal, S.K. Essentials of Educational Technology. Ludhiana, Tandon Publications (2005).
13. McIsaac, M. S. and Gunawardena, C. N. (2005). Distance Education. Retrieved from http:// www. aect.org / edtech /ed1/pdf/13.pdf. Accessed on 19 July, 2016.
14. Mehta, R. Crisis in Higher Education. Delhi : Kalpaz Publications (2004).
15. Ministry of Human Resource Development Department of Secondary and Higher Education (2005). Report of the Government of India Central Advisory Board of Education (CABE) Committee on Autonomy of Higher Education Institutions. Retrieved from http://mhrd.gov. in/sites/upload_files/mhrd/files/document-reports/Autonomy HEI.pdf. Accessed on 19 July, 2016.
16. Narkhede, S. Challenges of higher Education in India. New Delhi: Sarup and Sons (2001).
17. Pollack, I., and Sundermann, C. Creating safe schools: A comprehensive approach. Juvenile Justice(2001), 8(1), 13-20.
18. Purushotham, H.R. Team Teaching: An Alternative to Lecture Fatigue(2009). Edutracks, 9(1),5-7.

19. Singh, A. and G.D.Sharma. . Higher Education in India: The Institutional Context (ed.), NewDelhi: Konarch(1989).

Mapping of COs to syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO1	H	H	H	H
CO2	H	H		
CO3	M	H		
CO4	M	M	H	H
CO5				H

EDDE0014: HISTORY AND DEVELOPMENT OF EDUCATION IN INDIA (3-0-0)

COURSE OUTCOMES

1. Recall the characteristic features of education in ancient India, Pre- Independent India and post- Independent India. (Remembering)
2. Explain, compare and draw generalizations about the various educational commissionsand policies. (Understanding)
3. Justify the relevance of different educational features from ancient to post-independent India in present day educational system. (Application)
4. Critically analyze the various policies and commissions in terms of their relevance andimplementation. (Analysis)
5. Trace the contribution of each period to the shaping of the present education system.(Evaluation)
6. Construct ways and means of improving the quality and quantity of Indian educationsystem. (Creation)

Module I: Ancient Indian Education (8 Lectures)

Fundamentals of Ancient Indian Education, Salient features, purpose of studying Vedas, Relevance of Ancient Indian education in the 21st Century. Chief Characteristics of Vedic Educational System; Education in post Vedic (Buddhist) period – features; Female education; Swadhyaya (Self-Education, State patronage and Growth of education, Primary Education (Maktabs), Higher Education (Madrasas), Female Education, Student and Teacher relationship

Module II: Education during Pre Independent India (13 Lectures)

Anglicization of Education 1836-1855- Exponents of Oriental Education, The Anglicists, Macaulay's Minutes and its effect, Wood's Despatch – 1854, India Education Commission regarding Primary, Secondary and University Education, The University Commission (1902), The Hartog Committee (1928-29), The Filtration Theory of Education. Important Development in Education during 1921-1931- Inter University Board, Establishment of new Universities, Teachers Training, Technical Education

Module III: Education during Post Independent India (14 Lectures)

Various Commission and policies in Education - Secondary Education Commission 1953, Education Commission 1964-66, National Policy on Education 1986, Ramamurthy Review Committee 1990, National Commission on Teacher 1983-85, Problems of Indian Education- Wastage and Stagnation, Examination Reform, Inclusive Education and Education of the Marginalized.

Module IV: Current Government Policies (10 Lectures)

DPEP, National policy on ICT, Panchayat Raj Act, Rashtriya Madhyamik Shiksha Abhiyan, Rashtriya Uchchatar Shiksha Abhiyan ,SSA, RTE, NAEP, National Knowledge Commission, NAS, SPQEM, NEP-2020.

Suggested Readings

1. Acharya, P. Indigenous vernacular education in pre-British era: Traditions and problems. Economic and political weekly, 1981-1988. (1978)
2. Dash, M. Education in India: Problems and Perspectives, Eastern Book Corporation (2000)
3. Ghosh, S. C. History of Education in India, Eastern Book Corporation. (2007)
4. Govt. of India, report of the University Education Commission, Vol -I, Simla.(1949)
5. Jain, M. History in the New NCERT Textbooks Fallacies in the IIIC Report, Delhi NCERT. (2003)
6. Lall, M. The Challenges for India's Education System, Chatham House: London (2005)
7. M.H.R.D, Report of the University Education Commission (1948), Ministry of Education, New Delhi, Govt. of India (1948)
8. M.H.R.D. Challenges of Education (1985). A policy perspective, Ministry of Education, New Delhi, Govt. of India (1985)
9. M.H.R.D. Report of the Secondary Education Commission (1952). Ministry of Education, New Delhi, Govt. of India (1952)
10. Mookerji, R. K. Ancient Indian Education: Brahmanical and Buddhist, Delhi, Motilal Banarsidass Publishers. (1990)
11. Naik J.P. The role of govt. of India, Ministry of Education (1963)
12. Nurullah S., Naik J.P. and Oad L.K. . A student history of education in India, Mumbai: McMillan and Co.(1970)
13. Ramchandra, P. and Ramkumar V., Education in India. Eastern Book Corporation. (2005)
14. Rawat, P. L. , History of Indian Education: Ancient to Modern, Delhi Bharat Publication.(1956)
15. http://mhrd.gov.in/sites/upload_files/mhrd/files/document-reports/NPE86-mod92.pdf

16. http://www.teindia.nic.in/Files/Reports/CCR/Yash%20Pal_committe_report_lwb.pdf
17. http://ncte-india.org /ncte_new/pdf/NCFTE_2010.pdf
18. http://www.ncert.nic.in/rightside/links/pdf/framework/english/nf2005.pdf
19. MHRD. National Education Policy 2020. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

Mapping of COs to syllabus

Course Outcomes	Module I	Module II	Modul III	Module IV
CO1	H	H	H	H
CO2		H	H	H
CO3	M	H	H	H
CO4		H	H	H
CO5	M	H		
CO6			M	H

EDET0015: EDUCATIONAL TECHNOLOGY (3-0-0)

COURSE OUTCOMES

1. State the nature, scope and approaches of Educational Technology. (Remembering)
2. Describe the teaching models and explain the concept of instructional design. (Understanding)
3. Analyze the different instructional approaches in the process of teaching and learning.(Analysis)
4. Discuss the nature of the process of communication and the application of ICT in the teaching learning process. (Application)
5. Identify the various software and hardware and state its use both in face to face and virtual classroom platforms. (Application)

Module I: Educational and Behavioural Technology (13 Lectures)
Meaning, nature and scope; Historical perspective of Educational Technology; Approaches- Software, hardware and system; Utility and problems of Educational technology in Formal and non-formal education; Behavioural Technology: teacher behaviour and teaching behaviour, teaching skills, Micro Teaching; SSST and FIACS.

Module II: Designing Instructional System (12 Lectures)
Teaching learning process, variables, levels, functions, taxonomies of instructional objective, instructional strategies, PI, PSI, MI, CAI, BMLS.

Module III: Process of Communication and ICT (10 Lectures)
Concept and process of communication, Barriers to communication, Principles of communication,Mass Media and multimedia; Concept and need of ICT.

Module IV: Emerging trends in Educational Technology (10 Lectures)
Distance Education; Open learning system; New technologies- Videotapes, Radio, Teleconferencing, CCTV, INSAT, EDUSAT, Internet, Broadband; Resource centres for Educational Technology: CIET, UGC, IGNOU, NIOS; 3D printing, mobile learning, Gamification, Flipped, blended learning /classrooms, Cloud computing, Massive open online course (MOOCs), Flash notes, Virtual Reality, Wearables, etc.

Suggested Readings

1. Ahalt, S. Ten Emerging Educational Technology. Renci White paper Series, Vol. 3, No. 1 pp.1-18 (2015).
2. Barle David , The Process of Communication, Holt and Rinerhart New York (1960).
3. Bhatia, R.L. and Ahuja, B.N. Educational Technology. New Delhi: Surjeet Publications.
4. Bhatta B.D. and Sharma, S.R. Educational Technology- Concept and Techniques, Kanishka Pub. House New Delhi.(1992).
5. Dale Edgar. Audio Visual Methods in Teaching, Holt Rinehart and Einston, New York.(1961).
6. Das R.C.Educational Technology-A basic Text, Sterling, New Delhi. (1993).
7. Dhand,H., Techniques of Teaching, APH Publishing Corporation.
8. Hooft, M. V. Mobile, Wireless, connected information clouds and learning. Emergingtechnologies for learning. Vol. 3.pp. 30-46.(2008).
9. Jangira N.K. and Ajit Singh. Core Teaching Skills: The Micro Teaching Approach, NCERT, NewDelhi.(1982).
10. Joyce, and B Weil, Models of Teaching, Prentice Hall, New Jersey.
11. Mangal S.K. Foundations of Educational Technology, Prakash Brothers Ludhiana.
12. McIsaac, M. S. and Gunawardena, C. N. (2005). Distance Education. Retrieved from http://www.aect.org /edtech/ed1/pdf/13.pdf. Accessed on 19 July, 2016.

13. Nayak, A.K. Classroom Teaching Methods and Practices: APH, Publishing Corporation.
14. Passi, B.K. Becoming Better Teacher, Micro Teaching Approach, Sahita Mudranalya,Ahmedabad.(1976).
15. Sachdeva, M.S. A New Approach to Educational Technology, Vinod Publications.
16. Sharma R.A. Technological Foundations of Educational Publications Meerut.
17. Sharma, R.A. Technology of Teaching: International Publishing House.(1983)
18. Venkataiah: Educational Technology, APH Publishing Corporation New Delhi.
19. Walia. J.S. Essentials of Instructional Technology; Paul Publishers Punjab.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			H
CO 2		H		M
CO 3		H		
CO 4			H	H
CO 5	H			H

SPECIALISATION: EDUCATIONAL LEADERSHIP

EDEL0019: DEVELOPING EDUCATIONAL LEADERSHIP (3-0-0)

COURSE OUTCOMES

1. Explain the importance of education and describe the educational system andinstitutions (Understanding)
2. Appraise the nature of collaboration and role played by stakeholders in the field ofeducation. (Evaluation)
3. Critically analyze the curriculum content and pedagogy existing in schools. (Analysis)
4. Illustrate the role of leadership in the process of inclusion. (Application)
5. Describe the various features of good leadership in the field of education.(Remembering)

Module I: Education system and Institutions (15 Lectures)

a. Education as an ideal (What is education?; Aims of education); Education as a system; School as a social institution.
b. Decentralisation of Education: Education- a concurrent subject in the Constitution; Structure of the educational system in India; Study of the structure at the state level; Linkages within the system.
c. Roles and responsibilities of the personnel involved: Teacher as an academic leader, Head teacher as a school leader, CRC, BEO, DEO, DIET Principal, SCERT Director, NCERT Director, Panchayati Raj Institutions.
d. Reflecting on one's own experiences of schooling to understand school as a social institution, nature of relationships among the various stakeholders in the school and overarching values as stated by the school

Module II: Stakeholder Collaboration (10 Lectures)

a. Parent, learners, community, teachers as stakeholders: their expectations and roles. Ensuring their participation.
b. Analysis of research on impact of stakeholder participation, challenges and principles for successful collaboration.

Module III: Leadership for Inclusion (10 Lectures)

a. School Culture: Meaning and components; Hidden curriculum.
b. Zones of exclusion. Analysing curriculum-content and pedagogy to critically examine school processes; Identifying school processes that cause exclusion.
c. Synthesizing principles of inclusive institutional culture.

Module IV: Constructing 'Educational Leadership' (15 Lectures)

a. Leadership for quality education, equity and inclusion, continuous professional development of teachers, creation of learning communities, ensuring autonomy of learners, teachers and other staff, contextualisation of the curriculum.
b. Crafting vision and mission for an educational institution. Critical review of the vision based on the parameters of educational aims, ideals of administration and values of democratic society. Assess an educational issue to arrive at strategic principles, action plans, resource management to address the issue.

Suggested Readings

1. Apple, M. W., & Beane, J. A. Democratic schools. Association for Supervision and Curriculum Development, 1250 North Pitt Street, Alexandria, VA 22314 (1995).
2. Batra, S. (2003).From School Inspection to School Support. In Sood, N. (ed). Management of School Education in India. NIEPA: New Delhi. 2. Early, P., and Weindling, D. (2004).
3. Cheney, G. R., Ruzzi, B. B., & Muralidharan, K. A profile of the Indian education system. Prepared for the New Commission on the Skills of the American Workforce.(2005).
4. Dewey, J. Democracy and Education. New York: Macmillan. (1916).

5. Fullan, M. Why Teachers Must Become Change Agents. In Educational Leadership, 50 (6).(1993).
6. Govinda, R. Capacity Building for Educational Governance at Local Levels. Paper presented at the International Consultation on Educational Governance at Local Levels. Held at UNESCO, Paris 27-28 February 2001.(2001).
7. 7. NCERT. position paper on aims of education. New Delhi: NCERT Preamble to the Constitution of India concerning values for teachers.(2006).
8. School as a social institution, Andre Baitelle.
9. Sheshagiri K.M. Decentralisation of Education in India: Reflections from Kerala and Rajasthan.
10. Wren, D. J. (1999). School culture: Exploring the hidden curriculum. Adolescence, 34(135), 593.
11. A Changing Discourse: From Management to Leadership. In Early, P. and Weindling, D. (ed). Understanding School Leadership. Paul Chapman Publications: UK.
12. Senge, P. M. (1990). Organizations as learning communities.
13. Pollard, A. (2002). Reflective Teaching. Continuum: London. Chapters – 1,8,9. 39.
14. Hargreaves, A. (2000).Teachers and Teaching: History and Practice, Vol. 6, No. 2, 2000 Four Ages of Professionalism and Professional Learning.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			M
CO 2		H		
CO 3			H	M
CO 4			H	
CO 5	M			H

SPECIALISATION: EDUCATIONAL PSYCHOLOGY

EDDL0020: HUMAN DEVELOPMENT AND LEARNING (3-0-0)

COURSE OUTCOMES

1. Explain the nature of child and childhood education. (Understanding)
2. Characterize the nature of human growth, maturation and development. (Application)
3. Appraise the nature and theories of development. (Evaluation)
4. Describe an understanding about adjustment mechanism in social context.(Remembering)
5. Classify the differently abled persons and discuss their educational implications.(Analysis)

Module I: Understanding Child and Childhood (10 Lectures)

Importance of understanding child and childhood; capabilities of children belonging to different socio-economic and cultural backgrounds; idea of multiple childhood; nature-nurture debate; language development; learning and acquisition; promoting autonomy in children.

Development of case studies of children belonging to different backgrounds

Module II: Development and Learning (10 Lectures)

Stages of development; growth and maturation; Adolescence: why it is a sensitive period, the importance of recognizing issues related to adolescence; Erikson's stages of psycho-social development; Vygotsky's theory on social constructivism; concept of tools; zone of proximaldevelopment, Piaget and Vygotsky debate.

Developing a personal narrative of experiences of adolescence

Module III: Enabling learning (10 Lectures)

Bronfenbrenner's ecological systems; theory of development; social context of learning; enabling school environment; promoting independence of thought and action; parenting at different stages of development.

Students analyze views of parents on parenting and child care practices. Quality frameworks.

Module IV: Psychology of Adjustment and Adjustment Mechanisms (6 Lectures)

Adjustment as a process; a theory of cognitive adaptation. frustration and conflict; causes of maladjustment; contribution of Freud, Adler, Jung and Neo-Freudians to understand maladjustment, adjustment mechanisms. conflicts and defence mechanisms, mental hygiene.

Module V: Differently-abled persons and learning (9 Lectures)

Understanding differently abled persons; educational implications: ADHD, autism, dyslexia. juvenile delinquency.

Develop a detailed discussion paper on various kinds of learning difficulties

Suggested Readings

1. Arkoff & Abe. ‘ Adjustment and Mental Health’ .New York, McGraw- Hill (1968).
2. Bjorklund, D. ‘Child and Adolescence Development-an integrated approach’. Blasi
3. Wadsworth Cengage Learning Publications. (2010).
4. Bronfenbrenner,Urie. ‘The ecology of human development’. Harvard University Press
5. Cambridge. (1979).
6. Crow & Crow. ‘Understanding Our Behavior ’. N.Y. Alfred A Knoff Publications(1956).
7. Erickson, H.Erik. ‘Childhood and Society’. W.W. Norton Publication.(1993).
8. Erickson, H.Erik. ‘Stages of Psychosocial Development ’. Green Verlag, Gmbtt(2005) .
9. Freud S. ‘Psychopathology of Everyday Life-The Basic Writings of Sigmund Freud.’ New York,
10. Modern Library.(1938).
11. Kostelnik, J.M., Gregory,M.K., Soderman. K.A., & Whiren, P.A. ‘Guiding children’s social development and learning ’. Wadsworth Cengage Learning Publications(2012).
12. Kozulin A.,Gindis, B., Ageyev.,S.V & Miller, M.S. ‘Vygotsky’s Educational Theory in Cultural
13. context ’. Cambridge University Press.(2003).
14. Lahner, George. ‘ The Dynamics of Personal Adjustment ’. New Jersey: Prentice –Hall. (1964).
15. Lerner, J. ‘Learning Disabilities-Diagnosis and Teaching Strategies’. Boston HoughtonMifflin.(1985).
16. Lock, A & Strong, T. ‘Social Constructionism – Sources and Stirrings in Theory and
17. Practice’. Cambridge University Press (2010).
18. Mangal, S.K. ‘Educating Exceptional Children-An Introduction to Special Education’ .PHI
19. Learning Private Limited,Delhi(2010).
20. Mangal, S.K. Abnormal Psychology ’ N.D-Sterling Publications (revised edition)(1987). ‘
21. Mangal, S.K. ‘Advanced Educational Psychology ’. PHI Learning Private Limited,Delhi,(2002).
22. McLounghlin, J.A and Netick, A. . ‘Defining Learning Disabilities- A new and co-operative
23. direction ’.Journal of Learning disabilities.(1983).
24. Newman,M.B & Newman, R.P. ‘Development through Life-A psycho-social approach’.12th
25. edition, Cengage Learning Stamford.(2006).
26. Sinha, AKP, Singh, R.P. ‘Manual for Adjustment, Inventory for College Students’. Agra,
27. National Psychology Corporation. (1971).
28. Telford, C.W & Sawrey, J.M. ‘ The Exceptional Individuals’ .New Jersey,Prentice-Hall. (1967).

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H		M	
CO 2		H		H
CO 3			H	
CO 4			H	
CO 5	M			H

EDTP0022: PRINCIPLES & TECHNIQUES OF TEACHING AND PEDAGOGY (3-0-0)

COURSE OUTCOMES

1. Explain the nature of teaching. (Understanding)
2. Mention the theories of teaching and different models of teaching. (Analysis)
3. Distinguish the different methods of teaching. (Application)
4. Narrate the concept of pedagogy in the process of teaching and learning. (Evaluation)
5. Communicate the various Recent Developments in Pedagogy. (Application)
6. Describe the aspects of teaching in connection to various skills. (Analysis)

Module I: Concept and aspects of teaching (10 Lectures)

Teaching: Concept, nature and scope; Teaching competency: Understanding the child, understanding the subject, contextualization, punctuality, regularity, integrity, humility, accountability, humanism, empathy, enthusiasm; Skills of teaching: Explaining, questioning, stimulus variation, reinforcement, achieving closure, etc.; Integration of different teaching skills and Strategies of teaching: Autocratic, Permissive, Democratic. Study the biographies of famous teachers and develop teacher profiles within historical and contemporary perspectives.

Module II: Theories and models of teaching (10 Lectures)

Principles and maxims of teaching; Theories of teaching: behaviourism, cognitivism, constructivism, co-operative approach; Models of teaching: information processing models, social models, behavioural models and personal models Demonstration on models of teaching by students.

Module III: Teaching Methods (15 Lectures)
Teacher-centred methods: lecture, demonstration, team-teaching, mastery learning strategy; Learner-centred methods: programmed learning, personalized system of instruction, problem solving method; Activity-centred methods: seminar, workshops, peer-tutoring, group discussion, projects, heuristic method, panel discussion, brainstorming, symposium and role-play; Teaching aids: significance, types and uses Classroom teaching practice.

Module IV: Recent developments in Pedagogy (10 Lectures)
Pedagogy: concept and significance; History of pedagogy: Indian, Greek and Roman history of pedagogy; Innovative pedagogy: crossover learning, learning through argumentation, incidental learning, learning by doing, embodied learning; Pedagogical approaches for diversity in societyand its interface with the classroom.
Analysis of teaching in a real classroom situation

Suggested Readings
1. Aggarwal, J. C. Principles, methods and techniques of teaching. Delhi: Vikas Pub House.
2. Anderson. L. W.et al. International Encyclopedia of Teaching and Training Education,Pergmon press.
3. Joyce, B. & Weil, M. Models of teaching. New Delhi: Prentice Hall.
4. Jangira, N. K.Professional Enculturation: Innovative Experiments in Teaching and Training,New Delhi; Bookworth of India.
5. Ashton-Warner, S. Teacher. New York: Simon & Schuster.
6. Hall, G. E. & Quinn, L. F. & Gollnick, D. M. Introduction to Teaching: Making a Difference in Student Learning. Sage Publisher.
7. Puri, U. Teaching Techniques. ND: Pragun.
8. Sharma, B. L. & Saxena B. M. Methods of Teaching. Meerut: R. Lall.
9. Sharma, T. R. & Bhargava, R. Modern Teaching Aids. Agra: HP Bhargav Books.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M	H	H
CO 2	H	H	M	H
CO 3	M	H	M	
CO 4	H		H	H
CO 5	M	M	H	H
CO 6	H		M	

EDTE0023: TEACHER EDUCATION (3-0-0)

COURSE OUTCOMES
1. Describe the concept of teacher education. (Understanding)
2. Explain teaching as a profession. (Application)
3. Identify the structure of teacher education programmes. (Application)
4. Illustrate the recent trends of teacher education. (Remembering)
5. Prepare the course structure of Teacher Education with integrated Teacher EducationProgrammes. (Analysis)
6. Distinguish the various aspects of teaching as a profession. (Evaluation)

Module I: Concept and Fundamentals of Teacher Education (13 Lectures)
Meaning, nature and scope of teacher education; Aims and objectives of teacher education; Historical perspectives of teacher education - Kothari Commission, National Commission on Teachers (1983-85), NPE (1986), Revised POA (1992); Recent developments in teacher education - NCF 2005, NKC 2007 & NCFTE 2009. History and status of Teacher Education in North East India. Problems and issues of Teacher Education in N.E. India. Comparative analysis of Teacher education in the past and present.

Module II: Teaching as a Profession (12 Lectures)
Approaches to teacher education: Behaviouristic and constructivist approaches; Modification of teaching behaviour: Simulated teaching, Flanders' Interaction Analysis; Performance appraisal of teacher; Teacher effectiveness; Code of conduct and ethics in teacher education.
Classroom observation and analysis using Flanders' Interaction Analysis.

Module III: Structure of Teacher Education Programmes (10 Lectures)
Role of professional organizations and bodies of Teacher Education; Pre-service and In- service teacher education; Teacher education by open and distance learning; Role of different agencies in quality assurance – MHRD, UGC, NCERT, NCTE, SCERT, NAAC, RIE, SIE, IASE, UGC-HRDC
Analysis of a distance learning teacher education programme

Module IV: Recent trends in Teacher Education (10 Lectures)
Internship, Practice teaching for developing an effective teacher, Integrated Teacher education programme; Action research; ICT in teacher education; preparing teachers for inclusive classrooms; Issues and challenges in teacher education. Analyse the course structure of an integrated teacher education programme.

Suggested Readings

1. Aggarwal J.C. Teacher education, theory and practices. New Delhi: Doaba Home.
2. Altekur. A.S. Education in ancient India. Banaras: Nand Kishore Bros.
3. Anderson.L.W. et al. International Encyclopedia of Teaching and Training Education.Pergmon press.
4. Biddle, B. J. and Ellena. Contemporary research on teacher-effectiveness.
5. Buch. M.B. First survey of research in Education. Baroda: SERD.
6. Buch.M.B. Second survey of research in Education. Baroda: SERD.
7. Buch.M.B. Reading in in-service education. Sardar Patel Palasane, M.M. University.
8. Dunkin Michael J. The international encyclopedia of teaching and teacher education, Pergmon education forum, Vol 4 no 12, New York.
9. Harvilas, S. and Naik .J.P. A history of education in India. Bombay: Macmillan and co.
10. Hittlilman, D.R. A model for a competency based teacher preparation in Program-teacher education Forum, vol 4 no 12, New York.
11. Jangira N.K. Teacher training and teacher effectiveness an experience in Teaching. New Delhi: National Publishing House.
12. Kumar. T. P. Teacher education. APH Publishing Corporation.
13. NCERT: The Third Indian year book on education. New Delhi: NCERT. 1968.
14. NCTE, Teacher education curriculum (1978): A Framework. New Delhi: NCERT.
15. Shrimali .K.L. Better teacher Education. New Delhi: Ministry of education Govt. of India.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	M	H	H	M
CO 2	H	M	H	H
CO 3	H	H	H	H
CO 4	M	M	M	H
CO 5	H	H	H	H
CO 6	H	H	H	M

EDME0024: MEASUREMENT AND EVALUATION IN EDUCATION (3-0-0)

COURSE OUTCOMES
1. Describe the conceptual framework of educational measurement andevaluation.(Applying)
2. Mention different dimensions of educational measurement and evaluation.(Remembering)
3. Explain the concepts of reliability and validity of test scores. (Remembering)
4. Identify the tools and techniques to be used in the process of educational measurementand evaluation (Analyzing)
5. Apply the process of construction and standardization of tools. (Applying)
6. Find out reliability and validity of a tool. (Applying)

Module I: Educational Measurement (7 Lectures)
Overview of measurement and assessment; Types of measurement - psychological and physical; Functions of measurement - Prognosis, Diagnosis, Research; Scales of measurement, Properties and Types - Nominal, Ordinal, Equal interval, Ratio; General problems of measurement; High stakes' testing, Performance and portfolio assessment.
Critical evaluation of the current trends in educational measurement

Module II: Dimensions of Educational measurement and Evaluation (10 Lectures)
Diagnostic, Aptitude, Achievement, Intelligence; Mode of assessment - formal, informal, formative, summative, continuous, terminal, process, product, internal and external; Process of assessment - Teacher-made test, standardized test, Norm reference test and criterion reference test.
Review of Stanford-Binet Test and General Aptitude Test Battery (GATB)

Module III: Reliability and Validity of a Test (8 Lectures)
a. Overview of reliability - Methods of estimating reliability with computation - test retests method, Equivalent forms method, Split half method, Kuder-Richardson method; Inter-rater consistency; Interpreting reliability coefficient; factors influencing reliability measures.
b. Nature of validity, major considerations in validation – content consideration, construct consideration, test-criterion relationship, consideration of consequences; Methods of estimating validity; factors influencing validity; Relationship

between reliability and validity.
Practice session on estimating reliability and validity.

Module IV: Tools and techniques for educational measurement (10 Lectures)
Overview of constructing various types of objective tests; Guidelines for writing objective test items; Essay questions: forms, uses, guidelines for constructing, scoring criteria. Interpretive exercises: nature, forms, and uses of the interpretive exercises, Advantages and limitations.
Administration of a group test of intelligence using a standardized tool.

Module V: Standardization of a test (10 Lectures)
Planning the test: Determining the objective and test specification, preparing the preliminary format- writing, arrangement, review and editing of test items; tryout of the test - administration, scoring and item analysis; preparing the final form of the test - selection of items, fixing the time limit, direction to the examinee, preparation of scoring key; administration of the final form of the test- determining validity, reliability, norms, standard scores; manual of the test, interpretation of test results, characteristics and uses of standardized test.
Students will prepare, administer and standardize a test, following the set procedures of standardization of a test.

Suggested Readings

1. Gregory, R. J. Psychological testing: History, principles and application. Delhi: PearsonEducation pvt. Ltd.
2. Kaplan, R.M. & Saccuzzo, D. P. Psychological testing: Principles, applications, and issues. Kundli Haryana: Thomson Wadsworth.
3. Kubiszyn, T. & Borich, G. Educational testing and measurement: Classroom application and practice. Kundli Haryana: John Wiley & Sons, Inc.
4. Linn, R. L. & Gronlund, N. E. Measurement and assessment in teaching. New Delhi: PearsonEducation.
5. Sharma, R. A. Essentials of measurement in education and psychology. Meerut: R. Lall BookDepot.
6. Sidhu, K. S. New approaches to measurement and evaluation. New Delhi: Sterling PublishersPvt. Ltd.
7. Ebel, R. L. & Frisbie, D. A. Essentials of educational measurement. New Delhi: Prentice-Hall ofIndia Pvt. Ltd.
8. Patel, R. N. Educational evaluation theory and practice. Mumbai, India: Himalaya PublishingHouse Pvt., Ltd.
9. Singh, A. K. Tests, measurements, and research methods in behavioural sciences. Patna: Bharati Bhawan Publishers and Distributors.
10. Swain, S. K., Pradhan, C., & Khatoi, P. K. Educational measurement statistics and guidance. New Delhi: Kalyani Publishers.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H		M	
CO 2		M		H
CO 3	H		H	
CO 4	M			H
CO 5		H	H	
CO 6	H			H

SPECIALISATION: EDUCATIONAL LEADERSHIP

EDFM0026: FINANCIAL MANAGEMENT AND ACCOUNTING (3-0-0)

COURSE OUTCOMES
1. Describe accounts and finance in relation to education. (Application)
2. Illustrate the various processes of taxation regulations related to education. (Evaluation)CO3Work out the double entry accounting. (Analysis)
3. Illustrate the process of budgetary control and Auditing. (Application)
4. Identify the Process of Deduction of Tax and computation of Tax at source.(Remembering)
5. Explain the importance and working of Balance Sheet in accounting. (Evaluation)

Module I: Introduction (8 Lectures)
Evaluation of Financial Accounting; Difference between Accounting and Bookkeeping; Accounting Concepts; Principles, Bases and Policies.

Module II: Journal (8 Lectures)
Double Entry Accounting; Journal; Posting; Ledger.

Module III: Balance Sheet (8 Lectures)
Trial Balance; Final Account – Trading Account, Profit And Loss Account, Receipt And Payment Account; Income Expenditure Accounts; Balance Sheets.

Module IV: Financial Management (10 Lectures)
Decision Making; Meaning and Scope; Cost Analysis; Budgetary Control; Standard Costing; Financial Analysis; Relevant Cost; Management Accounting Framework; Function of Management Accounting; Internal Audit; School Accounting and Auditing; Investment.

Module V: Taxation Management (11 Lectures)
Basic Concepts; Deduction from Gross Total Salaries; Income From House, Property; Profits and Gains of Business and Profession; Capital Gains; Income from other Sources; Set off and Carry Forward of Losses; Assessment of Individuals and Computation of Tax at Source, Assessment of Companies and Fringe Benefit and Service Tax. VAT/ GST.

Suggested Readings

1. Block, S. B., G. A. Hirt, & B. R. Danielsen. Foundations of Financial Management. New York,NY: McGraw-Hill/Irwin.
2. Das, K.R., Sinha, K.M., & Choudhury, P. Theory and practice of bookkeeping and accountancy. Guwahati: lawyers book stall.
3. Lal, J & Srivastva, S. Financial Accounting: Principles & Practices. New Delhi: ChandPublications.
4. Wilson, M. Advanced Accountancy. Chennai: Scitech Publications.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	H	M	H
CO 2	H	H	H	H
CO 3	H	H	H	M
CO 4	H	H	H	H
CO 5	M	M	M	H
CO 6	H	H	H	M

EDLE0027: LIFE SPAN DEVELOPMENT AND EDUCATION (3-0-0)

COURSE OUTCOMES
1. Recognize the meaning, concept, process, nature, and scope of life, development, lifespan development, and emotions of an individual. (Remembering)
2. Understand the biological bases and anatomical structures controlling human development along with understanding emotional development and its associatedcomponents. (Understanding)
3. Analyze theories of development M1 and issues of human development at variousstages. (Analysis)
4. Apply the principles and knowledge of the theories of development and human anatomy in educating children as well as mitigating bio-psycho-socio-emotional issues.(Application)
5. Evaluate the influence of socialization on the development process of an individual.(Evaluation)
6. Creating models to bring about a balanced emotional development of students.(Creation)

Module I: Introduction to LifeSpan Development (8 Lectures)
Life Span Perspective: Importance of studying Life-Span Development, Characteristics of life-span development, Nature of Development, Scope of Lifespan development. Theories of Development (Brief discussion of all theories), Influence of Socialization and Development.
Analyze the role of education in socialization and development of the child.

Module II: Biological Bases of Human Development and Anatomy of the Nervous system (14 Lectures)
The Evolutionary perspective and Heredity-Environment Correlations, genetic foundation, Conception, effect of Teratogens on Prenatal Development, Neonatal health - Low birth weight, Neonatal Assessment; Neuron: Structure, types and functions. Structure of the nervous system, physiological basis of the action potential (neural response); Structure and function of the brain: fore brain, midbrain, hindbrain, cerebral cortex, temporal, parietal and occipital lobes; prefrontal cortex; The effect of hormones on the nervous system
Debate on heredity and environment: essential factors affecting human development.

Module III: Physical development across lifespan (11 Lectures)
Physical growth during childhood, adolescence and old-age brain development across lifespan, Bio- Psycho- Social health model, aging, biological theories of aging and death.
Discussion on educational implications of stages of physical development.

Module IV: Emotional and Moral Development (12 Lectures)
Development of Emotion, Temperament, Attachment, Love, intimacy, sexuality, self-identity, gender identity and personality across the life span.
Theories of moral development. Changes in moral reasoning (Kohlberg 's Theory). Development of values, Religion, Spirituality and Meaning in Life, Fowler 's Theory
'Emotions are springs of human actions'- A group discussion on teachers' role in bringing about balanced emotional development of students.

Suggested Readings

1. Berk, L.E. Child Development. New Delhi: Prentice Hall.
2. Bhaskar, R. Fundamentals of child psychology. Delhi: Swastik Publishers and Distributors.
3. Carlson, N.R. Physiology of behaviour. Boston.
4. Chatterjee,C., Suhita, P., Priyadarshi,C. and Vijayaraghavan, M.(Eds). Discourses on Aging andDying. Los Angeles: Sage.
5. Hurlock, E.B. Child development. New Delhi: Tata McGraw-Hill Publishing Company Limited.
6. Hurlock, E.B. A Life-Span Approach. New Delhi :Tata McGraw-Hill Publishing CompanyLimited.
7. Leukel, F. Introduction to physiological psychology. New Delhi: CPS Publishers.
8. Mallon, B. Dying, death and grief, working with adult bereavement. Los Angeles: Sage.
9. Mishra, A.K. Psychology of Aging. Jaipur: Sublime Publications.
10. Morgan, T.H and Steller, A.(1965).Physiological Psychology. New York: McGraw Hill.
11. Santrock, J.W. Life –Span development. New Delhi: Tata McGraw-Hill.
12. Santrock,J.W. Child Development. New Delhi: Tata McGraw-Hill Edition.
13. Sharma,R. N. and Sharma, R. Child Psychology. New Delhi: Atlantic.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			M
CO 2		H		H
CO 3	H	H		
CO 4	M	H	H	H
CO 5	H			
CO 6				H

EDLI0028: LEARNING AND INDIVIDUAL DIFFERENCES (3-0-0)

COURSE OUTCOMES

1. Recognize the concept, nature, process, laws, types, and methods of learning.(remembering)
2. Understand the relationship of learning with interest, motivation, maturation, andindividual difference. (Understanding)
3. Analyse various factors influencing learning. (Analysis)
4. Apply the laws and theories of learning, use components of learning to solve problems, and utilize the knowledge of individual differences to facilitate adequate provisions. (Application)
5. Evaluate the educational implications of learning and effectiveness of learning styles.(Evaluation)
6. Create a conducive environment of learning. (Creation)

Module I: Understanding Learning (10 Lectures)
Learning: Concept and Scope; Nature of learning: learning as a process and learning as an outcome; Laws of learning; Types of learning: factual, associations, conceptual, procedural, generalizations, principles and rules; Methods of effective learning; Learning curves - Types, features and its educational implications; Plateaus in Learning; Learning styles.
Students analyze their own learning styles.

Module II: Factors Influencing Learning (12 Lectures)
Factors influencing learning - Intellectual, Emotional, Physical and Social; Concept and nature of attention, determinants of attention, relationship with interest; Concept, nature and types of motivation – intrinsic, extrinsic and achievement; Learning and maturation; Learning to think, reason and solve problems
Discuss the role of a teacher in addressing various factors influencing learning.

Module III: Transfer of learning (10 Lectures)
Transfer of learning - Concept, Importance, Nature; Types of transfer of learning; Theories of transfer of learning - Theory of mental discipline, Theory of identical elements, Theory of generalization and theory of ideals; Methods of enhancing transfer of learning.
Developing a narrative of personal experiences on the basis of transfer of learning in various situations.

Module IV: Individual Difference (13 Lectures)
Concept of individual difference; Dimensions of individual difference; Determinants: Role of heredity and environment, their inter-relationship; Types/varieties of individual differences - Physical, mental, motor, emotional, interest and aptitude, attitudes, social and moral development. Individual difference and education; Influence of individual differences on learning outcomes; Provisions for individual differences in educational institutions; Implications of individual differences for organizing educational programmes Sharing session on the problems and issues related to individual differences as faced by the students.

Suggested Readings

1. Bhatnagar, S. Advanced Educational Psychology. Agra: Bhargava Book House.
2. Chand, T. Educational Psychology. Agra: Bhargava Book House.
3. Crow, R.B. & Crow, A. Educational Psychology. New Delhi: Eurasia Publishing House.
4. Dececee, J. P. The Psychology of Learning & Instruction. New Delhi, Prentice Hall.
5. Dhir, R.N. Educational Psychology. Chandigarh: Abhishek Publication.
6. Driscoll, M. P. Psychology of Learning for Instruction. Boston, Allyn and Bacon.
7. Gagne, R. M. The Conditions of Learning. New York, Rinehart &.Winston.
8. Guilford, J.P. The Nature of Human Intelligence. New York: McGraw Hill.
9. Hall, C & Hall, E. Human relations in education. Routledge.
10. Holt, J. How children fail? Penguin.
11. Hulac, D. M., & Benson, N. Getting Students to Work Smarter and Harder: Decreasing Off- Task Behaviour through Interpersonal Techniques. School Psychology Forum,5(1), 29-36.
12. Judd, C.H. Educational Psychology, Guwahati: Nivedita DK Distributions.
13. Kumar, K. What is worth teaching? Orient Black Swan.
14. Kuppuswamy, B. Advanced Educational Psychology. Jalandhar: Jalandhar University.
15. M. Gauvain & M. Cole, (Eds). Readings on the development of children. New York: W. H.Freeman & Co.
16. Mangal, S. K. Essentials of Teaching Learning and Information Technology. Ludhiana: TandonPublishers.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H		H
CO 3		H		
CO 4	H	H	H	
CO 5	H	H	H	H
CO 6		M	M	M

EDOC0029: ORGANISATIONAL COMMUNICATION (4-0-0)

COURSE OUTCOMES
1. Understand the concept, scope, importance, process, types, advantages, and barriers of communication in an organization. (Understanding)
2. Apply skills of presentation utilizing visual aids, implement decision making techniques for effective communication. (Application)
3. Analyse the communicative dimensions of team work and violation of professionalboundaries. (Analysis)
4. Create and draft business letters and design and develop conflict managementstrategies. (Creation)
5. Understand the concept, need, significance, and execution of administrative feedback in organizational communication. (Understanding)
6. Evaluate the modes of effective communication and feedback models in anorganization. (Evaluation)

Module I: Conceptual Framework of Communication (10 lectures)
Concept and functions of Communication; Communication and four senses; Communication process, communication model and its elements; scope of communication

Module II: Organisational Communication (12 lectures)
Relationship between Organisation and Communication; common modes of communication in an organisation: writing, conversation, reading, media, charts, proceedings, T.V. telephone, e-mail and other modes of communication; Formal and informal communication; practical approaches in understanding administrative communication: cross communication, downward communication, upward communication

Module III: Communication Techniques (13 lectures)
Presentation skills, effective use of voice in presentation: articulation, tone, pitch; making effective presentations; use of visual aids in presentation; communication in teams: project teams, quality improvement teams, virtual teams; communicative

dimension of team work- roles, norms, decision- making processes and management of conflict.

Module IV: Feedback and professional boundaries (10 lectures)
Feedback, Administrative feedback, models of feedback, assessing the listening skills; maintaining Professional Communication- professional boundaries, violation and maintaining of boundaries

Suggested Readings

1. Baker, G.S. Fitly Spoken: Developing Effective communication and social skills. NewYork:Paperback.
2. Gillis, T. The IABC Handbook of organisational communication: A guide to internal communication, public relations, Marketing and Leadership. New York: Jossey-Bass.
3. Hardman, E. Active Listening 101: How to turn down your volume to turn up yourcommunication skills.
4. Hargie, O. Skilled Interpersonal Communication: Research Theory and Practice.London: Routledge.
5. Harris, E. T. and Nelson, D. M. Applied Organisational Communication: Theory and practice in a global environment. London: Routledge.
6. Krishnamacharyulu, R. & Lalitha. Business communication: Global Media.
7. Lewis K. L. Organisation change: Creating change through strategies communication. NewYork. Wiley.
8. Miller, K. Organisational Communication: Approaches and Processes: London: WadsworthPublishing.
9. Tourish, D and Hargie, O. Key Issues in organizational communication. London: Routledge.

Mapping of COs to Syllabus

Course Outcomes	ModuleI	Module II	Module III	Module IV
CO 1	H	H		
CO 2		H	H	
CO 3		H	H	
CO 4		H	H	
CO 5				H
CO 6				H

SPECIALIZATION: EDUCATIONAL LEADERSHIP

EDEA0030: EDUCATIONAL ADMINISTRATION (3-0-0)

COURSE OUTCOMES
1. Recognize the nature, scope, objectives, significance, and elements of educationaladministration. (Remembering)
2. Understand the characteristics of successful and democratic administration along with understanding the concept of school, school management, supervision and its features, evaluation and its principles, and role of headmaster and teachers in school management. (Understanding)
3. Apply democratic educational administration in practical situations and the principles ofevaluation in supervisory works. (Application)
4. Analyse the duties of educational administrators/school managers including headmasterand teachers. (Analysis)
5. Evaluate democratic administration, functional basis of supervision, and roles ofeducational administrators. (Evaluation)
6. Utilize creative ways towards infrastructural resource management and supervisory programmes. (Creation)

Module I: Conceptual Framework of Educational Administration (12 Lectures)
Nature and scope of educational administration; Objectives of educational administration; Elements of educational administration; Characteristics of successful administration; Democratic administration.

Module II: School Management (10 Lectures)
Concept of School; Need of school; School management; Headmaster/Principal as the school manager and her/his qualities; Role of teachers and community in school management; Infrastructural resource management.

Module III: Concept of Supervision (12 Lectures)
Meaning of supervision; Difference between supervision and administration; Effective supervision; Functional basis of supervision; Supervision as leadership.Module IV: Evaluation and Supervision (11 Lectures)
Concept of evaluation; Principles of evaluation; Evaluation of supervisory programme; Evaluation of Educational administrative programme; Evaluation as a continuous programme for qualityimprovement.

Suggested Readings

1. Adams,H.P & Duckey,F.G. Basic Principles of supervision.
2. Arif, S., & Sohail, A. What Really Works in Leading a School? International Journal of Learning,16(10), 695-707.
3. Boghossian, P. Behaviorism, Constructivism, and Socratic Pedagogy. Educational Philosophy& Theory, 38(6), 713-722.

4. Cara, C. The Power of One with Many Revisited: Creating Inclusive, Accessible, Collaborative Education for All. International Journal of Learning, 14(8), 221-233.
5. Chandler, L. Design Dynamics and Mastery: A Multi-modal Teaching Tool for Design Students. International Journal of Learning, 14(5), 51-57.
6. Donahoo, S. & Hunter, R. Teaching Leaders to Lead Teachers: Educational Administration in the Era of Constant Crisis. Advances in Educational Administration, Volume 10, 1–4. Elsevier Ltd.
7. English, F. (ed.). Encyclopedia Educational leadership and Administration (Vol.1), Sage Publication: Thousand Oaks.
8. Stanley, A. G. & Samier, E. A.Political Approaches to Educational Administration and Leadership. Routledge: New York.
9. Starratt, R. Centering Educational Administration: Cultivating Meaning, Community, and Responsibility. Lawrence Erlbaum Associates, Publishers: New Jersey
10. Tarc, A. Education as Humanism of the Other. Educational Philosophy & Theory, 37(6), 833- 849.
11. White, R. & Cooper, K. (Ed.). Principals in Succession Transfer and Rotation in Educational Administration. Springer: New York.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H	H	
CO 3	H		M	H
CO 4		H	M	
CO 5	H	H	H	
CO 6		H		H

EDSR0031: ETHICS AND SOCIAL RESPONSIBILITY IN EDUCATION (3-0-0)

COURSE OUTCOMES

1. Recognize the meaning, need, and components of ethics and value, identify the significance of values and morals along with types of ego, and meaning, need, role, andtypes of social responsibility. (Remembering)
2. Understand the theoretical perspectives of ethics and social responsibility, relationshipof educational ethics with gender and leadership, and significance of teaching profession. (Understanding)
3. Evaluate the strategies of social responsibility and role of ethics in a workplace.(Evaluation)
4. Apply the criteria of profession and UGC's code of conduct for teachers. (Application)
5. Analyze the influence of globalization on ethics and developmental activities andimportance of code of conduct. (Analysis)
6. Mitigate the problems encountered in the process of delivering social responsibility.(Creation)

Module I: Educational Ethics (9 Lectures)
Concept of Ethics and educational ethics; Need of ethics in educational settings; Components of ethics; types of values, morals.

Module II: Theoretical Perspectives of ethics (12 Lectures)
Ethical theories: Utilitarianism, Kantian ethics, Natural rights theories; religious ethics; virtue ethics; Kantian vs utilitarian; gender and ethics; ethics and leadership. Concept of ego: psychological, ethical, rational. Moral philosophy.

Module III: Ethics and Social Responsibilities (12 Lectures)
Concept of social responsibility; Need of social responsibility; Types of social responsibility; Social responsibility of educators; Strategies of social responsibility.

Module IV: Professional Development (12 Lectures)
Concept of profession; Criteria for a profession; Teaching as a profession; Workplace and code of conduct, Technology and globalization in relation to professional ethics and developmental activities.

Suggested Readings

1. Hill, I. Curriculum Development and Ethics in International Education: Education forDisarmament, pp 49-58. Retrieved from Disarmament Forum.
2. Raina, R. Situating Ethics in Technology and Science, Economic and Political Weekly, june 5,(vol xlv no 23).
3. Roddick, A. Professionalism and Ethics. In Understanding Facilitation: Theory and Principles (pp 189 - 216).Christine Hogan. London: Kogan Page.
4. Sikand, Y. Deoband's Fatwas on Muslim Women, Economic and Political Weekly. May 22, (vol
5. xlv no 21).
6. Sreekumar, N. Ethics, profession and developmental concerns, Economic and Political.Weekly June 26.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	M	H	
CO 2		H		M
CO 3			H	H
CO 4				H
CO 5				H
CO 6			H	

SPECIALIZATION: EDUCATIONAL PSYCHOLOGY

EDSP0032: COUNSELLING SKILLS FOR EDUCATIONAL PSYCHOLOGISTS (3-0-0)

COURSE OUTCOMES

1. State the meaning, nature, objectives, scope, process, types, and approaches ofcounseling. (Remembering)
2. Explain various theories of counseling and understand the concept, need, and skills of educational psychologists. (Understanding)
3. Apply the theories and tools and techniques of counseling. (Application)
4. Assess the skills of counseling and role of teacher as a counselor. (Evaluation)
5. Analyze the theories of counseling and various types of guidance. (Analysis)
6. Create the tools and techniques to be used for student counseling and improvise teachers' role in counseling process. (Creation)

Module I: Introduction to Counselling (12 Lectures)

Meaning, nature, objectives and scope of counselling; counselling as a process: factors affecting counselling process, stages of counselling process; types: individual and group; approaches of counselling: Directive, Non-directive and Eclectic Counselling.

Module II: Theories of Counselling (12 Lectures)

Gestalt Counselling; Psychoanalytic Counselling; Cognitive Psychologists; Personality -Cattle's Truth Theory; Behavioral Counselling.

Module III: Introduction to Educational Psychologists (11 Lectures)

Concept of Educational psychologists; need of educational psychologists; educational psychology as a career; key skills for educational psychologists; concept of guidance, need and types of guidance; guidance and counselling services; tools and techniques to be used for student counselling process.

Module IV: Teacher as a Guide and Counsellor (10 Lectures)

Role of teacher as an educational psychologist; guidance worker and counsellor; Counselling skills: Building trust, Listening, Attending, Building rapport, Demonstrating Empathy, Observing; Difference between counsellors, educational psychologists, clinical psychologists.

Suggested Readings

1. Kinra, K. K. Guidance and Counselling, Pearson India (2008).
2. Alam, Shah. Basics of Guidance and Counselling, Global Vision Publishing House (2008).
3. Hansen, J. C. Counseling Process and Procedures. New York: Macmillan.(1982).
4. Madhukar, I. Guidance and Counseling. Authors Press.(2000).
5. NCERT. Guidance and Counseling. Module –I, NCERT, New Delhi (2009).
6. NCERT. Guidance and Counseling, Module –II NCERT, New Delhi (2009).
7. NCERT. Guidance and Counseling. Module –IX NCERT, New Delhi (2009).
8. Oberoi, S.C. Guidance and Counseling. Paperback, R.Lall publishers (2016).
9. Pandey, V.C. Educational Guidance and Counseling. Isha Books(2005).
10. Rao, S.N. Counseling and Guidance, McGraw Hill Education (1993).

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2		H	H	
CO 3		H	H	
CO 4				H
CO 5		H	H	
CO 6			H	H

EDCA0033: CHILD AND ADOLESCENT MENTAL HEALTH (3-0-0)

COURSE OUTCOMES

1. Recognize the historical background of mental health, objectives, scope, and need of mental health, factors affecting mental health of children and adolescents, and the characteristics of a mentally healthy person. (Remembering)
2. Explain the factors affecting mental health in childhood, the features of adolescents, and the role of parents and teachers in these regards. (Understanding)
3. Apply solutions to various problems pertaining to mental health of child andadolescents. (Application)
4. Evaluate problem behaviours among children and adolescents. (Evaluation)
5. Analyze the status of mental health of school going children and adolescents and thebest practices in mental health care. (Analysis)
6. Create awareness among the students about mental health of children and adolescentsand develop preventive measures for mental health by designing a mental health system. (Creation)

Module I: Introduction to Mental Health (11 Lectures)
Concept of mental health: Historical background of mental health, objectives, scope, and need of mental health, factors affecting mental health; characteristics of a mentally healthy person; Mental health promotion, preventive intervention & treatment.

Module II: Mental Health as a Primary Health Concern among children (12 Lectures)
Childhood as critical stage of development: Child mental health as a primary health concern, factors affecting child mental health; Children with problem behaviours and developmental difficulties- language difficulties, Autism, Need for a comprehensive mental health system; Integrated approaches to early childhood mental health; Government policies and programs addressing childhood well- being.

Module III: Mental Health as a Concern among Adolescents (12 Lectures)
Concept of adolescents and adolescence, Adolescence as a period and its characteristics, Adolescence as period of stress and storm; Indicators of mental health development among adolescents, Introduction to problem behaviours among adolescents - delinquency, anxiety, conflict, stress, depression, drug abuse, substance abuse, alcoholism, adjustment mechanisms.

Module IV: Education and Mental Health (10 Lectures)
Mental health services in schools; child guidance clinic; Role of parents and teachers in fostering mental health among children and adolescents; promoting psychological well-being among children and adolescents; guidance and counseling.

Suggested Readings

1. Chauhan, S.S. (2010). Advanced Educational Psychology, Noida. Vikas Publishing House Pvt.Ltd.
2. Goswamee, G. (2008) Child Development and Child Care. Guwahati: Arun Prakashan.
3. Hadfield, J.A., (1952) Psychology and Mental Health, A Contribution to developmental Psychology, George Allen & Unwind.
4. Kapur, M. (1995) Mental Health of Indian Children. New Delhi: Sage Publications.
5. NCERT. (2009) Developing Mental Health and Coping Skills, Module 10, NCERT, New Delhi.
6. Nayar, S. U. (2012) Child and Adolescent Mental Health. New Delhi: Sage Publications.
7. Sharma, N. (1999) Understanding Adolescence. New Delhi. National Book Trust, India.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H			
CO 2	H		H	H
CO 3	H		H	H
CO 4		H	H	
CO 5	M		M	H
CO 6	H	H		

EDRM0034: RESEARCH METHODOLOGY IN EDUCATION (4-0-0)

COURSE OUTCOMES

1. Describe the conceptual framework of Research process. (Understanding)
2. Explain the methods and designs in Educational Research. (Analysis)
3. Apply and interpret the tools and techniques of research. (Application)
4. Examine the organization and analysis of data. (Remembering)
5. Analyze the application of statistics in Educational research. (Application)

6. Design and develop the synopsis and thesis writing. (Creation)

Module I: Introduction to Research in Education (13 Lectures)
Meaning and nature of research; Methods of Acquiring knowledge; Types of Research: Fundamental, applied, action research; Quantitative, Qualitative research; Principles and scope of Research in education; Scientific method and process of research; Preparation of synopsis for any research work in education; Ethics of Research.

Module II: Methods and Designs in Educational Research (14 Lectures)
General steps of research; review of related literature; Concept of Research Design and Types of designs; Methods of Educational Research: Historical, Survey, experimental, case study; Concept of hypotheses, Types and Testing hypotheses, Levels of significance, Fiduciary limits, Type I and Type II Errors.

Module III: Sampling and Tools of Research in Education (16 Lectures)
Concepts of Population and sample; Probability and Non-Probability sampling; Sample size and features of a good sample, Sampling Error; Tools of Research: Achievement Test, Intelligence Test, Observation, Interviews, Questionnaires, Attitude scale; Process of Development of tools; Nature of data and sources of data.

Module IV: Statistics in Educational Research (17 Lectures)
Concept, significance and functions of statistics; Measures of Central Tendency and measures of Variability; Coefficient of correlation: Product moment and rank difference method, Applications of z-test, t-test and f-test, Chi-square, median test, sign test, Report writing.

Suggested Readings

1. Check, J. and Schutt, R.K: Research methods in Education, Sage Publication, New Delhi (2014).
2. Broota, K. D: Experimental Design in Behavioural Research, New Age International Publisher,New Delhi. (2010).
3. Mohanti, B. & Misra, S.: Statistics For Behavioural and Social Science, Sage Publication, IndiaPvt Ltd, New Delhi. (2016).
4. Ferguson, G. A Statistical Analysis in Psychology and Education, Mc Graw Mill, NewYork. (1981).
5. Garrett, H. E. Statistics in Psychology and Education, Vikils, Feiffer and Semen's Ltd, Bombay (1998).
6. Koul, L. Methodology of Research in Education, Vikash Publications, New Delhi (2009).
7. Mangal, S.K and Mangal, S. Research Methodology in Behavioural Sciences, PHI Pvt, Ltd, Delhi (2013).
8. Best, J.W. & Kahn, J. V: Research in Education, PrenticeHall of India, New Delhi. (2006).
9. Edward, A. L. Techniques of Attitude scale construction, Appelton century crofts, Inc, NewYork (1957).
10. Mangal, S.K: Statistics in Psychology and Education, Prentice Hall of India, New Delhi (2002).
11. Cohen, L & Manion, L.: Research Methods in Education, London: Routledge. (1994).
12. Guilford, J.P: Fundamental statistics in Psychology and Education, McGraw Hill Book co NewYork. (1995).

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	H		
CO 2		H		H
CO 3	H		H	
CO 4			H	
CO 5				H
CO6				H

EDFE0035: PHILOSOPHICAL FOUNDATIONS OF EDUCATION (4-0-0)

COURSE OUTCOMES
CO 1: To inculcate awareness about the nature of philosophy and educational philosophy amomg the students
CO 2: To make the students well aware of the Indian philosophical thoughts in education
CO 3: To make the students well aware of the Western philosophical thoughts in education
CO 4: To make the students learn and understand the contribution of Indian and Western Thinkers in the field of education

Module I: Introduction to Philosophy and Educational Philosophy (15 lectures)
Philosophy: Definition, Concept, Branches of philosophy and its educational implications, Functions of philosophy, Knowledge: Concept, nature, types, theories; Education: Narrow and Wider Meaning, nature, Goals of Education in the 21st century, Relationship between philosophy and Education, Functions of Educational Philosophy.
National values as enshrined in the Indian constitution- socialism, secularism, justice, liberty, democracy, equality, freedom with special reference to education.

Module II: Indian Schools of Thought (15 lectures)
Astika and Nastika; Sankhya, Yoga, Vedanta, Buddhism, Jainism, with special reference to vidya; Dayanand Darshan.

Islamic traditions: its educational aims and methods of acquiring valid knowledge.

Module III: Western Philosophical Thought (15 Lectures)
Some major schools; Naturalism, Idealism, Rationalism, Pragmatism, Realism, Existentialism, Marxism and - Their educational implications with special reference to epistemology, axiology and the process of education.

Module IV: Contribution of Thinkers to the development of Educational thought for Social Change (15 Lectures)
Indian: Vivekananda, Tagore, Gandhi, Aurobindo, J. Krishnamurty, and Savitribai Phule
Western: Paulo Freire, Nel Noddings and Wollstonecraft
Social Philosophy of Education – Freedom, Equality, Democracy and Education.

References

1. Bhayrappa, S.L.(1988): Values on Modern Indian Educational Thoughts, NCERT, New Delhi.
2. Brammel, D.T.(1971) : Patterns of Educational Philosophy, Runehart and Winston, New York.
3. Das, A & Das, A. J. (2021, June). Educational Contribution of Savitribai Phule in 21st Century India. International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, (4), pp.1281-1286, URL: www.ijtsrd.com/papers/ijtsrd42547.pdf
4. Delors, Jacques, et al; (1996). Learning: The Treasure within report of the international commission on education for 21st century, UNESCO.
5. Dupius, A.M (1972): Philsophy of Education in Historical Perpective, Thomson Press, New Delhi.
6. Freire, P. (1971). Pedagogy of the oppressed. New York: Herder And Herder.
7. Moore, T. W. (2010). Philosophy of Education: An introduction. Routledge, New York.
8. Radhakrishnan. S. (2008). Indian Philosophy. Vol. 1. 2nd edn. USA: Oxford University Press .
9. Radhakrishnan. S. (2008). Indian Philosophy. Vol. 2. 2nd edn. USA: Oxford University Press .
10. Shivendra, C. S. (2006). Philosophy of Education. Atlantic publishers and Distributers. https://www.google.co.in/books/edition/Philosophy_of_Education/u6UQJ1sWrQoC?hl=en&gbpv=1&dq=functions+of+philosophy+of+education&printsec=frontcover
11. Wollstonecraft, M. (1792). A Vindication of the Rights of Women. https://www.gutenberg.org/ebooks/3420

Mapping of COs to syllabus

COs	MODULE I	MODULE II	MODULE III	MODULE IV
CO1	H	M	M	M
CO2	M	H	M	M
CO3	M	M	H	M
CO4	M	M	M	H

EDEP0036: FUNDAMENTALS OF EDUCATIONAL PSYCHOLOGY (4-0-0)

COURSE OUTCOMES
CO 1: To make the students aware of the nature of educational psychology
CO 2: To learn about the nature of human development and personality as an important segment of any individual
CO 3: To create understanding about the conceptual framework of learning and intelligence
CO 4: To create awareness among the students about concepts of thinking process and creativity of individuals

Module I: Introduction to Educational Psychology (10 Hours)
Educational Psychology: concept, nature, concerns and scope, methods, and functions of educational psychology

Module II: Human Development and Personality (15 Hours)
Human growth and development: Concept, principle, factors influencing development and their relative role; Theories of growth and development; Piaget, Bruner, Erickson and Kohlberg – their educational implications.
Personality: Concept, Nature, Determinants, Theories: Freud, Carl Rogers, Gordon Allport, Max Wertheimer and Kurt Koffka; Assessment-Projective techniques

Module III: Learning and Intelligence (20 Hours)
Learning: Concept, Theories of Learning: trial and error, classical conditioning, operant conditioning Gagne's theory of learning, Carl Roger's theory of learning and field theory of learning; cognitive view point and information processing; Educational implications of the view points on learning;
Intelligence: Concept, Nature, Intelligence Quotient; Theories: Unitary theory, Two factor theory, SOI Model, Gardner's theory of multiple intelligence, Sternberg's Information Processing theory of intelligence; Assessment of Intelligence; Concept of Social Intelligence , Emotional Intelligence- Concept, Characteristics of an Emotionally intelligent person, Importance of Emotional Intelligence, Emotional Quotient.

Module IV: Problem solving, Thinking, Metacognition and Creativity (15 Hours)
Problem Solving: Meaning and Definition, Steps in Problem Solving, Factors affecting Problem Solving, and Strategies for Problem Solving.
Thinking: Definition and concept, nature, Theories, Tools, Types, Training for Development of thinking.
Metacognition: Concept, Strategies to develop students' Metacognition in the classroom
Creativity: Concept, Nature, Theories, The creative process, Assessment of creativity, Strategies to foster and develop creativity.

Suggested Readings

1. Bhatnagar, S. Advanced Educational Psychology, Agra: Bhargava Book House (2002).
2. Chand, T. Educational Psychology, Agra: Bhargava Book House (2002).
3. Cheng, E. C. K. (2021). Developing Metacognitive Teaching Strategies Through Lesson Study. Singapore, Springer. https://www.google.co.in/books/edition/Developing_Metacognitive_Teaching_Strate/tNxFEAAAQBAJ?hl=en&gbpv=0
4. Crow, R.B. and Crow, A. Educational Psychology, New Delhi: Eurasia Publishing House (1964).
5. Dececee, J.P. The Psychology of Learning and Instruction, New Delhi: Prentice Hall (1970).
6. Dhir, R.N. Educational Psychology, Chandigarh: Abhishek Publication (2002).
7. Ewen R. B. An Introduction to the theories of personality, 7th Edition. New York: Psychology press (2010).
8. Guilford, J.P. The Nature of Human Intelligence, New York: McGraw Hill (1967).
9. Judd, C.H. Educational Psychology, Guwahati: Nivedita DK Distributions (2002).
10. Kuppuswamy, B. Advanced Educational Psychology, Jalandhar: Jalandhar University Publications (1963).
11. Mukunda, K. V. What did you ask at school today? A handbook of child learning. Noida, UP: HarperCollins, 371 (2009).
12. Rao, K.R., Parajpe, A.C. and Dalal, A.K. (Ed). . Handbook of Indian Psychology, New Delhi: Cambridge University Press India (2008).
13. Reynolds, W. M and Miller, G. E. . Current perspectives in Educational Psychology. In Handbook of Psychology Vol. VII (ed.) Irving B. Weiner. Canada: John Wiley and Sons, Inc (2003).
14. Rogers, C. Transition, self-regulation, independent learning and goal theory. Psychology of Education Review, 36(2), 26-31 (2012).
15. Sahoo, F.M. Psychology in Indian Context, Agra: Bhargava Book House (2002).
16. Sharma, R.N. Educational Psychology, Guwahati: DVS Publication (2002).
17. Sternberg, R.J. Contemporary Theories of Intelligence. In Handbook of Psychology Vol. VII (ed.) Irving B. Weiner. Canada: John Wiley and Sons, Inc (2003).
18. Swiderski, S. M. Transforming Principles into Practice: Using Cognitive Active Learning Strategies in the High School Classroom. Clearing House (2011), 84(6), 239-243. doi:10.1080/000986 5.2011.590549.
19. Weinstein, C., Acee, T. W., and JaeHak, J. Self-regulation and learning strategies. New Directions For Teaching and Learning (2011), 2011(126), 45-53. doi:10.1002/tl.443.

Mapping of COs to syllabus

COs	M1	M2	M3	M4
CO1	H	M	M	M
CO2	M	H	M	M
CO3	M	M	H	M
CO4	M	M	M	H

EDPC0037: PEACE EDUCATION AND CONFLICT MANAGEMENT (3-0-0)

COURSE OUTCOMES
1. Describe the importance and relevance of peace education (Application)
2. Explain the concept of peace as held by different thinkers and other religious beliefs. (Analysis)
3. Discuss the awareness of the modes and methods for conflict management. (Application)
4. Compare the global issues and peace movements. (Evaluation)
5. Narrate the various methods of conflict Management. (Application)
6. Describe the theories of Peace. (Analysis)

Module I: Understanding peace as a dynamic social reality (16 lectures)
- Basic concepts of Peace and Peace Education; nature, meaning, objectives. Theories of peace – democratic peace and active peace; Role of social organizations: Family, Religion, Mass Media, Community, School
- Some thinkers on harmony: Dalai Lama, Gandhi, Mother Teresa; Concept of peace education; peace teacher, peace method and other enabling practices in an educational setting.

Module II: Conflict management and its methods (7 lectures)
Meaning, types, levels and factors for conflict; methods and modes of conflict resolution - mediation, negotiation, diplomacy,

coercive methods; creative peace building, cross cultural methods.

Module III: Global issues and peace movements (7 lectures)
Human rights, population control, non-alignment movement, campaign for nuclear disarmament and role of world organizations in promoting peace.

Module IV: Practicum (30 lecture)
Any two activities to be conducted from the following
1. Field visit to place/organization-government/non-government working towards building peace
2. Exhibition on Peace related themes
3. Strategies to create peace building: Meditation, Yoga, Dramatization, Debate
4. Thematic analysis on documentary based on peace
5. Organise workshop on peace/ awareness programme on social marginalisation.

Suggested Readings

1. Dalai Lama. The joy of living and dying in peace. (ed.) Donald S. Lopez. Jr. Dharamsala: Tibetan and Archives (1998).
2. Diwahar, R. R. and Agarwal, M. (Ed). . Peace education. New Delhi: Gandhi Marg (1984).
3. Doyle, M. W. Liberal peace: Selected essays. London and New York: Routledge (2012).
4. Duckworth, C. Teaching peace: a dialogue on the Montessori method. Journal of Peace Education(2006), 3(1), 39-53.
5. Fountain, S. Peace education in UNICEF. New York: UNICEF (1999).
6. Gat, A. The Democratic peace theory reframed: The impact of modernity. World Politics (2005), 58, pp. 73-100.
7. Girard, K. Preparing teachers for conflict resolution in the schools. Washington, DC: ERIC Clearinghouse on Teaching and Teacher Education (1995).
8. Hopper, B. Peace education and years 1to 10 studies of society and environment key learning Area. Queensland: Queensland School Curriculum Council.(2002).
9. Johan, G. Peace by peaceful means. New Delhi: Sage Publication.(1996).
10. Krishnamurti, J. (n.d). Education and Significance of life. Retrieved from http://www.jkrishnamurti. org /krishnamurti-teachings/view-text.php?tid=51&chid=66876.
11. Layne, C. Kant or Cant: The Myth of the Democratic Peace. International Security, Vol. 19. Issue 2, pp. 5-49.(1994).
12. Montessori, M. Peace and Education. India: The Theosophical Publishing House (1943).
13. Morrison, M. L. Peace Education. Australia: McFarland(2003).
14. Nair, G. Peace education and conflict Resolution in school. Health Administrator Vol. XVII, Number 1:38-42 (1997).
15. Pant, D. and Gulati, S. Ways to peace: a resource book for teachers. New Delhi: National Council of Educational Research and Training (2014).
16. Salomon, G., & Nevo, B. Peace Education: The Concept, Principles, and Practices around the World. London: Lawrence Erlbaum Associates(2002).
17. Sheean, V. Mahatma Gandhi, a great life in brief. New Delhi: Random House.(1955).
18. UNESCO. Peace Education: Framework for Teacher Education. New Delhi: UNESCO (2005).

Mapping of COs to Syllabus

	Module I	Module II	Module III	Module IV
CO 1	H	M	H	
CO 2	M	H		H
CO 3	H		H	
CO 4	H		H	
CO 5		H		H
CO 6	M			H

EDSF0038: SOCIOLOGICAL FOUNDATIONS OF EDUCATION (4-0-0)

COURSE OUTCOMES
CO 1: To make the students aware of the nature of sociology of education and social institutions
CO 2: To understand and summarize the contributions of different theoretical perspectives on better understanding of the society
CO 3: To assess the various aspects of school as a social institution
CO 4: To create awareness about the cross-national perspectives on the sociology of education and modern Indian society

MODULE I: SOCIOLOGY OF EDUCATION (15 lectures)
Concept and nature of sociology of education; Difference between sociology of education and educational sociology; Social institutions and their functions: Social Groups; Social Organization; Social Stratification; Social Change

MODULE II: THEORETICAL PERSPECTIVE OF EDUCATIONAL SOCIOLOGY (15 Lectures)
Theoretical approaches to educational sociology: Standpoint Theory, theory of social learning by Bandura, Conflict Theory, Structural Functionalism, Symbolic Interaction Theory, Theories of Social Movements- Relative Deprivation, Resource Mobilization, Political Process Theory

MODULE III: SCHOOL AS A SOCIAL INSTITUTION (15 Lectures)
School as a social institution; School as an organization; Social mobility by means of education; Organisational climate types, classroom climate and its impact; Social aspects of education; Role of schools in modern society; Role of modern mass communication media in education

MODULE IV: CROSS-NATIONAL PERSPECTIVES ON THE SOCIOLOGY OF EDUCATION AND MODERN INDIAN SOCIETY (15 Lectures)
Culture - Conceptual understanding of culture, Role of education in cultural context; Education and cultural change; Modern Indian Society: Globalization, Liberalization, Privatization, Modernization, Westernization; Constitutional Provisions; National Integration and International understanding

SUGGESTED READINGS

1. Below, S. V., Powell, J. J., & Roberts, L. W. Educational Systems and Rising Inequality: Eastern Germany after Unification. Sociology of Education, 86 (4), 362-375. (2013)
2. Binder, A. J. Sociology of Education's Cultural, Organizational, and Societal Turn. Sociology of Education, 86(4), 282-283. (2013)
3. Bose, S. A Contextual Analysis of Gender Disparity in Education in India: Women's Status and Community. Sociological Perspectives, 55(1), 67-91. (2012)
4. Brown, F.J. Educational Sociology, Prentice Hall of India, New Delhi.
5. Clinard, M. B., & Elder, J. W. Sociology in India: A Study in the Sociology of Knowledge. American Sociological Review, 30(4), 581-587. (1965)
6. Damle, Y. B. Sociology in India: its teaching and status. International Social Science Journal, 26(2), 343-348. (1974).
7. Goel, S. K. Education, Training, and Rehabilitation of the Handicapped in India. Retrospect and Prospect. Education & Society, 8(1), 21-29. (1990)
8. Harding, 0. J. Rethinking the Cultural Context of Schooling Decisionism Disadvantaged Neighborhoods: From Deviant Subculture to Cultural Heterogeneity. Sociology of Education, 84(4), 322-339. (2011)
9. Hodkinson, A., & Devarakonda, C. Conceptions of inclusion and inclusive education: A critical examination of the perspectives and practices of teachers in India, Research in Education, (82), 85-99. (2009)
10. MacIver and Page- Society: An Introductory Analysis, Macmillan.
11. Nakamura, T. Sociologization, Pedagogization, and Resocialization: Has the Post-war Japanese Sociology of Education Suffered from the Galapagos Syndrome? International Journal of Japanese Sociology, 22(1), 64-79. (2013)
12. Sharma, C. L. Crisis of Character in India: The Need for Moral Education. Education & Society, 8(1), 64-73. (1990)
13. Smith R. Eliot et al., .Social Psychology. U.S.A.: Taylor and Francis. (2000)
14. Von Below, Powell, J. W., & Roberts, L. W. Educational Systems and Rising Inequality: Eastern Germany after Unification. Sociology of Education, 86(4), 362-375. (2013)
15. Wright, R. The Fourth Sociology and Music Education: Towards Sociology of Integration. Action, Criticism, and Theory for Music Education, 13(1), 12-39. (2014)

MAPPING OF COs TO SYLLABUS

	Module I	Module II	Module III	Module IV
CO 1	H		H	
CO 2		M		
CO 3			H	
CO 4			H	
CO 5				H
CO6				H

EDCI0039: CURRICULUM DEVELOPMENT AND INSTRUCTION (3-0-0)

COURSE OUTCOMES
1. Explain the nature of curriculum. (Application)
2. Describe the basis of curriculum development. (Analysis)
3. Distinguish the approaches of curriculum development. (Evaluation)
4. Mention the process of curriculum development. (Application)
5. Frame about the assessment of curriculum. (Remembering)

6. Distinguish the Factors influencing curriculum implementation. (Understanding)

Module I: Understanding curriculum (6 lectures)
Contemporary definition of curriculum; curriculum criteria, curriculum goals and values, basic principles of curriculum and instruction Brainstorming session on the issues and trends of school/college curriculum

Module II: Philosophical underpinnings of curriculum (15 lectures)
Curriculum types and Models of teaching: Social, Information Processing, Personalist, and Behavioral,
Child-Centered, Society-Centered, Knowledge-Centered, or Eclectic; Goals and Philosophies of Education across changing education paradigms - Idealism, Realism, Perennialism, Essentialism, Experimentalism, Existentialism, Constructivism and Reconstructivism
Analysis of the philosophical underpinnings of the present day curriculum

Module III: Approaches to curriculum development (10 lectures)
Tagore, Gandhi, Krishnamurthy, Plato, Dewey, Montessori, Don Bosco, Freire.
Detailed discussion on the pedagogical approach of one of the above thinkers

Module IV: Curriculum development frameworks in 21st Century (6 lectures)
NCTE Framework for 21st Century Curriculum and Assessment; UNESCO - A Futures Perspective in the Curriculum, Learning Environment, Skills, Assessment, Professional Development; Curriculum and Future - Concepts from Social Sciences
A review of the NCTE framework for 21st century Curriculum and Assessment

Module V: Curriculum development and assessment (8 lectures)
Developing a curriculum document: Approach and organization, stages of curriculum development, guidelines of statutory bodies with regard to curriculum development – UGC, NCTE, NCF; Curriculum integration: disciplines, media and technology; evaluating and assessing a curriculum; Models of curriculum; Curriculum implementation - Factors influencing curriculum implementation

Suggested Readings

1. Dottrens, R. The Meaning of the Terms Curriculum and Syllabus, in The Primary School Curriculum, (France: UNESCO) pp 79-89.
2. Dewey, J. The School and Society in Society and Education, Introduction by Philip W. Jackson (Chicago: The University of Chicago Press)
3. Pring, R. Curriculum Integration in The Curriculum: Content, Design and Development (ed), (London Institute of Education Bulletin, Spring). pp- 4-8.
4. Tyler Ralph, W. Basic Principles of Curriculum and Instruction. (University of Chicago Press).
5. Vallance, E. Hiding the Hidden Curriculum in Curriculum Theory Network. Stanford University 4:1, pp 5-21
6. Kumar, Krishna. Origins of India's 'Textbook Culture from Comparative Education Review 32(4) pp 452-464.
7. Bruner, J. Folk Pedagogies. In Leach, Jenny and Moon, Bob (eds) Learners and Pedagogy (pp4-20). London: Paul Chapman Publishing in Association with the Open University.
8. Keddie, Nell. Classroom Knowledge in Young, M. F. D. (ed), Knowledge and Control. (London: Collier Macmillan)
9. Coleman, J. The Concept of Equality of Educational Opportunity in Equality and Achievement in Education. (Boulder: Westview Press)
10. Winch, C. Constructing Worthwhile Curricula in Quality and Education (Oxford: Blackwell) pp45-56
11. Akkari, A. Socialization, Learning and Basic Education in Islamic Contexts in Educational Theories and Practices from Majority World (ed), Sage, New Delhi, pp220-244.
12. Bernstein, B. Class and Pedagogies: Visible and Invisible in Karabel and Hasley (ed) Power and Ideology in Education, Oxford University Press
13. Hoare. Q and Smith G. N. On Education in Selection from The Prison Notebook of Antonio Gramsci (ed), India: Orient Longman Pvt Ltd
14. Freire, P. chapter 2 Pedagogy of the Oppressed, New York: Seabury Press
15. Education for Poor: Quality and Relevance? British Journal of Sociology of Education 13(4)
16. Kohlberg, L and Meyer, R. Development as the Aim of Education Harvard Educational review 42(4)
17. Tanner, Laurel N. The Meaning of Curriculum in Dewey's Laboratory School (1896-1904) Journal of Curriculum Studies, 23(2) 101-117
18. Kumar, K. What is Worth Teaching? In What is Worth Teaching. Hyderabad, Orient Longman

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H		H	
CO 2	H	H	M	H

CO 3	H	H	M	
CO 4	H		H	H
CO 5	M	M	H	
CO 6	M		M	H

EDJG6002: JOURNALING - A TECHNIQUE FOR PERSONAL AND ACADEMIC GROWTH (1-0-2) – Practicum

COURSE OUTCOMES

1. Recall one's life experiences. (Remembering)
2. Explain clearly and specifically one's life experiences. (Understanding)
3. Develop the skill of writing. (Application)
4. Analyze life experiences at a conscious level and enhance reflective thinking. (Analysis)
5. Synthesize one's thoughts in an organized manner and create a new piece of writing. (Creation)

Journaling is a strategy for making sense of experiences. The objective of journaling is to develop in students a reflection that can be described as an inner dialogue with oneself whereby a person calls forth his or her own experiences, beliefs, and perceptions about an idea; informing and transforming functions of knowledge; and a conscious and systematic mode of thought. This is to nurture in future educational leaders a sense of reflective practice.

Each student is required to maintain a reflective journal, using the Visible Thinking Routine (Harvard), as a critical structure for guiding their journal writing. The students are to submit the journal every Friday. Journaling has to be done six days of the week. At the end of the semester, the student will be awarded a grade/marks after assessing the learning.

Suggested Readings

1. Davies, M. (2011). Concept mapping, mind mapping and argument mapping: what are the differences and do they matter?. Higher education, 62(3), 279-301. Retrieved from http://download.springer.com on 19th July 2016.
2. Dhankar, Rohit (2013). Can reflective practice be taught? Teacher Plus 2013. (http://www. teacherplus.org /cover-story/can-reflective-practice-be-taught).
3. Hubbs, D. L., and Brand, C. F. . The paper mirror: Understanding reflective journaling (2005). Journal of Experiential Education, 28(1), 60-71.
4. Liuolienė, A., and Metiūnienė, R. Students' Learning Through Reflective Journaling
5. Coactivity / Santalka,(2009). 17(4), 32-37. doi:10.3846/1822-430X.2009.17.4.32-37.
6. Lowe, G. M., Prout, P., and Murcia, K. . I See, I Think I Wonder: An Evaluation of Journaling as a Critical Reflective Practice Tool for Aiding Teachers in Challenging or Confronting Contexts. Australian Journal Of Teacher Edu (2013).

Mapping of COs to Syllabus

Course Outcomes	M1
CO1	H
CO2	H
CO3	H
CO4	H
CO5	H

EDES6003: EDUCATIONAL SEMINAR I (0-0-2) – Practicum

COURSE OUTCOMES

1. Develop higher cognitive abilities to respond to new knowledge, critical thinking, and keen observation of research conducted. (Understanding & Evaluation)
2. Develop the abilities to seek clarification, defend the ideas of others, and presenteffectively. (Application & Creation)
3. Develop the feeling of tolerance, co-operation, and respect of the ideas and feelings ofothers. (Understanding)
4. Acquire good manners of putting questions and answering the questions of others effectively and develop emotional abilities. (Analysis & Application)

During the course of the programme, students are expected to present a series of seminars which will address fundamental intellectual, conceptual and practical issues in current educational philosophy and application. They may also deal with other relevant topics such as use of ICT in education, design of new and innovative curricula, methodological issues in education, etc. Students will be assisted through guest lectures, discussions, field work in education related institutions and active engagement with faculty members. During these interactions students will be provided with an opportunity to explore how best to bring new interdisciplinary scholarship, technology and critical thinking into the development of the chosen seminar area. They will also consider alternative pedagogic strategies, teaching techniques and technologies. Students will prepare and present a final paper based on these seminars. The course will be evaluated on the basis of the seminars and the final paper.

Mapping of COs to Syllabus

CO 1	H
CO 2	H
CO 3	H
CO 4	H

EDSV6004-SCHOOL VISITS (0-0-2) - PRACTICUM

COURSE OUTCOMES

1. Aware of the school environment and its functioning. (Remembering)
2. Understand the dimensions of use of lands, different amenities and different equipment available in the schools. (Understanding)
3. Analyze the role of teachers and their code of ethics. (Analysis)
4. Apply measures to improve the outputs of the school. (Application)
5. Assist the principal/teachers in the smooth functioning of schools. (Application)

Report to be Prepared:

Report on Inputs:

- Human Resources
- Non-Human ResourceReport on Processing:
- Teaching-Learning Process
- Analysis of Curriculum
- Analysis of Time table
- Use of Hardwares
- Use of Softwares
- Modes of Transactions
- Identifying the problems faced by teachers
- Classroom Management etc

Report on Outputs:

- Subject wise Performance
- Causes of poor and high Performance

Attitude of Teachers and Students towards School

Mapping of COs to Syllabus

CO 1	H
CO 2	H
CO 3	H
CO 4	H
CO 5	H

EDDI6005: DISSERTATION PHASE-I (0-0-2)

COURSE OUTCOMES

1. Develop the skill to prepare the Research Proposal. (Application)
2. Apply the skill in collection of data in the field. (Application)
3. Develop the ability to analyze the data. (Analysis)
4. Ability to write the report in standard academic formats. (Creation)

Every student shall undertake a research project work under the supervision and guidance of a faculty member. The students are expected to complete the literature review and present a research proposal during the first phase. The dates, mode and components of evaluation and the weightages attached to them shall be published by the department at the beginning of the semester.

Mapping of COs to Syllabus

Course Outcomes	Phase-I
CO 1	H
CO 2	H
CO 3	H
CO 4	H

EDDI6007: DISSERTATION PHASE-II (0-0-4)

COURSE OUTCOMES

1. Develop the skill to prepare the Research Proposal. (Application)
2. Apply the skill in collection of data in the field. (Application)
3. Develop the ability to analyze the data. (Analyzing)
4. Ability to write the report in standard academic formats. (Application)

The students of the final semester will have to compile their research study in the form of a dissertation. Each dissertation has to be systematically structured following proper methodology of educational research. To set the dissertations in a standardized pattern the supervisor should ensure that it follows proper sequence containing following aspects:

Preliminary section

1. Title page
2. Approval sheet
3. Acknowledgments
4. Table of contents
5. List of tables (if any)
6. List of figures (if any)

Main body

1. Introduction
    - Conceptual framework of the theme
    - Some relevant studies
    - Rationale/Justification of the study
    - Statement of the problems
    - Operational terms
    - Statement of the study
    - Objectives of the study
    - Hypotheses
    - Delimitation of the study
2. Review of related literature
3. Method and Procedure of the study
    - Procedures used
    - Methods of gathering data
    - Description of data gathering tools
4. Presentation and Analysis of Data
    - Texts
    - Tables
    - Figures
    - Statistical treatment
    - Analysis of data gathered and interpretations
5. Conclusion
    - Brief restatement of problems and procedures
    - Major findings and conclusion
    - Educational implications
    - Recommendations for further research

Reference section

1. References (APA sixth edition)
2. Appendix

The supervisor will help students to understand the detailed steps of writing a dissertation. He/ she will ensure that the dissertation is prepared keeping in view Of Intellectual Property Rights, maintenance of research ethics and avoidance of plagiarism. Phase I of the course is carried out in the 3rd semester where the students will work on research proposal, literature review and thefirst part of the data collection. In the 4th semester they will complete data collection, analysis, and preparation of a research report (Phase II). Students are required to make a presentation of the dissertation submitted to the department on the date set in the academic calendar for the same.

Mapping of COs to Syllabus

Course Outcomes	Phase-II
CO 1	H
CO 2	H
CO 3	H
CO 4	H

EDIN6008: INTERNSHIP (0-0-3)

COURSE OUTCOMES

1. To acquaint the students with the total environment of the school.(Remembering)
2. To learn about the functioning of the school.(Understanding)
3. To observe the administrative and managerial activities.(Remembering)
4. To observe the morning assembly and teaching work in the classroom for having an ideaof teaching work.(Analysis)
5. To prepare lesson plans and teaching aids for conducting classes.(Application)
6. To observe and participate in the co-curricular activities and extracurricular activities.(Application)
7. To organize the co-curricular and extracurricular activities. (Creation)
8. To understand the behaviour of teachers, students, principal, headmaster and othersupporting staff. (understanding)

Activities to be performed:

I. Organization/ observation of morning assembly.
II. Classes to be taught during the day by preparing lesson plans.
III. Unplanned classes to be taken during the day if some teachers are on leave. Observing the class of an effective/ good teacher.
IV. Participating/ organizing co-curricular activities. Participating/ organizing extracurricular activities. Any other specific events of the day.
V. Undertaking action research or case study.
VI. On the basis of daily reports the students are to prepare the final report on the schoolInternship Programme.

EVALUATION:

	Stock of daily reports and Action research	30
	Preparation of final report	10
	Lesson plans	20
	Teaching aids developed	10
	Presentation of final report and viva voce	30
		100

Mapping of COs to Syllabus

CO 1	H
CO 2	H
CO 3	H
CO 4	H
CO 5	H
CO 6	H
CO 7	H
CO 8	H

EDES6009: EDUCATIONAL SEMINAR II (1-0-1) – Practicum

COURSE OUTCOMES

1. Develop higher cognitive abilities to respond to new knowledge, critical thinking, and keen observation of research conducted. (Understanding & Evaluation)
2. Develop the abilities to seek clarification, defend the ideas of others, and presenteffectively. (Application & Creation)
3. Develop the feeling of tolerance, co-operation, and respect of the ideas and feelings ofothers. (Understanding)
4. Acquire good manners of putting questions and answering the questions of others effectively and develop emotional abilities.(Analysis & Application)

Following the previous course of Educational Seminar-I, in the present course of the programme the students are expected to present a series of seminars which will address fundamental intellectual, conceptual and practical issues in current educational philosophy and application. They may also deal with other relevant topics such as use of ICT in education, design of new and innovative curricula, methodological issues in education, etc. Students will be assisted through guest lectures, discussions, field work in education related institutions and active engagement with faculty members. During these interactions students will be provided with an opportunity to explore how best to bring new interdisciplinary scholarship, technology and critical thinking into the development of the chosen seminar area. They will also consider alternative pedagogic strategies, teaching techniques and technologies. Students will prepare and present a final paper based on these seminars. The course will be evaluated on the basis of the seminars and the final paper.

Mapping of COs to Syllabus

CO 1	H
CO 2	H
CO 3	H
CO 4	H

EDTP6010: TEACHING PRACTICE (1-0-1) - Practicum

COURSE OUTCOMES

1. Understand the concept and purpose of teaching practice (Understanding)
2. Develop skill of preparing lesson plan (Creating)
3. Practice various teaching skills in classroom situations (Application)

Module I: Concept of Teaching Practice (10 Lectures)

Introduction to Teaching Practice, Concept of teaching practice Objectives of teaching practice, Concept of Lesson Plan, significance of lesson plan, Approaches for preparing lesson plan, Format of lesson plan, Teaching skills and Micro Teaching

Module II: Preparation of Lesson Plan (20 Lectures)

Preparation of Lesson Plan and Presenting lesson plans, Preparing 10 lesson plans for Secondary / Senior Secondary / UG students Delivering four (4) Lesson Plans in Secondary / Senior Secondary / UG Classes One lesson plan for final practice teaching

Evaluation Scheme:

Internal Assessment : 40 Marks (Based on Test)
External Assessment : 60 Marks
Record : 20 Marks
Final Teaching practice : 20 Marks
Viva : 20 Marks

Suggested Readings

1. Bloom, B.S. Taxonomy of Educational Objectives, New York (1956).
2. Passi, B.K. Becoming Better Teacher: Microteaching Approach, Ahmedabad: SahityaMudranalaya(1976).
3. Gage, N.S. “Theories of Teaching” in theories of learning and instruction, Chicago UniversityPress (1968).
4. Jangira, N.K. & Singh, A. Core Teaching Skills: The Microteaching Approach, NCERT, New Delhi(1983).
5. Kapoor, K.C. et.al (Ed.): Teacher Education in the 21st century. Ambala Cantt.:The AssociatePublisher (2008).
6. Mangal, S.K & Mangal, U. Essentials of Educational Technology, PHI Learning Pvt. Ltd, Delhi(2014).
7. Aggarwal, J.C. Essentials of Educational Technology, Innovation in Teaching-Learning, VikasPublishing House Pvt. Ltd. New Delhi (2014).
8. Freeberg, M.J & Drescoli, A. Universal Teaching Strategies, Boston: Allyn and Bacon (1992).
9. Stone, Edgar & Morris, Sidney : Teaching Practice: Problems and Perspectives, London(1972).

Mapping of COs to Syllabus

Course Outcomes	M1	M2
CO 1	H	
CO 2		H
CO 3		H

SWCA6010: COMPUTER APPLICATION FOR SOCIAL SCIENCES (1-0-1) - Practicum

COURSE OUTCOMES

1. Describe the application of the basics of Word Processing. (Applying)
2. Illustrate the basics of Excel Worksheet. (Applying)
3. Explain the basics of PowerPoint Presentation tools. (Analyzing)

4. Work out data analysis in research using Statistical Analysis Packages. (Applying)
5. Identify and describe the practical aspects of Computer Applications. (Evaluating)

Module I: Basics of Microsoft Office Word Processing (7 lectures)
Word Processing: Meaning, Features, advantages, Structure of a word Processor window, creating document, opening, saving document, Printing, Find and replace, Creating table, Mail Merge-Maindocument data source and merging.

Module II: Basics of Microsoft Office Excel Worksheet (8 lectures)
Worksheet Package: Cells, rows, columns, Range, Structure of a worksheet window, creating, opening and saving, Printing a worksheet document, creating tables, charts, data analysis using formulae in worksheet.

Module II: Basics of Microsoft Office PowerPoint Presentation (5 lectures)
Presentation Package; creating presentations in a presentation package, text tables, charts, Animation, running slide show, saving the slides, Printing the presentations.

Module IV: (Practicum) Using Statistical Packages for Data Analysis (10 lectures)
Qualitative Data Analysis, Quantitative Data Analysis. Statistical Packages for Data Analysis: Statistical Package for Social Sciences (SPSS), Analysis of moment structures (AMOS)

Suggested Readings
1. Foster, JJ. Data analysis using SPSS for Window, Sage Publication, Ltd., London, 1988.
2. Gaur, Ajai S., et al Statistical Methods and Practices in Research. Response Books, New Delhi,2006.
3. Kelle, V., Computer Aided Qualitative Data Analysis: Theory, Methods and Practice, Sage Publication, Ltd., London, 1988.
4. Lincoln, Y.S. and N.K Danzin, Handbook of Qualitative Research, Sage Publication, California,1994.

Full Marks: 50
Internal: 20 Practicum & Viva: 30

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV
CO 1	H	H	H	H
CO 2	H	H	H	H
CO 3	H	H	H	H
CO 4	H	H	H	H
CO 5	H	H	H	H

EDSL0200: SERVICE LEARNING (A COMMUNITY-UNIVERSITY ENGAGEMENT PROGRAMME) (1-0-1)

COURSE OUTCOMES
1. Learn the concept of service learning and community engagement. (Remembering)
2. Understand the importance of service learning and community engagement fordeveloping the skills of addressing real life issues in one’s own community. (Understanding)
3. Develop the ethics of civic participation. (Applying)
4. Develop an understanding of the importance of communication skills in interacting with community members. (Understanding)
5. Be exposed to and empathize with people who are less fortunate than they are, economically, socially, academically, medically etc. (Applying)
6. Organize awareness programmes, rallies, campaigns, social service etc. (Analysing)
7. Develop the skills of problem solving and reflective thinking. (Analysing)
8. Realize one's potentiality to make a difference in the life of their community members.(Evaluating)
9. Understand and experience the system of inequality that exists in the Educationalsystem. (Evaluating)
10. Applying the pedagogical concepts learned in class in the educational institutions of thecommunity. (Creating)

Module I: Service Learning and Community- University Engagement
Concept of service learning and community-university engagement; History of service learning in the context of Indian Universities; Principles for an effective service learning; Principles of a good service learning pedagogy; Models of Service learning: Project Model, Charity Model, Social Justice Model.
1. Programs of Service learning: Community Engagement, Field Education, Volunteerism, Internship.
2. Benefits of Service learning:For Students, Academic enhancement, Personal/ Professional Growth, Understanding Diversity, Civic learning, Critical reflection, For the University, For the community.
3. Service learning: A means to Inclusive Education: Experiential Learning, Expo populations, Challenge to comfort zones,

Reflection sure to diverse on Experiences, Personal growth, Professional growth.

Module II: Practices for Service Learning and Community- University Engagement

By collaborating with the Community Members, Village Panchayats, Parents, Educational Institutions (Heads, Teachers and Students), Anganwadis, Balwadis etc. and following the mentioned Models and Programs of Service Learning students can be engaged with the community welfare in the following ways: (**Any….**)

1. Creating awareness among community members regarding Early childhood care andnutrition.
2. Creating awareness among community members about parenting.
3. Self-participatory internship in a school of one's own choice.
4. Creating awareness among school children and community members and providing
5. training in developing one's life skills.
6. Providing teachers training in pedagogy.
7. Providing training to school teachers in the use of ICT for enhancing students' learning.
8. Providing training to teachers in the preparation of teaching aids by using availablecommunity resources.
9. Creating awareness on Mental Health and strategies for its sustenance.
10. Creating awareness on the importance of Physical health and ways of maintaining one's
11. health.
12. Creating awareness on the importance of education and ways of creating a conduciveenvironment for proper learning.
13. Creating awareness on AIDS.
14. Creating awareness on Population explosion- its effects and ways of population control.
15. Creating awareness on life skills and ways to develop one's life skills.

EVALUATION:

INTERNAL	
Attendance	5
Non-Formal	5
Project presentation and Viva	10
EXTERNAL	
Organization of activities and project report	30

Suggested Readings

1. Brown, Erin Marie Burke. (2015). Service-Learning Challenges and Strategies. Service-LearningInstitute: Viginia Commonwealth University. Downloaded from http://scholarscompass.vcu.edu/service_institute/servicelearning_2015/background_infoma tion/1
2. Centre for Community Engagement. (n.d.). Faculty Toolkit for Service Learning. Middlesex Community College Downloaded from https://www.uml.edu/docs/Faculty_Toolkit_MCC_tcm18-52567.pdf.
3. Cress, Christine M., Collier, Peter J., Reitenauer, Viki L. (2005). Learning Through Serving: A Student Guidebook for Service Across Disciplines. Sterling Virginia.
4. Lavery, S., Chambers, D. and Cain, G. (2018). Service Learning: Enhancing Inclusive Education. Emerald Publishing. United Kingdom.
5. Mittal, Pankaj. Fostering Social Responsibility by Higher Education: COVID-19 and Beyond. https://youtu.be/4Yz1h0DtoBo.
6. Narasimharao, B PanduRanga. (2010). Tertiary Education Institutions for Corporate Education, Need and Relevance of Corporate Education centres. Downloaded from https://www.researchgate.net/publication/216686564.
7. PRIA. (2014). Occasional Paper: Participatory Research in Asia Fostering Social Responsibilityin Higher Education in India. New Delhi.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II
CO 1	H	H
CO 2	H	H
CO 3	H	H
CO 4	H	H
CO 5	H	H
CO 6	H	H
CO7	H	H
CO 8	H	H
CO 9	H	H
CO 10	H	H

VALUE ADDED COURSES

EDES6011: EDUCATION FOR SUSTAINABLE DEVELOPMENT (1-0-1)

COURSE OUTCOMES

1. To create awareness about the concept of Sustainable Development. (Remembering)
2. To create skill among the students to find out the sustainability of any economic activity.(Understanding)
3. To create awareness among students about the concept of Education for SustainableDevelopment. (Applying)
4. To create an understanding among the students about the role of Education inSustainable Development. (Analysing)

Module I: Introduction to Sustainable Development (5 Lectures)

Concept of Development**;** Concept of Sustainability**;** Sustainable Development: Its 5 Ps (People, planet, prosperity, peace, and partnership)**;** Sustainable Development Goals- 17

Module II: Curricular Framework for Education for Sustainable DevelopmenT (10 Lectures)

Definition and meaning of Education for Sustainable Development; Principles; Key themes: Climate change, Biodiversity, Sustainable production and consumption, Reduction of poverty; Key Sustainable Competencies to be developed through ESD: Systems thinking Competencies, Anticipatory Competency, normative competency, Strategic competency, Collaboration Competency, Critical thinking competency, Self-awareness Competency and integrated problem Solving Competency; Pedagogical approaches in ESD: Whole- institution approach, Learner centered approach, Action oriented learning, Transformative approach; Teaching techniques for ESD: Simulations, Class discussions, Issue Analysis Techniques, Storytelling.

Module III: Practical Implications of ESD (15 Lectures) (Any two)

Sharing their own stories of struggle/ success with the class

Visiting neighboring areas to collect community related stories/ activities towards the realizationof Sustainable Development Goals.

Surveying industries and submitting reports on its sustainability norms. Surveying schools and submitting reports on its sustainability norms.

EVALUATION:

	Written test	10
	Attendance	5
	Non- formal	5
	Reports (2)	15+ 15= 30
		50

Suggested Readings

1. UNESCO. (2012). Education for Sustainable Development: Source Book. Retrieved from https://sustainabledevelopment.un.org/content/documents/926unesco9.pdf.
2. Bubaker F. Shareia. (2015). Theories of Development. International Journal of Language and Linguistics.2(1), Pp. 78-90. Retrieved from http://ijllnet.com/journals/Vol_2_No_1_March_2015/9.pdf.
3. UNESCO. (2016). Incheon Declaration and Framework for Action. Retrieved from http://uis.unesco.org/sites/default/files/documents/education-2030-incheon-framework-
4. for-action-implementation-of-sdg4-2016-en_2.pdf.
5. UNESCO. (2017). Education for Sustainable Development Goals: Learning Objectives. Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000247444?utm_sq=gj34xbfn94#:~:text=Target%204.7%20of%20the%20SDGs,peace%20and%20non%2D%20violence%2C%20global.
6. UNESCO. (2018). Issues and trends in Education for Sustainable Development. Retrieved from https://www.ensi.org/global/downloads/Publications/433/Issues%20and%20trends%20in%20Education%20for%20Sustainable%20Development.pdf.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III
CO1	H	H	H
CO2	H	H	H
CO3	L	H	H
CO4	L	M	H

EDTT6012: TEACHER AND TEACHING SKILLS (1-0-1)

COURSE OUTCOMES

1. To create awareness among the students about conceptual framework of teaching skills.(Remembering)
2. To make the students well aware of the sources of teaching skills. (Understanding)
3. To create awareness about the approaches concerning teaching skills. (Applying)

Module I: Introduction to Teaching and Teacher

Concept of teaching; Structure of teaching; Levels and phases of teaching.

Module II: Concept of Teaching Skills

Meaning of teaching skill**;** Significance of teaching skills for a teacher**;** Sources and identification ofteaching skills**;** Social skills for a teacher.

Module III: Micro teaching as an approach

Concept of Micro teaching; Need of micro teaching; Steps of micro teaching; Preparation of micro teaching lesson plan; Teaching practice for teaching skills through micro teaching lesson plans.

Suggested Readings

1. Abraham, P. P. (1974). Effectiveness of Micro Teaching in the development of questioningskill. M.Ed. Dissertation. M. S. University, Baroda.
2. Aggarwal, J.C (2014): Essentials of Educational Technology, Innovation in Teaching-Learning,Vikas Publishing House Pvt. Ltd. New Delhi
3. Allen, D. W. and Fortune, J. C. (1976): An analysis of micro teaching: A new procedure inteacher education. Stanford University, California.
4. Anupam and Kapoor, K. C. (2012). Micro teaching as an approach in Secondary SchoolTeacher. International journal of Education and Research. 1 (5). ISSN 0975-7481.
5. Jangira, N.K. & Ajit Singh (1983): Core Teaching Skills: The Microteaching Approach, NCERT,New Delhi
6. Kapoor, K.C et. al. (Ed) (2008): Teacher Education in the 21st Century, The AssociatedPublishers, Ambala cantt.
7. Kapoor, K.C. (2020): Teaching of Geography for Secondary School Teachers. DVS Publishers,Guwahati.
8. Mangal, S.K & Mangal, U (2014): Essentials of Educational Technology, PHI Learning Pvt. Ltd,Delhi.
9. Passi, B.K. (1976): Becoming Better Teacher: Microteaching Approach, Ahmedabad: Sahitaya.

Mapping of COURSE OUTCOMES

Course Outcomes	Module I	Module II	Module III
CO1	L	H	H
CO2	L	H	L
CO3	L	M	M

EDHW6013: EDUCATION FOR HEALTH AND WELLNESS

Credits: 2

Total Marks: 50 - Internal: 40 % (20 Marks) Total Hours: 30 External: 60% (30 Marks)

Course objectives

After completing the course, students will be able;

1. To acquire the knowledge, about health and physical education
2. To acquire the knowledge about health and safety education
3. To understand the nature of injuries and providing first aid
4. To develop the skills for organising games and sports in educational institution.
5. To acquire the knowledge about yoga

Module-I: concept of Health Education

a. Meaning, Definition, objectives of health education
b. Nutrition, Malnutrition, Personal Hygiene, Health education in schools, Health Services.
c. Food and Nutrition: Meaning, classification, constituents of food, vitamins and their deficiency, Balanced Diets, Diets for obesity and under Weight

Module-II Introduction to Physical & Yoga Education & Wellness Studies

a. Meaning, Definition, Objectives and scope of Physical education
b. Physical fitness: Meaning, definition, components, and benefits
c. Games and sports
d. First Aid: Road Accident, water accident, fire accident

e. Yoga Education: Meaning, Definition and uses of yoga for focussed mind.
f. Selected Asanas and Pranayama: Physical exercises
g. Dimensions of Wellness & Mindfullness.

Practicum:
a. Preparation of first aid kit
b. Health awareness programme
c. Demonstration of Asanas and Pranayama
d. Organizing games
e. Writing about the eminent performers in games and sports

Suggested Readings:

1. Nash, T.N. (2006). Health and Physical education. Hyderabad: Nilkamal publishers
2. Prasad, Y.V. (2006). Methods of teaching physical education. New Delhi: Discovering publishing house
3. Chandra, S.S & Krishanan, P. (2005). Health education and physical education. Delhi: Surjeet Publications
4. Mangal, S.K. (2005). Health and physical education. Ludhiana: Tandon Publication

EDFL6015: FAMILY LIFE EDUCATION
Credits: 2 (1-0-1); Hours: 30
Marks: 50 (Attendance-5, NF-5, Theory-20, Practical-20)

COURSE OUTCOMES:
CO 1: To develop understanding about the concept of Family life education and its core elements (Understanding)
CO 2: To practice abstinence from sex until marriage (Application)
CO 3: To develop the skills of positive parenting (Application)
CO 4: To recognize different types of child abuse and take steps towards its prevention (Analysis)
CO 5: To prepare pamphlets and organize awareness programmes in the community (Creation)

MODULE I: Family Life Education And Its Core Elements (15 Hours)
- Family life education: Concept, principles, objectives and importance
- Role of Individual, Family and Community in Family Life Education
- The benefits of abstinence from sex until marriage
- Positive parenting: building healthy relationship with your kids
- Child abuse and neglect

MODULE II: Practicum (30 Hours)
- Prepare pamphlets related to family life education, child abuse, abstinence from sex until marriage
- Organizing awareness in nearby schools through Role Play concerning to different issues of family life education

Suggested REadings

1. Aggarwal, J.C (2003): Population Education, Delhi: Shipra Publications
2. Kapoor, K.C & Kapoor, A. (2013): Population Education, Guwahati, EBH, Publications
3. National Center for Injury Prevention and Control (2021), Preventing Child Abuse & Neglect, Centers for Disease Control and Prevention; available at https://www.cdc.gov/violenceprevention/pdf/can/CAN-factsheet_508.pdf
4. Chacko, T. (n. d.). Importance of Family Life Education. Indira Gandhi National Open University; available at https://www.egyankosh.ac.in/bitstream/123456789/80000/1/Unit-3.pdf
5. NIH News in Health (Special Issue), A monthly newsletter from the National Institutes of Health, U.S. Department of Health and Human Services, page 1-6; available at https://newsinhealth.nih.gov/sites/nihNIH/files/Special-Issues/Parenting.pdf
6. Abstinence (2019), Alberta Health Services; available at https://teachingsexualhealth.ca/app/uploads/sites/4/Abstinence_Final-1.pdf
7. Maher, B. (n. d.). Why Wait: The benefits of abstinence until marriage, pages 1-14; available at https://downloads.frc.org/EF/EF11B20.pdf
8. What Is Child Abuse and Neglect? Recognizing the Signs and Symptoms (2019). Child Welfare Information Gateway. Children's Bureau/ACYF/ACF/HHS, pages 1-8; available at https://www.childwelfare.gov/pubpdfs/whatiscan.pdf
9. Child Abuse. Indira Gandhi National Open University, pages 29-44; available at https://egyankosh.ac.in/bitstream/123456789/31579/1/Unit-2.pdf
10. Dahiya, A. (2018). Child Abuse: Forms, Factors Responsible, and Protection Issues, World Wide Journal of Multidisciplinary Research and Development, 4(2): 59-62, E-ISSN: 2454-6615; available at http://wwjmrd.com/upload/child-abuse-forms-factors-responsible-and-protection-issues_1518437447.pdf

MAPPING OF COs

	Module I	Module II
CO1	H	
CO2	H	H
CO3	H	H
CO4	H	H

EDWE6014: WOMEN EMPOWERMENT (2 CREDIT) 1-0-1

Course outcomes:

1. To familiarize students with the concept of women empowerment (R)
2. To make students aware on issues related to gender discrimination (U)
3. To analyze issues related to health conditions of Indian women.(An)
4. To organize/perform various activities related to women empowerment (Ap)

Module-1

Concept of Women's Empowerment (15 hrs)

a) Gender discrimination
b) Women's Rights
c) Health conditions and work related issues of women
d) Women empowerment through education

Practicum: (any two) (30 hrs)

I. Visiting women self - help groups.
II. Organizing flash mob, skits in neighboring areas.
III. Reporting on one stop Centre scheme by Government of India.
IV. Releasing a magazine on status of women then and now.

Mapping of Cos to Syllabus

	CO1	CO2	CO3	CO4
Module 1	H	H	H	H
Module 2				H

Process of Evaluation: 50 Marks
Attendance- 5
Non-formal -5
Theory- 20(MCQ)
Practical-20

Suggested Readings

1. Agrawal, S.P. 2001.Women Education in India, Guwahati: Eastern Book House.
2. *Importance of education in empowerment of women in India*. (n.d.). Retrieved November 18, 2022, from https://www.motherhooduniversity.edu.in/pdf/Publications/2016/Khushboo%20Singh.pdf
3. *Ma [education] second semester EDCN 806E [English edition]*. (n.d.). Retrieved November 18, 2022, from https://stage.tripurauniv.ac.in/Content/pdf/Distance%20Education%20Notice/Education%20for%20Empowerment%20of%20Women%20_%20MAEducation%20_806E%20English_21072017.pdf
4. *Role of education in the empowement of women in India - eric*. (n.d.). Retrieved November 18, 2022, from https://files.eric.ed.gov/fulltext/EJ1081705.pdf
5. Seth, Mira. 2001. Women and Development. New Delhi: Sage Publication

DEPARTMENT OF ENGLISH

VISION
To be a centre of excellence in learning, teaching and research in the areas of language and literature by imparting personalized education, inculcating human values and thereby contributing to nation building.

MISSION
- To develop critical thinking, creative writing and interpretive ability
- To foster professionalism to face the competitive world by developing language and communicative skills and by maintaining creative literary activity
- To generate sensitivity to culture and ethical issues
- To develop human potential to its fullest by mentoring and upholding human and spiritual values
- To prepare individual to become responsible citizens of tomorrow

PROGRAMME OUTCOMES- MA ENGLISH
PO1: **Critical Thinking:** Apply theoretical knowledge to make a critical analysis, intervene using innovative frameworks and evaluate and follow up.
PO2: **Effective Communication:** Engage in inter and intra personal communications, behavioural change communication and proficiency in information Communication Technology.
PO3: **Scientific Temper:** To build essential skills of life including questioning, observing, testing, hypothesizing, analysing and communicating.
PO4: **Effective Citizenship:** Demonstrate empathetic social concern and engage in service learning and community engagement programmes for contributing towards achieving local, regional and national goals.
PO5: **Ethics:** Recognize different value systems including your own, understand the moral dimensions of your decisions and accept responsibility for them.
PO6: **Environment and Sustainability:** Participate and promote sustainable development goals.
PO7: **Gender Sensitization and Social Commitment:** To imbibe Gender sensitivity and the sense of social responsibility for self and community for the benefit of the society at large.
PO8: **Self-directed and Life-long learning:** Engage in continuous learning for professional growth and development.

PROGRAMME SPECIFIC OUTCOMES
PSO1: To familiarize with the writers of English literature across different ages and continents, their theories, perspectives, models and methods.
PSO2: To be able to demonstrate competence in analysis and critically analyse scholarly work in the areas of English language teaching, literary research and translation.
PSO3: To enhance literary and critical thinking.
PSO4: Application of the knowledge of Literature, theories, research and skills in different fields of literary practice.
PSO5: To develop the technical skills and ethical decisions appropriate for the holistic professional development in the field.

LIST OF COURSES

1.1 Chaucer to Elizabethan Period - Poetry, Drama and Romance
1.2 Literary and Social History of England-Chaucer to Elizabethan Period
1.3 Shakespearean Drama I- Comedy and History Plays
1.4 Rhetoric and Prosody
1.5 T.S. Eliot
1.6 Thomas Hardy
1.7 Media Literacy
1.8 Leadership and Social responsibility
1.9 Gender Studies
1.10 English Language Teaching
1.11 Seminar and Presentation I
2.1 Restoration to Romantic Period-Poetry and Drama
2.2 Literary Criticism-Plato to F.R. Leavis
2.3 Shakespearean Drama II-Tragedy and Tragi-comedy
2.4 Approaches to Language and Literary Research
2.5 Classics in Translation
2.6 Indian Women Writers
2.7 Environment and Disaster Management
2.8 Peace Education and Conflict Management
2.9 Introduction to Social Psychology
2.10 North-East Indian Literature in English
2.11 Seminar and Presentation II
3.1 Victorian to Post-modern Period- Poetry, Drama and Fiction
3.2 Post-colonial Literature-Poetry, Drama and Fiction
3.3 American Literature-Poetry, Drama and Fiction
3.4 Literary and Critical Theory
3.5 Gender and Literature
3.6 Linguistics and Stylistics I
3.7 Introduction to Modern European Literature I
3.8 Colonial and Post-colonial African Literature I
3.9 Project Phase I
4.1 Indian Writing in English-Poetry, Drama and Fiction
4.2 South-Asian Literature
4.3 Linguistics and Stylistics II
4.4 Introduction to Modern European Literature II
4.5 Colonial and Post-colonial African Literature II
4.6 Project Phase II-Dissertation

MAPPING of COURSES to PO/PSOs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO 5**
1.1									H				
1.2									H				
1.3									H				
1.4	L								M	M		H	
1.5	M								H	M			
1.6	M								H	M			
1.7		H		M	M								L
1.8				M	H		M						
1.9				L	M		H				M	M	
1.10		H						M		H		H	M
1.11	M		M					M		H	M	H	L
2.1					L				H				
2.2	H										H		

2.3									H				
2.4		H								H		M	M
2.5									H	M			
2.6	L						M		H		M		
2.7						H							
2.8				H	H			L					
2.9	M		L	L	H					M	M		
2.10				L					H		L		
2.11	M		H					M		H	L	H	M
3.1									H				
3.2	M								H	L	M		
3.3									H				
3.4	H									M	H	L	
3.5	M				M		H		L	M	M	L	
3.6		M								H		M	
3.7									H				
3.8	M						M		H	M		L	
3.9	H		H					M		H	M	M	M
4.1									H		M		
4.2									H		L		
4.3		L								H		M	
4.4									H				
4.5	M						M		H	M	H		
4.6	H		H					M		H	M	H	H

DETAILED SYLLABUS - MA ENGLISH

EGEP0001: CHAUCER TO ELIZABETHAN PERIOD - POETRY, DRAMA AND ROMANCE (4-0-0) (CREDITS: 04)

Course Outcomes:

1. Define the fundamental concepts of the three genres of Poetry, Drama and Romance from the age of Chaucer to Elizabethan period (Remembering).
2. List the representative writers and their texts of the fourteenth century (Understanding).
3. Experiment the characteristic features and forms of Poetry, Drama and Romance from the age of Chaucer to Elizabethan period (Applying).
4. Categorize the socio-political background and factors that influenced and shaped the literary texts of the period (Analyzing).
5. Evaluate the given text critically in its literary context, use of various literary devices, thematic and symbolic significance and the use of Language and style (Evaluating).
6. Estimate the given texts as literary works of the corresponding age (Creating).

Module I: Selected Poetry (25 lectures)

a. Geoffrey Chaucer 's ''Prologue'' to The Canterbury Tales
b. Edmund Spenser 's The Faerie Queene (Book III)
c. William Shakespeare's Sonnets No. 18, 29,34
d. Philip Sidney's Astrophel and Stella

Module II: Selected Drama (20 lectures)

a. Christopher Marlowe's *The Jew of Malta*
b. Ben Jonson's *The Alchemist*

Module III: Selected Romance (15 lectures)

Sir Thomas More's *Utopia*

Suggested Readings

1. Texts of Selected Poetry, Drama and Romance.
2. Drabble, Margaret. ed. *The Oxford Companion to English Literature*. Oxford: OUP

3. Ferguson, Margaret. et al. ed. *The Norton Anthology of Poetry*. New York: London.
4. Shakespeare, William. *William Shakespeare Sonnets*, Rupa Publishers
5. Tillyard, E. M. W. *Elizabethan World Picture*. Peregrine Books, 1970
6. Trevelyan, G.M. *English Social History: A Survey of Six Centuries, Chaucer to Queen Victoria.* Penguin, 1987

Mapping of COs to Syllabus:

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H	H	H
CO 2	H	H	H
CO 3	H	H	H
CO 4	H	H	H
CO 5	H	H	H
CO 6	H	H	H

EGLS0002: LITERARY AND SOCIAL HISTORY OF ENGLAND - CHAUCER TO ELIZABETHAN PERIOD (3-0-0) (CREDITS: 03)

Course Outcomes:

1. Define the different Periods involved in the Literary and Social History of England from the Medieval to Elizabethan age (Remembering).
2. List the chronological changes that intervened in the history of England during fourteenth and early fifteenth century (Understanding).
3. Use the characteristic features, significant changes, development and modes indicating transition from the Medieval life, The Black Death to the Elizabethan theatre in the reading of the given texts (Applying).
4. Identify the various socio-political factors responsible for these developments and their influences in the shaping of the Literature of the period (Analyzing).
5. Explain the various literary and socio-political influences for the literature production at the various stages from the Medieval age to the coming of Elizabethan theatre (Evaluating).
6. Estimate the contextual background involved in the shaping up of various literary works (Creating).

Module I (15 lectures)

a. The Church and Medieval Life
b. Towns and Villages in Medieval England
c. Feudalism
d. The English Manorial System and Medieval Agriculture

Module II (15 lectures)

a. The Black Death and its Aftermath
b. Medieval English Theatre
c. Medieval Romance
d. Fabliau, Lyric, Dream Allegory and Ballad

Module III (15 lectures)

a. Caxton and the Printing Press
b. Renaissance and the Literature: The University Wits, the Elizabethan Prose, the Metaphysical Poetry, etc.
c. Reformation
d. The Elizabethan Theatre

Suggested Readings

1. Abrams, M.H. *A Glossary of Literary Terms*. Prism India.
2. Ashok, Padmaja. *The Social History of England*. Orient Black Swan.
3. Choudhury, Bibhas. *English Social and Cultural History*. PHI, 2009.
4. Peck, John and Martin Coyle. *A Brief History of English Literature*. Palgrave.
5. Sanders, Andrew. *The Short Oxford History of English Literature*. Oxford: OUP.
6. Trevelyan, G.M. *English Social History: A Survey of Six Centuries, Chaucer to Queen Victoria.* Penguin, 1987

Mapping of COs to Syllabus:

Course Outcomes	Module 1	Module 2	Module 3
CO 1	M	M	H
CO 2	H	H	H

CO 3		H	H
CO 4	H	H	
CO 5		H	H
CO 6	H	H	

EGRP0004: RHETORIC AND PROSODY (2-0-0) (CREDITS: 02)

Course Outcomes:

1. Recall the different figures of speech based on Comparison (Remembering)
2. Classify the differences between Metonymy and Synecdoche (Understanding)
3. Apply the rules of prosody in scanning a piece of poetry (Applying)
4. Distinguish between Irony and Sarcasm (Analysing)
5. Explain the different figures of speech used in a passage (Evaluating)
6. Discuss the dominant types of meters used in English versification (Creating)

Module I: Introduction to Rhetoric (10 lectures)
Rhetoric; Difference between Grammar and Rhetoric; Relation between Rhetoric and Emotion; Rhetoric and Oratory; Prosody; Difference between Poetry and Prose; Syllable, Foot, Accent, Pitch; Primary and Secondary accent; Rules governing Accent; Rhythm, Rhyme, Metre; Scansion

Module II: Figures of Speech (10 lectures)
Contribution of Figures of Speech to Literary Expression, Classification of Figures of Speech, Figures based on Similarity or Resemblance, Association, Contrast or Difference, Imagination, Indirectness, Sound, Construction; Miscellaneous Figures of Speech

Module III: Prosody: Different kinds of Metre and Poetry (10 lectures)
Types of Metre; Special Metres; Types of Poetry

Suggested Readings:

1. Bhattacharya, Arunodoy. *Studies in English Rhetoric and Prosody.* Books Way.
2. Chakraborti, M.*Principles of English Rhetoric and Prosody*. Kolkata: The World Press Pvt. Ltd.
3. Corbett, Edward P.J. and Connors, Robert J. *Classical Rhetoric for the Modern Student.* OUP.
4. Lanham, Richard A. *A Handlist of Rhetorical Terms*, University of California Press.

Mapping of COs to Syllabus:

Course Outcomes	**Module 1**	**Module 2**	**Module 3**
CO1		H	
CO2	H	H	
CO3	M	M	H
CO4	M	H	
CO5		H	
CO6			H

EGTS0005: T.S. ELIOT (3-0-0) (CREDITS: 03)

Course Outcomes:

1. Define Modern poetry as a literary genre and T.S. Eliot as a Modernist poet (Remembering)
2. Outline the style and characteristic features of T.S Eliot poetry (Understanding)
3. Identify the salient features of Modern poetry through the works of T.S.Eliot (Applying)
4. Analyse T.S. Eliot's works in terms of theme, technique, prosody, approach, focus, vision and influences (Analysing)
5. Evaluate the influences, impact and effectiveness of the works of T.S. Eliot (Evaluating)
6. Discuss and summarize the various literary and poetic aspects of his works against the individual and socio- political propensities (Creating)

Module I: Introduction to T.S. Eliot. (10 lectures)
Modern English Poetry. Life and Career of T.S. Eliot. Formative influences on the poet. Characteristics of the poet's mind and art. Themes, poetic techniques and features found in his poetry. T.S Eliot 's contribution to poetry, society and life.

Module II: Prescribed Texts of T.S. Eliot. (35 lectures)

a. "The Waste Land"

b. The Murder in the Cathedral

Suggested Readings:

1. The prescribed texts in the course
2. Behr, Cardene. *T.S. Eliot: A Chronology of His Life and Works*. Macmillan.
3. Eliot, T.S. "Hamlet and His Problem (1919)," "The Metaphysical Poets "(1921), "Religion and Literature" (1935) in *Selected Essays, 1917-1932*, Faber and Fabre 1999.
4. Haughton, Hugh and Valerie Eliot. *The Letters of T. S. Eliot: Volume 1: 1898-1922*. Yale University Press, 2011.
5. Moody, David. A. *The Cambridge Companion to T.S. Eliot*. CUP.

Mapping of COs to Syllabus:

Course Outcomes	Module 1	Module 2
CO1	H	
CO2	H	
CO3	H	
CO4	H	H
CO5	H	H
CO6	H	H

EGTH0006: THOMAS HARDY (3-0-0) (CREDITS: 03)

Course Outcomes:

1. Define English Victorian novel and Thomas Hardy as a Victorian novelist (Remembering)
2. Demonstrate the characteristic features of Thomas Hardy's fiction (Understanding)
3. Identify the Victorian elements and modernist features in the works of Thomas Hardy (Applying)
4. Analyse critically Hardy's style through the theme, plot, characterization and settings found in the prescribed texts (Analysing)
5. Evaluate Hardy's works in terms of the philosophical content, Historical perspective, literary aspect and language and style (Evaluating)
6. Discuss and summarize the thematic content, approach, literary aspects, and socio- political background of the period in Hardy's fiction (Creating)

Module I: Introduction to Thomas Hardy (10 lectures)

English Victorian Novel. Life and Career of Thomas Hardy. Formative influences on the writer. Characteristic features of the individual novelist. Themes, Wessex setting and Techniques used in his novels. Writer's contribution to the art of Novel writing and society.

Module II: Prescribed Texts of Thomas Hardy (35 lectures)

a. Tess of D' Urbervilles

b. Far From the Madding Crowd

c. "The Three Strangers"

Suggested Readings

1. The prescribed texts.
2. Allen, Walter E. *The English Novel: A Short Critical History.* London: Phoenix.
3. Bayley, J. *An Essay on Thomas Hardy.* Cambridge.
4. Drabble, M. *The Genius of Thomas Hardy*. London

Mapping of COs to Syllabus:

Course Outcomes	Module 1	Module 2
CO1	H	
CO2	H	M
CO3	H	M
CO4	M	H
CO5	H	H
CO6	M	H

EGET0007: ENGLISH LANGUAGE TEACHING (3-0-0) (CREDITS: 03)

Course Outcomes:

1. Define the vast body of Language teaching methodologies (Remembering)
2. Demonstrate the different approaches to teaching of English as a second language (Understanding)
3. Apply theoretical assumption as well as practical language teaching skills while dealing with second language learners in the classroom (Applying)
4. Analyse the specific issues such as the First and Second Language acquisition, Mother tongue interference in learning a foreign language, TG Grammar, Psychological and Sociological perspectives in Language learning, Role of technology in language learning (Analysing)
5. Compare and estimate the utility and feasibility of different language teaching methodologies and techniques in different language teaching- learning situations with proper forms of testing (Evaluating)
6. Design as well as adapt on the syllabuses of second language teaching and constructing lesson plans for dealing with language learners of different linguistic backgrounds (Creating)

Module I: Introduction to English Language Teaching (10 lectures)
Introduction, Fundamental concepts of Language Teaching, Historical Perspective of ELT, Language Pedagogy. Elements of the Structure of English Language.

Module II: Methods and Approaches of Teaching English (20 lectures)
Theoretical aspects of Language Acquisition and Learning; Language Skills assessment; Psychological approach to language teaching in a bilingual/ multilingual context; Use of Technology in Language Teaching; Educational Technology; Testing and Evaluation.

Module III: Grammar and Practical Language Skills (10 lectures)
Parts of Speech; Articles and Prepositions; Degrees of Comparison; Direct and Indirect Speech; Sentence patterns; Letter Writing; Report Writing; Reading Comprehension; Listening and Speaking; English Speech Sounds – Vowels and Consonants, Stress and Intonation patterns; Language Games; Vocabulary Expansion; Telephonic Conversation; Teaching English for Academic and Business Purpose.

Module IV: Language through Literature (5 lectures)
Role of Literature in Language Learning; Teaching of Literature; Use of Language Model.

Suggested Readings

1. Ray Mackay, *A Basic Introduction to English Language Teaching*; Oxford, 2018.
2. Penny Ur, *A Course in English language Teaching*, CUP.2010.

Mapping of COs to Syllabus:

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H	H		
CO2	M	H	M	
CO3	H	H	M	M
CO4	H	H	M	M
CO5	M	H	H	M
CO6	H	H	H	H

EGRR0008: RESTORATION TO ROMANTIC PERIOD – POETRY AND DRAMA (4-0-0) (CREDITS: 04)

Course Outcomes:

1. Define various genres of literature, viz. poetry and drama and identify the recurrent themes of the Restoration and Romantic era. (Remembering)
2. Apply the historical onset while reading the texts. (Applying)
3. Analyse the themes critically and compare as well as contrast the different characters of the selected dramas. (Analysing)
4. Interpret the selected literary works and critically evaluate the plot, theme and character of the dramas and the theme and figures of speech in the poems. (Evaluating)
5. Assess and evaluate the selected dramas and poems vis-à-vis their context and socio- political and cultural background. (Evaluating)
6. Invent a new interpretation of the texts. (Creating)

Module I: Selected Poetry (25 lectures)

a. John Dryden: “Mac Flecknoe”

b. Lord Byron: "Love's Last Adieu"
c. William Wordsworth: "Composed on Westminster Bridge"
d. John Keats: "Ode to a Nightingale"
e. P. B. Shelley: " To a Skylark"

Module II: Selected Drama (35 lectures)
a. George Etherege: *The Man of Mode*
b. William Congreve: *The Double Dealer*
c. John Dryden: *All for Love*

Suggested Readings
1. Dryden, John. *Mac Flecknoe and Other Poems*.
2. Appelbaum, Stanley. *English Romantic Poetry: An Anthology*.
3. Selected Critical Texts (mentioned in the detailed course)
4. Fisk, Deborah Payne. *The Cambridge Companion to English Restoration Theatre*.
5. Perry, Henry Ten Eyck. *The Comic Spirit in Restoration Drama: Studies in the Comedy of Etherege, Wycherley, Congreve, Van Brugh and Farquhar.*

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2
CO1	H	H
CO2	H	H
CO3	H	H
CO4	H	H
CO5	H	H
CO6	H	H

EGEP0001: CHAUCER TO ELIZABETHAN PERIOD - POETRY, DRAMA AND ROMANCE (4-0-0) (CREDITS: 04)

Course Outcomes
1. Define the literary form of drama, especially tragedy and tragi-comedy. (Remembering)
2. Interpret the selected literary works, i.e. the Shakespearean tragedy and tragi- comedy and they are able to explain the plot, theme and character of the dramas. (Understanding)
3. Apply critical reading skills to the two very distinct forms of Shakespeare's drama. (Applying)
4. Analyse selected texts for a better understanding of the genius of William Shakespeare. (Analysing)
5. Assess and critically appreciate the selected dramas. (Evaluating)
6. Negotiate with the complexity of ideas winded around plot, theme and character of the selected dramas. (Creating)

Module I: Tragedy (30 lectures)
a. William Shakeaspear: *Macbeth*
b. William Shakespear: *King Lear*

Module II: Tragi-Comedy (30 lectures)
a. William Shakespeare: *TheMerchant of Venice*
b. William Shakespeare: *The Winter 's Tale*

Suggested Readings
1. *Shakespearean Tragedy: Lectures on Hamlet, Othello, King Lear and Macbeth,* latest edition, Bradley, A.C, 2017, Pinnacle Press.
2. *The Oxford Shakespeare: The Complete Works,* 2nd Edition, Wells, Stanley and others, 2005, OUP.
3. *The New Cambridge Companion to Shakespeare,* 2nd Edition, De Grazia and Wells Stanley, 2010, CUP.
4. *English Drama 1586 – 1642: The Age of Shakespeare, Latest Edition,* Hunter, G.K, 1997, OUP.
5. Johnson, Samuel. "Preface to Shakespeare." 131-61, *Indian Edition*, D.J. Enright and Ernst De Chickera ed.

English Critical Texts: 1975, Oxford

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2
CO 1	H	H
CO 2	H	H
CO 3	H	H
CO 4	H	H

CO 5	H	H
CO 6	H	H

EGAL0011: APPROACHES TO LANGUAGE AND LITERARY RESEARCH (3-0-0) (CREDITS: 03)

Course Outcomes
1. Explain basic concepts of research and its methodologies. (Understanding)
2. Identify research topics and select and define appropriate research problems and parameters. (Remembering)
3. Organize and conduct research in an appropriate manner. (Applying)
4. Analyse literary works from various genres by applying various theories and approaches. (Analysing)
5. Assess and evaluate the various works of literature to write research reports and papers. (Evaluating)
6. Discuss, summarize and critically appreciate the various approaches to language and literary research. (Creating)

Module I: Introduction (10 lectures)
Meaning of Research; Objectives of Research; Motivation in Research; Different types of Research Methods; Research Methods Vs Research Methodology; Difference between Methods and Techniques; Ethics in Research; Review of Literature

Module II: Hypothesis and Data Collection (10 lectures)
Formulation of Hypothesis; Types of Hypothesis; Methods of Testing Hypothesis; Determining Sample design; Methods of Sampling; Methods of Collection of Data (Primary Data and Secondary Data); Processing and Analysis of Data; Types of Analysis

Module III: Critical Approaches to Literature (15 lectures)
Russian Formalism and New Criticism; Feminism and Gay and Lesbian Studies; Psychoanalysis; Marxism; Archetypal Criticism; Narratology; Race Ethnicity and Postcolonial Studies; Structuralism; Post-structuralism; Deconstruction; Ecocriticism; Cultural Studies.

Module IV: Analysis and Report-Writing (10 lectures)
Testing of Hypothesis; Interpretation; Different techniques of Interpretation; Citation and Bibliography; Writing and Presentation of Report

Suggested Readings
1. *The Art of Literary Research*, 4th Edition, Altick, Richard D. & Fenstermaker, John J, 1992, W.W Norton & Company.
2. Correa, Delia Da Souza & Owens, W.R. *The Handbook to Literary Research,* 2nd Edition*,* 2009, Routledge.
3. *Literary Theory,* 3rd Edition, Eagleton, Terry, 2008, University of Minnesota Press.
4. *Research Methodology: Methods and Techniques*, 3rd Edition, Kothari, C. R. & Gaurav Garg, 2013, New Age International.
5. *MLA Handbook for Writers of Research Papers*.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	H		H
CO 2	H	H		H
CO 3	H	H	H	H
CO 4			H	
CO 5			H	H
CO 6			H	

EGTR0012: CLASSICS IN TRANSLATION (3-0-0) (CREDITS: 03)

Course Outcomes
At the end of this course students will be able to:
1. Define the history, theories, and methodologies in Translation Studies. (Remembering)
2. Illustrate fundamental questions related to translation of the major poets of classical literatures of Roman, Greek and Sanskrit. (Understanding)
3. Apply various theories and methods of translation. (Applying)
4. Examine critically the translated literary texts, critically analyse the themes and the style of literary expression in the selected texts. (Analysing)
5. Evaluate the high intrinsic quality of the classics and their fundamental importance in shaping ancient literary standards and cultural ideals. (Evaluating)
6. Discuss, summarize and critically appreciate the selected classics in translation. (Creating)

Module I: Introduction to Translation Studies (20 lectures)
Introducing Translation; History of Translation Theories; Significance of Translation in a Multi- Linguistic and Multi-Cultural Society/World; Different Types/Modes of Translation (Semantic, Literal, Literary, Functional, Communicative, Technical); Understanding the dynamics and challenges in Translation.

Module II: Selected Texts (25 lectures)
a. Ovid: *Metamorphoses*- Book I “Creation”, Book III “Tiresias”, Book IV “Persius and Andromeda”, Book VI “ Procne and Phiomela” , Book VIII “Daedalus and Icarus”, Book IX “Hercules”, Book X “ Orpheus and Eurydice”, Book XI “Troy”, Book XII “Achilles”, Book XIII “Ulysses”
b. Homer: *Odyssey*
c. Kalidasa: *Abhijnana Shakuntalam*

Suggested Reading:
1. *Translation Studies*, 4th Edition, Bassnett, Susan. 2014, Routledge.
2. *The Theory and Practice of Translation.* New Edition*,* Nida, E, 1998, Brill.
3. *Introducing Translation Studies,* 3rd Edition, Munday, Jeremy, 2012, Routledge.
4. *Classics in Translation: from Homer to Juvenal,*1st Edition, Jones, Peter V, 1998, Duckworth.
5. Tr. *Metamorphoses of Ovid,1st Edition,* Innes, Mary M, 1975, Penguin.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2
CO 1	H	
CO 2	H	H
CO 3	H	
CO 4		H
CO 5	H	
CO 6		H

EGIW0013: INDIAN WOMEN WRITERS (3-0-0) (Credits: 03)

Course Outcomes
1. Define the literature by women in India in English. (Remembering)
2. Summarize and critically appreciate the selected literary works and find out the commonalities in terms of themes and issues. (Understanding)
3. Apply feminist theories and feminist reading techniques to critically interpret and assess the selected texts. (Applying)
4. Analyse the contribution of women writers to the Indian English literary tradition. (Analyzing)
5. Judge the essence of women’s literature and appreciate the gamut of women’s lives and concerns as represented in literature. (Evaluating)
6. Construct a critical reading of the poetry, drama, short stories and novels produced by women of India in different historical periods. (Creating)

Module I: Selected Poets (12 lectures)
a. Toru Dutt: “Sita”
b. Sarojini Naidu: “The Gift of India”
c. Kamala Das: “The Old Playhouse”

Module II: Selected Playwrights and Short Story Writers (15 lectures)
a. Manjula Padmanabhan: *Harvest*
b. Mahasweta Devi: “Draupadi”

Module III: Selected Novelists (18 lectures)
Easterine Kire: *Mari*

Suggested Readings
1. *Undoing Gender*, 1st Edition, Butler, Judith. 2004, Routledge.
2. *Literature and Gender*, 1st Edition, Goodman, L, 1996, Routledge.
3. Indian Women Writers in English, 1st Edition, Mohanty, S.K., 2012, Surendra Publications.
4. Unbound: 2,000 years of Indian Women’s Writing, 1st Edition, Zaidi, Annie (ed.), 2015, Aleph Book Company.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H	H	H

CO 2	H	H	H
CO 3	H	H	H
CO 4	H	H	H
CO 5	H	H	H
CO 6	H	H	H

EGNE0014: NORTH-EAST INDIAN LITERATURE IN ENGLISH (3-0-0) (CREDITS: 03)

Course Outcomes

1. Define the vast body of writings in English from Northeast of India. (Remembering)
2. Interpret the emerging trends of literature from northeast of India in its different genres- poetry, fiction and translation (Understanding)
3. Apply theoretical assumption as well as critical reading skills to the study of vibrant areas of Northeast literature. (Applying)
4. Examine the most significant topics like colonialism, identity and unity, cultural loss, ethnic conflicts, universality in the literature of Northeast region before and after British Colonial Period (Analysing)
5. Explain different literary themes and recurrent issues reflected in the vast body of Northeast writings in English. (Evaluating)
6. Elaborate on the existing critical views on Northeast India's literary texts with reference to the Modern and Postmodern Theories on Literature. (Creating)

Module I: Selected Poetry (15 lectures)

a. Easterine Kire: "Riddu Riddu'' & "Narcissus''
b. Robin Ngangom: "My Invented Land"
c. Nongkynrih Mona Zote: "Rez"

Module II: Selected Fiction/Non-Fiction Writers (30 lectures)

a. Mamang Dai: *The Legends of Pensam*
b. Mitra Phukan: *The Collector's Wife*

Suggested Readings

1. *The Oxford Anthology of Writings from North East India: Poetry and Essays,* Indian Edition, Misra, Tillotama,2010, OUP.
2. *Emerging Literatures from North East India: The Dynamics of Culture, Society and Identity, 1st Edition,*
Zama, Magarat Ch, 1900, SAGE publications.
3. *Dancing Earth: An Anthology of Poetry from North-east India*, 1st Edition, Ngangom, Robin S. & Nongkynrih, Kynpham Singh, 2009, Penguin.
4. *Exploring North-East Indian Writings in English:* 2 volumes, 1st Edition, Swami, Indu, 2010, VDM Verlag.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2
CO 1	H	H
CO 2	H	H
CO 3	H	H
CO 4	H	H
CO 5	H	H
CO 6	H	H

EGVP0015: VICTORIAN TO POST-MODERN PERIOD-- POETRY, DRAMA & FICTION (4-0-0) (CREDITS: 04)

Course Outcomes

1. Define the socio-cultural set up of England from Victorian to Post-Modern era. (Remembering)
2. Illustrate the Victorian, Modern and Post-modern elements and themes prominent in the prescribed texts. (Understanding)
3. Develop and apply theoretical interpretations of the prescribed texts. (Applying)
4. Analyse the various prominent genres of the era, background of the texts and the authors. (Analysing)
5. Assess and evaluate the plot, theme, characters and context of the texts under study. (Evaluating)
6. Construct a critical reading based on historic aspects evident in the texts. (Creating)

Module I: Victorian Period: Poetry, Fiction, and Drama (20 lectures)

a. "Ulysses": Alfred Lord Tennyson
b. *Wuthering Heights*: Emile Bronte.

c. *Playboy of the Western World*: J.M. Synge

Module II: Modern Period: Poetry, Fiction, and Drama (20 lectures)

a. "Wreck of the Deutschland": G. M. Hopkins
b. *Heart of Darkness*: Joseph Conrad
c. *Pygmalion*: G. B. Shaw

Module III: Post-Modern Period: Poetry, Fiction, and Drama (20 lectures)

a. "Digging": Seamus Heaney
b. *The French Lieutenant's Woman*: John Fowles
c. *Waiting for Godot*: Samuel Beckett

Suggested Readings

1. David, Deirdre. *The Victorian Novel*. Cambridge University Press, 2012.
2. Bradbury, Malcolm and James Mc Farlane. *Modernism: A Guide to European Literature*. Penguin Publication, 1978.
3. Hutcheon, Linda. *The Poetics of Postmodernism*. Routledge Publication,1988.
4. Waugh, Patricia. *Metafiction: The Theory and Practice of Self- Conscious Fiction*. Routledge Publication, 1988.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H	H	H
CO 2	H	H	H
CO 3	H	H	H
CO 4	H	H	H
CO 5	H	H	H
CO 6	H	H	H

EGPL0016: POST-COLONIAL LITERATURE-- POETRY, DRAMA & FICTION (3-0-0) (CREDITS: 03)

Course Outcomes

1. Recall the various critical elements in adherence to the Post-colonial literature. (Remembering)
2. Illustrate the historical context of Post-colonial literature and the use of racist and colonial undertones in the texts under study. (Understanding)
3. Identify the texts on the basis of the historical background, socio-political conditions of the respective time period and establish a connectedness across the commonalities of the theme and structure of the texts under study. (Applying)
4. Analyse the various postcolonial theories and literary concepts from texts written in corresponding time frames and by authors coming from varied socio-linguistic milieu. (Analysing)
5. Evaluate the significance of Post-colonial literature from the historical, socio-political and literary perspective and its evolution within a relevant theoretical framework along with the writer's psyche and contribution towards it. (Evaluating)
6. Formulate the understanding of world literatures from the postcolonial perspective. (Creating)

Module I: Introduction to Post-colonial Studies (8 lectures)

Historical background of Post-colonial Studies, Post-colonial theory, Decolonization, Globalization, Hybridization, identity, culture, 'othering'.

Module II: Selected Texts (10 lectures)

a. *Orientalism*: Edward Said (Selections)
b. *Nation and Narration*: Homi K. Bhabha

Module III: Selected Novels (12 lectures)

a. *The Shadow Lines*: Amitav Ghosh
b. *Foe*: J. M. Coetzee

Module IV: Selected Drama and Poetry (15 lectures)

a. *A Dance of the Forest*s: Wole Soyinka
b. "Vultures": Chinua Achebe
c. "Phenomenal Woman": Maya Angelou

Suggested Readings

1. "The Danger of a Single Story" (Transcript) by Chimamanda Adichie.
2. Benson, Eugene and L. Conolly (Eds). *Encyclopaedia of Postcolonial Literatures in English*. Routledge, 2005
3. Moore-Gilbert, Bartet al (Eds.) *Postcolonial Theory: Contexts*, Practices, Politics. Routledge, 1997

4. Mongia, Padmini. *Postcolonial Theory*. Oxford, 1996
5. Mukherjee, Meenakshi and Harish Trivedi (Eds.) *Interrogating Postcolonialism*. Indian Institute of Advanced Studies, 1996.
6. Ashcroft, Bill et al. *The Empire Writes Back*. Routledge, 2002.
7. Nayar, Pramod K. *Postcolonial Literature: An Introduction*. Pearson Education India, 2008.
8. Young, Robert J.C. *Postcolonialism: A Very Short Introduction*. Oxford UP,2003.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2	H	M	M	M
CO 3		H	H	H
CO 4	M	H	H	H
CO 5		H	H	H
CO 6	M	H	H	H

EGAL0017: AMERICAN LITERATURE – POETRY, DRAMA & FICTION (3-0-0) (CREDITS: 03)

Course Outcomes
1. Define intricacies of American literature. (Remembering)
2. Explain diversified range of subjects portrayed in American literature. (Understanding)
3. Organize a comparative study between literature from the conventional European colonial powers and a colonised yet culturally and politically dominant nation like America. (Applying)
4. Discover the colonial experience of America and its post-colonial recuperation (Analysing)
5. Interpret the complexities of race and identity as expressed through the indigenous cultures of the American society in the post-colonial context (Evaluating)
6. Develop a critical perspective towards the contemporary reading of a colonial text (Creating)

Module I: Introduction (10 lectures)
The Colonial Period ("Declaration of Independence", 1776), American Nationalism, Romanticism, Transcendentalism (Selections from Emerson), Selections from *Studies in American Indian Literature* by Paula Gunn Allen

Module II: Drama (10 lectures)
a. *Who is Afraid of Virginia Woolf*: Edward Albee
b. *Death of a Salesman*: Arthur Miller

Module III: Novels (15 lectures)
a. *Moby Dick*: Herman V Melville.
b. *The Scarlet Letter*: Nathaniel Hawthorne

Module IV: Poems (10 lectures)
a. "When Lilacs Last in the Dooryard Bloom'd": Walt Whitman
b. "The Raven": Edgar Allan Poe
c. "The Red Part": Linda Hogan

Suggested Readings
1. Ellmann, Richard (Ed.). *The New Oxford Book of American Verse*. Oxford University Press, 2001.
2. Horton, R W and H.E. Edwards (Eds.).*Backgrounds of America Literary Thought*. Prentice Hall, 1974.
3. Spiller, Robert E. *The Cycle of American Literature*. Macmillan, 1961.
4. Gray, Richard. *History of American Literature*. Blackwell, 2008.
5. Chase, Richard. *The American Novel and its Tradition*. Johns Hopkins Press, 1990.
6. Krasner, David. (Ed.) *A Companion to Twentieth Century American Drama*. Blackwell, 2005.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	M	M
CO 2	H	H	H	H
CO 3	H	M	M	M
CO 4	H	M	H	M
CO 5	H	H	H	H
CO 6	H	M	M	M

EGLT0018: LITERARY AND CRITICAL THEORY (4-0-0) (CREDITS: 04)

Course Outcomes
1. Define contemporary critical theories. (Remembering)
2. Explain the genesis and growth of the modern critical theories in the context of literary texts. (Understanding)
3. Construct awareness of contemporary as well as Indian theories of literary aesthetics and utilize the theories to generate new approaches of looking at literary texts. (Applying)
4. Examine texts on the basis of their understanding of critical theoretical paradigms related to literature (Analysing)
5. Evaluate the texts in terms of their political, social, psychoanalytical, feministic and economic implications. (Evaluating)
6. Develop a more profound critical approach after the study of these theories. (Creating)

Module I: Canonical literary theories and theorists (20 lectures)
a. Deconstruction with reference to “Structure, Sign and Play in the Discourse of the Human Sciences”: Jacques Derrida
b. Post- modernism with reference to “The Death of the Author”:Roland Barthes
c. Marxist literary theory with reference to *Ideology and the State Apparatuses* (extract):Louis Althusser
d. Post- structuralism with reference to *The Order of Discourse* (extract) : Michel Foucault

Module II: Important texts (10 lectures)
a. “Myth, Fiction and Displacement”: Northrop Frye
b. Selections from *Seven Types of Ambiguity*: William Empson
c. Selections from *Culture and Society, 1780-1950*: Raymond Williams

Module III: Critical essays and concepts (30 lectures)
a. “Castration or Decapitation?”: Hélène Cixous
b. “Discourse in the Novel” from *The Dialogic Imagination*: M. M. Bakhtin
c. Selections from *Practicing New-historicism*: Stephen Greenblatt
d. “What Makes an Interpretation Acceptable”: Stanely Fish
e. “Trans-corporeal Feminisms and the Ethical Space of Nature”: Stacy Alaimo
f. Excerpts from *The Natyashastra*: Bharata Muni

Suggested Readings
1. Cuddon, J.A. *A Dictionary of Literary terms and Theories*. Penguin, 1997.
2. Wimsatt, William K and Cleanth Brooks (Eds.).*Literary Criticism: A Short History*. Routledge, 1957.
3. Selden, Raman and Peter Widdowson, *A Reader’s Guide to Contemporary Literary Theory.* 5th
4. Edition, University Press of Kentucky, 1993.
5. Alaimo, Stacy and Susan Hekman. Material Feminisms. Indiana University Press, 2008. Project MUSE

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	M	M	H
CO 2	H	H	H
CO 3	M		H
CO 4	H		H
CO 5	H	H	H
CO 6	H	H	H

EGGN0019: GENDER AND LITERATURE (2-0-0) (CREDITS: 02)

Course Outcomes
1. Define the various thoughts and theories pertaining to feminist writings and feminism. (Remembering)
2. Explain the themes and topics and relate it to real life situations. (Understanding)
3. Develop new ideas by connecting the various topics taught. (Applying)
4. Analyse the various movements related to gender issues and new developments in gender studies in literature. (Analysing)
5. Evaluate the interdisciplinary aspect in various texts. (Evaluating)
6. Discuss the meanings, ideas and thoughts regarding gender and its connection with literature. (Creating)

Module I: Selected Feminist Writings (12 Lectures)
a. “Vindication of the Rights of Woman”: Mary Wollstonecraft (Excerpts)
b. “The Laugh of the Medusa”: Helene Cixous
c. *The Second Sex*: Simone de Beauvoir (Selections)
d. *The Gender Trouble*: Judith Butler (Selections)

Module II: Selected Fiction (12 Lectures)

a. *Funny Boy*: Shyam Selvadurai
b. *Sunlight on a Broken Column*: Attia Hussain

Module III: Selected Short Story and Poetry (6 Lectures)

a. "The Wife's Letter": Rabindranath Tagore
b. "Purdah": Imtiaz Dharker

Suggested Readings

1. De Souza, Eunice (Ed.) *Nine Indian Woman Poets*. Oxford University Press, 1997.
2. Butler, Judith. *Gender Trouble*: *Feminism and Subversion of Identity.* Roudedge,1990.
3. Chaudhari, Sukanta (Ed.). *Rabindranath Tagore: Selected Short Stories.*Oxford,2000.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H		
CO 2	H	M	M
CO 3	H	M	M
CO 4	H	M	M
CO 5		H	H
CO 6	M	H	H

EGLS0020: LINGUISTICS AND STYLISTICS I (3-0-0) (Credits: 03)

Course Outcomes

1. Define the key concepts of Linguistics. (Remembering)
2. Illustrate the differences between Stylistics and Linguistics. (Understanding)
3. Identify and explain the different levels of language. (Applying)
4. Analyse Linguistics and Traditional Grammar. (Analysing)
5. Recommend Stylistics as an interdisciplinary field of study. (Evaluating)
6. Discuss the different branches of Stylistics. (Creating)

Module I: Introduction to Linguistics (35 lectures)

Definition of Language and its characteristics, Definition, Scope and Goal of Linguistics, Linguistics and Traditional Grammar, Langue and Parole, Competence and Performance, Synchrony and Diachrony, Syntagmatic and Paradigmatic, Sign, Signifier and Signified, Language and Society, Dialect and Idiolect, Standard Language, Register and Style, Bilingualism and Multilingualism, Pidgin and Creole, Language maintenance, Language Shift and Language Death

Module II: Introduction to Stylistics (10 lectures)

Definition, Nature and Scope of Stylistics, Stylistics, Linguistics and Literary Criticism, Major Thinkers in Stylistics, Objectives of this discipline, Stylistics and levels of language, Stylistics and Style, Different branches of Stylistics, Stylistics as an interdisciplinary field

Suggested Readings

1. Toolan, Michael. *Language in Literature: An Introduction to Stylistics.* Routledge, 1998.
2. Simpson, Paul. *Stylistics.* Routledge, 2014.
3. Lyons, John. *Language and Linguistics.* Cambridge University Press, 1981.
4. Bradford, Richard. *Stylistics.* Routledge, 1997.
5. Carter, Ronald and Paul Simpson. *Language, Discourse and Literature: An Introductory Reader in Discourse Stylistics.* Routledge, 1998.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2
CO 1	H	
CO 2	H	H
CO 3	H	H
CO 4	H	
CO 5		H
CO 6		H

EGIM0021: INTRODUCTION TO MODERN EUROPEAN LITERATURE I (3-0-0) (CREDITS: 03)

Course Outcomes
1. Recall the vast body of writings of European Literature. (Remembering)
2. Interpret the emerging trends of European Literature through the genres of poetry and fiction. (Understanding)
3. Apply critical reading skills to study the emerging and vibrant areas of literature at a wider range. (Applying)
4. Analyse the specific issues such as the double challenge of truth and liberty, of identity and unity, of cultural loss and recovery, of ethnic specificity and aesthetic universality in the writings of contemporary European writers. (Analysing)
5. Evaluate the core issues as depicted in the literature of Modern Europe. (Evaluating)
6. Develop critical understanding of various texts. (Creating)

Module I: Major Aesthetic Developments (10 lectures)
Constructivism, Realism, Symbolism, Naturalism, Aestheticism, Futurism, Vorticism, Imagism, Expressionism, Dadaism, Surrealism, Cynicism, Skepticism, Resistance, Despair and Alienation

Module II: Selected Modern European Poetry (15 lectures)
a. “The Albatross”: Charles Baudelaire
b. “The Apple Orchard”: Rainer Maria Rilke

Module III: Modern European Fiction (20 lectures)
a. *Crime and Punishment:* Fyodor Dostoevsky
b. *The Castle*: Franz Kafka

Suggested Readings
1. Abrams, M.H. and, Geoffrey Galt Harpham. *A Glossary of Literary Terms*. Cengage Learning, ,2 015
2. Bloom, Harold. *The Western Canon: The Books and School of the Ages*. Harcourt, 1994.
3. Bradbury, Malcolm and James Mac Farlane (Eds) *Modernism: A Guide to European Literature, 1890-1930.* Penguin, 1976.
4. Cohen, Walter. A *History of European Literature*. Oxford University Press, 2017.
5. Cohen, J.M. *A History of Western Literature.* Transaction Publishing, 2007.
6. Hamburger, Michael. *The Truth of Poetry: Modernist Poetry Since Baudelaire*. Anvil Press Poetry, 2004.
7. Moretti, Franco(Ed.). *The Novel*. Princeton UP, 2006.
8. Nicoll, Allardyce. *British Drama*. Barnes &Noble, 1961.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H		
CO 2		H	H
CO 3	H	M	M
CO 4	M	H	H
CO 5	H	M	M
CO 6		H	H

EGAL0022: COLONIAL AND POST-COLONIAL AFRICAN LITERATURE I (3-0-0) (CREDITS: 03)

Course Outcomes
1. Define the complexities of race, gender and identity related to African literature. (Remembering)
2. Illustrate the vast body of writings in English from Africa. (Understanding)
3. Apply critical reading skills to interpret the vibrant area of literature. (Applying)
4. Analyse the specific issues such as colonialism, identity and unity, cultural loss, ethnic specificity and universality in the literature of Africa during and after the Colonial Period. (Analysing)
5. Evaluate the specific issues pertaining to the colonial experience and literature of Africa. (Evaluating)
6. Discuss various African literary texts from a critical perspective. (Creating)

Module I: Selected Poetry (10 lectures)
a. “A Far Cry from Africa”: Derek Walcott
b. “The Mystic Drum”: Gabriel Okara

Module II: Fiction (20 lectures)
a. *No Longer at Ease*: Chinua Achebe
b. *Purple Hibiscus*: Chimamanda Ngozi Adichie

Module III: Drama (15 lectures)
a. *The Lion and the Jewel*: Wole Soyinka

b. *The Dilemma of a Ghost:* Ama Ata Aidoo

Suggested Readings

1. Achebe,Chinua. *Arrow of God*.William Heinemann Ltd, 1958.
2. Adichie, Chimamanda Ngozi. *Purple Hibiscus.* Algonquin Books, 2003.
3. Aidoo, Ama Ata. *The Dilemma of a Ghost*. Longman:, 1995.
4. Bell, Bernard W. *The Afro-American Novel and Its Tradition*. University of Massachusetts Press, 1989.
5. Dathorne, O.R. *The Black Mind: A History of African Literature*. University of Minnesota Press, 1974.
6. King, Lovalerieet al. *Contemporary African American Literature: The Living Canon*. Indiana University Press, 2013.
7. Ngugi, MukomaWa. *The Rise of the African Novel*. University of Michigan Press, 2018
8. Soyinka, Wole. *The Lion and the Jewe*l. Oxford UP, 1962.
9. The prescribed texts

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H	H	H
CO 2	H	H	H
CO 3	H	H	H
CO 4	H	H	H
CO 5	H	H	H
CO 6	H	H	H

EGIW0023: INDIAN WRITING IN ENGLISH – POETRY, DRAMA & FICTION (4-0-0) (CREDITS: 04)

Course Outcomes

1. Define the literature produced in India in English. (Remembering)
2. Illustrate and comment on poetry, drama, short stories and novels produced in India in their various socio-cultural contexts. (Understanding)
3. Identify and explain the various critical theories involved in the production of various indigenous texts. (Applying)
4. Analyse the techniques, style of writing and contribution of various writers to the Indian English literary tradition. (Analysing)
5. Evaluate the Indian writings in English and their representation of the Indian ethos on a global forum and critically interpret the evolution of English language in India (Evaluating)
6. Discuss the selected literary works and find out the commonalities in terms of themes and issues. (Creating)

Module I: Selected Poetry (10 lectures)

a. "Philosophy": Nissim Ezekiel
b. "The Looking Glass": Kamala Das
c. "A River": A.K. Ramanujan
d. "A Poem for Mother": Robin Ngangom
e. "Indian Summer": Jayanta Mohapatra

Module II: Selected Drama & Short Story (15 lectures)

a. *Dance Like a Man*: Mahesh Dattani
b. "The Road to Salvation": Munshi Premchand

Module III: Selected Fiction (20 lectures)

a. *Coolie*: Mulk Raj Anand
b. *Palace of Illusions* : Chitra Banerjee Divakaruni

Module IV: Selected Travel Writing and Non-fiction (15 lectures)

a. *In an Antique Land*: Amitav Ghosh
b. "Language and Spirit" Foreword to *Kanthapura*: Raja Rao

Suggested Readings

1. George, K.M.(Ed), *Contemporary Indian Short Stories in English and Modern Indian Literature.* Sahitya Akademi, 1992.
2. Deshpande, G.P. (Ed.) *Modern Indian Drama*: An Anthology. Goodreads, 2000.
3. Naik, M.K. *A History of Indian English Literature.* Sahitya Akdemi, 1982.
4. Dattani, Mahesh. *Dance Like a Man. Penguin, 2006*
5. Divakaruni, Chitra Banerje*. Palace of Illusions, Doubleday, 2008*

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	M	M	M	H
CO 2	H	H	H	
CO 3	M	M	M	H
CO 4	H	H	H	H
CO 5	H	H	H	H
CO 6	H	H	H	H

EGSA0024: SOUTH-ASIAN LITERATURE (4-0-0) (CREDITS: 04)

Course Outcomes

1. Define the South Asian literary milieu. (Remembering)
2. Outline the literary, social, political and cultural dynamics of these texts. (Understanding)
3. Apply the knowledge from these texts to assess the socio-cultural aspect of these areas. (Applying)
4. Examine the texts with reference to the classic literary texts that they have studied earlier. (Analysing)
5. Evaluate the overall political and social implications of the area as suggestive in these texts. (Evaluating)
6. Discuss the emotions and aspirations of the writers from South Asia reflected in their writings. (Creating)

Module I: Introduction (20 lectures)

Geo-political conditions, Historical background of South Asian Literature, Imperialism, Colonialism, Nationalism,Orientalism, De-colonization, Specific issues with reference to history, politics and linguistic inventiveness in the literature of South-Asian countries.

Module II: Selected Poetry (10 lectures)

a. 'Love', 'Marriage', 'Children', 'Work', 'Joy and Sorrow' and 'Houses' from *The Prophet*: Khalil Gibran
b. Selected poems from 'Masnavi': Rumi

Module III: Selected Fiction (30 lectures)

a. *Ice Candy Man*: Bapsi Sidhwa
b. *The Kite Runner*: Khaled Hosseini
c. *The Bones of Grace*: Tahmima Anam

Suggested Readings

1. Mukherjee, Surjit. *Translation as Recovery*. Orient Longman, 2018.
2. Narasimhaiah, C.D. *East and West Poetics at Work.* Sahitya Academy, 1994.
3. Walsh, W. *Commonwealth Literature*. Oxford University Press, 1973.
4. Ashcroft, Bill et al. (Eds.) *The Empire Writes Back*. Routledge, 2002.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H		
CO 2	M	H	H
CO 3		H	H
CO 4		H	H
CO 5	H	H	H
CO 6		H	H

EGLS0025: LINGUISTICS AND STYLISTICS II (3-0-0) (CREDITS: 03)

Course Outcomes

1. Define the role of language in the contemporary world. (Remembering)
2. Interpret and stylistically appreciate works of literature. (Understanding)
3. Apply sound, word and sentence structure in transcribing a word or analysing sentence. (Applying)
4. Analyse the structure of a word or sentence linguistically and stylistically and read the various genres critically. (Analysing)
5. Assess and evaluate the structure of language using linguistic and stylistic tools. (Evaluating)
6. Compose phonetically using stress and intonation patterns. (Creating)

Module I: Phonology, Morphology, Syntax and Semantics: Basic Concepts (35 lectures)

Organs of Speech, Vowel and Consonant Sounds, Syllable and Word-Stress, Sentence stress and Intonation, Phonetic and

Phonemic transcription, Phonological structure of English language, Morphological structure of English language, Phonemes, Morphemes, Allomorphs and Morphs, Inflectional and Derivational Morphology, Word formation processes in English language, Syntactic Structure of English language, Immediate Constituent Analysis, Semantic level of language, Word-Meaning relations: Synonym, antonym, homonym, hyponym, meronym and polysemy. Layers of Meaning: Deep and Surface Structure

Module II: Reading in Stylistics (10 lectures)
Language and Literature, Levels of language at work, Sentence styles: development and illustration, Interpreting patterns of sound, Techniques of speech and through presentation, Dialogue in drama, Style in poetry: an exploration, A sociolinguistic model of narrative, Exploring metaphors in different kinds of texts, Style variation in narrative, Stylistics and media, An application of cognitive stylistics in poetry, Literature as discourse, Stylistic appreciation of poetry/prose

Suggested Readings
1. Balasubramanian, T. A.*Textbook of English Phonetics for Indian Students*. Macmillan, 1981. Crystal, David. *Linguistics*. Penguin, 1990.
2. Hudson, R.A. *Sociolinguistics*. Cambridge UP, 1980.
3. Lyons, John*. Language and Linguistics: An Introduction*. Cambridge UP,1981.
4. Simpson, P. *Stylistics: A Resource Book for Students*.Routledge, 2004.
5. Trudgill, Peter. *Sociolinguistics*. Penguin, 1990.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2
CO 1	H	
CO 2		H
CO 3		H
CO 4	H	H
CO 5	H	
CO 6	H	

EGEL0026: INTRODUCTION TO MODERN EUROPEAN LITERATURE II (3-0-0) (CREDITS: 03)

Course Outcomes
1. Relate the characteristics of modern European literature with the readings of other modern European texts (Remembering)
2. Interpret different representative texts of European literature- poetry, fiction and Drama. (Understanding)
3. Identify modernist aspects of contemporary European literatures (Applying)
4. Analyse the modernist issues such as humanism, individualism, meaninglessness of life, liberty and identity, cultural loss and recovery and aesthetic universality in the literature from different nations of Europe. (Analysing)
5. Evaluate the overall Western modern philosophy in the works of the various writers of the area. (Evaluating)
6. Discuss the changing trends and movements of literature as reflected in the selected texts. (Creating)

Module I: Selected Modern European Poetry (20 lectures)
a. "Lament for a Bullfighter": Federico Garcia Lorca
b. "To his Own Beloved Self": Vladimir Mayakovsky

Module II: Selected Modern European Drama (15 lectures)
a. *Six Characters in Search of an Author:* Luigi Pirandello
b. *Rosencrantz and Guildenstern are Dead:* Tom Stoppard

Module III: Modern European Fiction (10 lectures)
a. *The Stranger*: Albert Camus
b. *The Tin Drum:* Gunter Grass

Suggested Readings
1. Abrams, M.H. and Geoffrey Galt Harpham. *A Glossary of Literary Terms*. Cengage Learning, 2015.
2. Bloom, Harold. *The Western Canon: The Books and School of the Ages*, Harcourt, 1994.
3. Bradbury, Malcolm and James MacFarlane (Eds). *Modernism: A Guide to European Literature, 1890-1930.* Penguin, 1976.
4. Cohen, Walter. A *History of European Literature*. Oxford University Press, 2017.
5. Cohen, J.M. *A History of Western Literature.* Transaction Publishing, 2007.
6. Hamburger, Michael. *The Truth of Poetry: Modernist Poetry since Baudelaire*. Anvil Press Poetry, 2004.
7. Moretti, Franco(Ed.). *The Novel*. Princeton UP, 2006.
8. Nicoll, Allardyce. *British Drama*. Barnes & Noble, 1961.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H	H	H
CO 2	H	H	H
CO 3	H	H	H
CO 4	H	H	H
CO 5	H	H	H
CO6	H	H	H

EGPC0027: COLONIAL AND POST-COLONIAL AFRICAN LITERATURE II (3-0-0) (CREDITS: 03)

Course Outcomes

1. Define the complexities of race, gender and identity related to African literature. (Remembering)
2. Interpret the emerging genres of African English literature- poetry, and fiction (Understanding)
3. Apply theoretical assumption as well as critical reading skills to the study of African literature. (Applying)
4. Analyse the post-colonial issues of identity unity, cultural loss, ethnic specificity, universality in the literature of Africa in both Colonial and post-colonial contexts. (Analysing)
5. Assess the plot, theme, characters and context of the selected texts. (Evaluating)
6. Create an intense theoretical paradigm for the reading of the text. (Creating)

Module I: Selected Poetry (10 lectures)

a. "On Being Brought from Africa to America": Phillis Wheatley
b. "Telephone Conversation": Wole Soyinka

Module II: Selected Fiction (20 lectures)

a. *By the Sea* : Abdulrajak Gurnah
b. *July's People*: Nadine Gordimer

Module III: Selected Non-Fiction (15 lectures)

a. "On Abolition of the English Department": Ngugi wa' Thiong'o
b. "The African Writer and the English Language": Chinua Achebe.

Suggested Readings

1. Achebe, Chinua. *Hopes and Impediments*. PenguinBooks,1990.
2. Ngugi, MukomaWa. *The Rise of the African Novel,* University of MichiganPress. 2018.
3. Fanon, Frantz. *The Wretched of the Earth*. Translated by Constance Farrington. Penguin Books, 1963.
4. Thiong'o, Ngugi wa. *Decolonising the Mind*, East African Educational Publishers, 1986.
5. Gurnah, Abdulrajak : *By The Sea* , Bloomsbury Publishing , 2021

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	M	M	H
CO 2	H	H	H
CO 3	H	H	H
CO 4	H	H	H
CO 5	M	H	M
CO 6	M	M	H

EGLC0028: LITERARY CRITICISM: PLATO TO F.R. LEAVIS AND SELECT TWENTIETH CENTURY PERSPECTIVES (4-0-0) (CREDITS: 04)

Course Outcomes:

1. List out the characteristics of a tragic hero according to Aristotle. (Remembering)
2. Compare between Plato and Aristotle's theory of mimesis. (Understanding)
3. Apply the twentieth century perspectives in literary research (Applying)
4. Analyse critically a selected text in the field of Literary Criticism. (Analysing)
5. Explain Coleridge's theory of Imagination. (Evaluating)
6. Discuss the contributions of I A Richards in the field of Literary Criticism. (Creating)

Module I: Literary Criticism: Key Ideas and Concepts – Plato to Dryden (10 lectures)

Plato: Views on Poetry, Theory of Mimesis; Horace: Observations on drama; Longinus: Ideas On the Sublime, Sources of Sublimity in Literature; Philip Sidney: Ideas on "An Apology for Poetry"; John Dryden: ideas (classical, modern, French and English drama) from "An Essay on Dramatic Poesy"

Module II: Literary Criticism and Theory: Key Ideas and Concepts – Johnson to F. R. Leavis and Select Twentieth Century Perspectives (20 lectures)

Samuel Johnson: Views on Shakespeare,; William Wordsworth: Views on Poetry, Poetic Diction;; John Keats: Negative Capability, Egotistical Sublime; Matthew Arnold: The Touchstone Method, High Seriousness, Grand Style; I. A. Richards: The Referential and Emotive Uses of Language, Statement and Pseudo-Statement; Tenor and Vehicle, Stock Response; F.R. Leavis: Enactment, Literary Criticism and Philosophy; Russian Formalism, New Criticism, Marxism and Psychoanalysis

Module III: Selected Critical Texts (30 lectures)

a. *Poetics* : Aristotle
b. *Biographia Literaria* (Chapter 13) : Samuel Taylor Coleridge
c. " Tradition and the Individual Talent ": T. S. Eliot

Suggested Readings

1. Culler, Jonathan. *Literary Theory: A Very Short Introduction*.
2. Abrams, M.H. *A Glossary of Literary Term*s.
3. Cuddon, J.A. *The Penguin Dictionary of Literary Terms and Literary Theory.*
4. Habib, M.A.R. *A History of Literary Criticism: From Plato to the Present.*
5. Enright, D. J, Ernst De Chickera ed. *English Critical Texts: Indian Edition*. Oxford,1975

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1			H
CO 2	H		H
CO 3		H	
CO 4			H
CO 5			H
CO 6		H	

EGSL0200: SERVICE LEARNING- LANGUAGE COMMUNICATION (2-0-0) (CREDIT: 02)

Course Outcomes

1. Describe the nature of Service Learning and the principles of Community University Engagement (Remembering)
2. Understand the importance of engagement with nearby communities and develop a mutual partnership in terms of the sharing of knowledge with the local communities (Understanding)
3. Apply the principles of Community University Engagement in the linguistic study of local communities in terms of spoken English and study of speech expressions (Applying)
4. Analyze the linguistic expressions of the communities and the gap of communication in terms of English language. (Analyzing)
5. Evaluate the expressions of the communities and summarize the socio-cultural constructs behind the expressions under Service-learning study. (Evaluating)
6. Design a project report on their understanding of Service learning and involvement with the communities. (Creating)

Module I: Understanding Service Learning (15 lectures)

Introduction to Service Learning; Understanding Community University Engagement; Historical Overview of Community University Engagement in India; Principles of Community University Engagement; Forms of Community University Engagement; Community Based Participatory Research; Social Responsibility of Higher Education Institutions of India

Module II: Interaction with Communities (15 lectures)

Foundations of English grammar; English phonetic symbols (vowels and consonants); Common idioms and phrases in English; Understanding the Key concepts of languages: the socio-cultural context; Exploring different speech communities; Learning unique linguistic expressions; Exploring idioms and phrases: the socio-cultural construct that binds them; Basics of translation; Field Visit; Assessment: Assignment writing and Submission

Suggested Readings

1. Abbi, Anvita. *A Manual of Linguistic Fieldwork and Structures of Indian Languages*. Lincom Europa.2001
2. Colina, Sonia. *Fundamentals of Translation*.CUP. 2015
3. Hall Budd. et al. *Strengthening Community University Research Partnerships: Global Perspectives*. University of

Victoria,2015
4. Kaye, Berger Catheryn. *A Complete Guide to Service Learning*. Free Spirit Publishing, 2004
5. Rastogi, Pratap. *Art of English Translation*. Ramesh Publishing House,2016

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2
CO 1	H	
CO 2	H	
CO 3	H	
CO 4		H
CO 5		H
CO 6		H

EGSM6001: SEMINAR AND PRESENTATION I (0-0-1) (Credit: 01)

Course Outcomes:
1. Define academic writing, seminar presentation and publication (Remembering).
2. Identify research topics for sustained and rigorous investigation so that original write- ups can be developed (Understanding).
3. Assess and evaluate the various works of literature to write research reports and papers (Applying).
4. Prepare write-ups for scholarly journals by doing analysis of textual evidence (Analysing).
5. Estimate critical reading, research, discussion and composition around a particular topic/theme or subject (Evaluating).
6. Synthesize and expand their abilities to absorb, synthesize and construct arguments in a close-knit community (Creating)

Module I: Introduction to Seminar (2 Lectures)
Basics of Seminar:
a) Definition of Seminar
b) Type of Seminars: Students Seminar, National Seminar, International Seminar. Purpose of the seminar.
c) The object of study
d) The scope of study

Module II: Introduction to Seminar (3 Lectures)
Methodology:
a) Steps to write a seminar paper/Research Methodology.
b) Topics of the seminar paper.Presentation:
- How to present a seminar paper: paralinguistic features.
- Mode of Presentation: Essay-type Presentation, Paper Presentation, Powerpoint(Ppt.) Presentation

Module III: Practical (15 Lectures)
a) Two presentations per period.
b) Each will be allotted 10-15 minutes for presentation. Followed by a discussion and commentary on the paper presented.

Suggested Readings
1. Correa, Delia Da Souza & Owens, W.R. *The Handbook to Literary Research*. Routledge. 2009.
2. Kothari, C. R. & Gaurav Garg. *Research Methodology: Methods and Techniques.* New Age. 2019
3. *MLA Handbook for Writers of Research Papers,* Eighth Edition. MLA. 2016.

Mapping of COs to Syllabus:

Course Outcomes	**Module 1**	**Module 2**	**Module 3**
CO1	H		
CO2	H		
CO3	H	H	
CO4		H	
CO5		H	H
CO6		H	H

EGSP6002: SEMINAR AND PRESENTATION II (0-0-1) (CREDIT: 01)

Course Outcomes
1. Define academic writing, seminar presentation and publication.(Remembering)
2. Identify research topics for sustained and rigorous investigation so that original write- ups can be developed. (Applying)

3. Estimate and expand their abilities to absorb, synthesize and construct arguments in a close-knit community. (Evaluating)
4. Assess and evaluate the various works of literature to write research reports and papers. (Evaluation)
5. Develop critical reading, research, discussion and composition around a particular topic/ theme or subject. (Creating)
6. Compose write-ups for scholarly journals by doing analysis of textual evidence. (Creating)

Module I: Making an Argument in Research Paper (3 lectures)

a. Beginning: Choosing a topic
b. Body of the Research Paper.
c. Review of Literature.
d. Developing an argument.
e. Bringing a critical interpretation into writing.
f. Framing the Conclusion.
g. Referencing and Citation.
h. Bibliography

Module II: Practical (17 lectures)

a. Two presentations per period.
b. Each will be allotted 10-15 minutes for presentation.
c. Followed by a discussion and commentary on the paper presented.

Suggested Readings

1. Correa, Delia Da Souza & Owens, W.R. *The Handbook to Literary Research*. Routledge. 2009
2. Kothari, C. R. & Gaurav Garg. *Research Methodology: Methods and Techniques.* New Age. 2019
3. *MLA Handbook for Writers of Research Papers,* Eighth Edition. MLA. 2016.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2
CO1	H	
CO2	H	
CO3	H	H
CO4	H	
CO5	M	H
CO6	M	H

EGPP6003: PROJECT PHASE I (1-0-1) (CREDITS: 02)

Course Outcomes

1. Define academic writing, research paper and publication. (Remembering)
2. Identify research topics for sustained and rigorous investigation so that original write-ups can be developed. (Understanding)
3. Estimate and expand their abilities to absorb, synthesize and construct arguments in a close-knit community. (Applying)
4. Analyse the various works of literature to write research reports and papers. (Analysing)
5. Evaluate critically through reading, research, discussion and composition around a particular topic/ theme or subject. (Evaluating)
6. Compose write-ups for scholarly journals by doing analysis of textual evidence. (Creating)

Module I: Conceptualizing, Planning and Preparing a Research Paper (15 lectures)

- Introduction to academic/ research writing
- Avoiding Plagiarism in research
- Selection of a research topic
- Developing an outline of the research paper
- Choosing an appropriate title for the research paper
- Writing an abstract
- Review of Literature
- Developing an argument
- Bringing a critical interpretation into writing
- Drawing inferences/ framing a conclusion
- MLA Handbook 8th Edition
- Referencing and Citation

- Bibliography

Module II: Practical- Writing and editing a Research Paper (15 Lectures)
- Draft of the abstract
- Draft of the literature review
- First draft of the research paper
- Second draft of the research paper
- The final research work

Suggested Reading
1. Correa, Delia Da Souza & Owens, W.R. *The Handbook to Literary Research*. Routledge. 2009
2. Kothari, C. R. & Gaurav Garg. *Research Methodology: Methods and Techniques.* New Age. 2019
3. *MLA Handbook for Writers of Research Papers,* Eighth Edition. MLA. 2016.

Mapping of Course Outcomes

Course Outcomes	MODULE 1	MODULE 2
CO 1	H	H
CO 2	H	H
CO 3	H	H
CO 4	H	H
CO 5	H	H
CO 6		H

EGPP6004: PROJECT PHASE II (2-0-6) (CREDITS: 08)

Course Outcomes
1. Define academic writing, dissertation and publication. (Remembering)
2. Identify research topics for sustained and rigorous investigation so that original write-ups can be developed. (Understanding)
3. Estimate and expand their abilities to absorb, synthesize and construct arguments in a close-knit community. (Applying)
4. Analyse the various works of literature to conduct detailed analytical research. (Analysing)
5. Evaluate critically through reading, research, discussion and composition around a particular topic/ theme or subject. (Evaluating)
6. Compose scholarly write-ups by conducting detailed, in-depth analysis of a research area. (Creating)

Module I: Conceptualizing, Planning and Preparing a Research Topic (30 lectures)
- Introduction to Project work and Dissertation writing
- Topic and Proposal
- Literature review
- Perspective/ Theoretical framework
- Chapterisation
- Resources
- Limitation and Scope
- Critical interpretation and Documentation
- MLA Handbook 8th Edition
- In-text Citation
- Bibliography/ Referencing
- Plagiarism

Module II: Practical- Writing and editing a Research Paper (90 Lectures)
- Working Proposal
- Final Proposal
- Abstract
- Outline of the Dissertation
- Draft of the literature review
- First draft of the Chapters
- Second draft of the Chapters

- The final Dissertation

Suggested Reading

1. Correa, Delia Da Souza & Owens, W.R. *The Handbook to Literary Research*. Routledge. 2009
2. Kothari, C. R. & Gaurav Garg. *Research Methodology: Methods and Techniques.* New Age. 2019
3. *MLA Handbook for Writers of Research Papers,* Eighth Edition. MLA. 2016.

Mapping of Course Outcomes

Course Outcomes	MODULE 1	MODULE 2
CO 1	H	H
CO 2	H	H
CO 3	H	H
CO 4	H	H
CO 5	H	H
CO 6		H

VALUE ADDED COURSES

EGES0138: EFFECTIVE COMMUNICATION SKILLS (1-0-1) (CREDITS: 02)

Course Outcomes

1. Describe the types of communication. (Remembering)
2. Differentiate from a variety of social functions including greetings, introductions and farewells, making and responding to requests, suggestions, invitations and apologies, conducting simple transactions in shops and offices, asking for and giving directions, etc. (Understanding)
3. Illustrate the daily routines in a series of simple phrases and sentences. (Applying)
4. Categorize the form and function of the basic official correspondences. (Analysing)
5. Evaluate formal and informal writings, preparing reports, letters, memorandum, notices, agenda, minutesetc. (Evaluating)
6. Formulate the rationale of descriptive, narrative, expository and argumentative writing. (Creating)

Module I: Communication and Grammar skills (8 lectures)

Language and communication: Differences between speech and writing, Distinct features of speech, Distinct features of writing, Parts of Speech, Person, Gender, Number, Use of Tense, Aspect and Modals, Degrees of comparison, Sentence types, Negation and Relative Clauses, Narration, Voice change, Proverbs, Vocabulary, Proper use of words, Idioms, Accentuation, Intonation, Understanding Various Englishes.

Module II: Developing Communicative Skills (7 lectures)

Introductory, developmental, transitional and concluding paragraphs: Coherence and cohesion, Descriptive, narrative, expository and argumentative writing, Introduction to soft skills, people and social skills, presentation, interaction and effective communication.

Official letter, Paragraph writing, Note-making, Topic Sentence, Telephonic Conversation, Group Discussion regarding job interview & C. V. Writing, formal and informal writings, reports, handbooks, manuals, letters, memorandum, notices, agenda, minutes.

Module III: Self-Learning (15 lectures)

Practice and drill sessions, online learning via tutorials (link to be provided by the teacher in-charge), self- assessment of progress, submission of assessment reports to the teacher.

Suggested Readings

1. English and Soft Skills. S.P. Dhanavel. Orient BlackSwan 2013
2. Fluency in English - Part II, Oxford University Press, 2006.
3. Business English, Pearson, 2008.
4. Language, Literature and Creativity, Orient Blackswan, 2013.
5. The Cambridge Grammar of the English language. Huddleston and Pullam, CUP,2002.

Mapping of Course Outcomes

Course Outcomes	MODULE 1	MODULE 2	MODULE 3
CO 1	H	H	H
CO 2	H	H	H
CO 3	H	H	H
CO 4	H	H	H

CO 5	H	H	H
CO 6		H	H

EGML0028: MYTH IN LITERATURE (2-0-0) (CREDITS: 02)

Course Outcomes
1. Remember some of the recurrent classical myths in literature (Remembering)
2. Understand that myths have strong metaphoric function (Understanding)
3. Understand how the application of the myth in the select texts throws more light in understanding the complex ideas therein (Applying)
4. Co-relate the original story in the myth to the story in the corresponding literature (Analyzing)
5. Rate the potentiality of the myth in leveraging literary ideas (Evaluating)
6. Adopt the myth as vehicle of thought in creative writings (Creating)

Module I: Myth Concepts (7 lectures)
Myth, mythology, mytheme, archetype, archetypal, archetypal criticism, mythopoeia, myth critics

Module II: Recurring Myths (15 lectures)
Myth of: Zeus (Jupiter/Jove), Venus (Aphrodite), Cupid (Eros), Adonais, Hercules, Odysseus, Achilles, Oedipus, Electra, Helen, Diana, Hera, Orpheus and Eurydice, Hades, Leda and Swan, Trojan War

Module III: Myth in Literature-significance of select myth (8 lectures):
Geoffrey Chaucer: : Myth of Thisbe and Dido in *Legend of Good Women*
P.B.Shelley : Myth of Adonais in "Adonais"
W.B.Yeats : Myth of Leda and Swan in "Lead and the Swan"
T.S.Eliot : Myth of Phiomela, Cleopatra and Tiresias *The Waste Land*

Suggested Readings

1. Frye, Northrop. "Myth, Fiction and Displacement"
2. Graves, Robert (1955). *The Greek Myth*. Penguin, 1992
3. Matyszak ,Philip. *The Greek and Roman Myths – A Guide to the Classical Stories*. Thames and Hudson, 2010.
4. Powell, Barry B. *Classical Myth*. Oxford University Press, 2020
5. Bahun, Sanja. *Myth, Literature, and the Unconscious*. Routledge, 2013.

Mapping of Course Outcomes

Course Outcomes	MODULE 1	MODULE 2	MODULE 3
CO 1	H	H	H
CO 2	H	H	H
CO 3	H	H	H
CO 4	H	H	H
CO 5	H	H	H
CO 6	H	H	H

EGSD0029: SHAKESPEAREAN DRAMA (4-0-0)

Course Outcomes
1. Define drama as a literary genre (Remembering).
2. Explain the significant stages in the making of Shakespearean plays-tragedy, comedy, tragic-comedy and history plays (Understanding).
3. Apply the substance of the given criticism in the given plays (Applying).
4. Analyse the content of the given critical readings and their applicability in the given plays (Analysing).
5. Evaluate the theme, plot, literary techniques, characteristic features and creative energy of Shakespeare through the given plays (Evaluating).
6. Compile the content, style and the literary aspects of the given Shakespearean texts (Creating).

Module I: Tragedy and Tragi-comedy (25 lectures)
a) *Hamlet*
b) *Winter's Tale*

Module II: Comedy and History Plays (25 lectures)
a) *The Tempest*

b) *Julius Caesar*

Module III: Shakespearean Criticism (10 lectures)

a) Dollimore. Jonathan. “Introduction: Shakespeare, Cultural Materialism and New Historicism.” Political Shakespeare: Essays in Cultural Materialism, edited by Jonnathan Dollimore and Alan Sinfield, Manchester University Press, 1994

b) Neill, Michael. “Post-colonial Shakespeare? Writing Away from the Centre.” Post-Colonial Shakespeare, edited by Ania Loomba and Martin Orkin, Routledge, 2002

Suggested Readings List:

1. Texts prescribed in the Course.
2. Bloom, Harold, *Elizabethan Drama*. Infobase Publishing, New York.
3. Dutton, Richard and Howard, Jean. *A Companion to Shakespeare’s Works*, Vol.II. Blackwell, Oxford.
4. Greenblatt, Stephen. *Tyrant: Shakespeare on Power*. Vintage, 2019.
5. Haris, Jonathan Gil. *Shakespeare and Literary Theory*. Oxford University Press, 2012.
6. Legatt, Alexander. *Shakespeare’s Political Drama*. Rout ledge, London.

CO Mapping:

COs	Module I	Module II	Module III
CO1	H	H	L
CO2	H	H	L
CO3	M	M	H
CO4	M	M	H
CO5	H	H	M
CO6	H	H	M

EGIL0030: INTRODUCTION TO LINGUISTICS (4-0-0)

Objectives:

The aim of this paper is to introduce the students to the different branches of linguistics and its scope. The course will enable the students to have a better understanding of the philosophical and theoretical perspectives governing the studies in languages.

Course Outcomes:

CO 1: Define the basic concepts of linguistics. (Remembering)
CO 2: Understand the theoretical perspectives governing linguistic studies. (Understanding)
CO 3: Identify the levels of language structure. (Applying)
CO 4: Analyse the course of development of language with reference to traditional grammar approaches. (Analysing)
CO 5: Examine the basic phonological and morphological patterns of languages. (Evaluating)
CO 6: Summarize the course of development of language studies. (Creating)

Module I: Theoretical perspectives (30 Hours)

a) Origins of language; the nature of human language; language and cognitive development- the critical period; Language acquisition- Behaviourist Approach, Innateness Hypothesis, Stages in Language acquisition; Sapir-Whorf Hypothesis.

b) Structuralism- the influence of Prague School; American Structuralism; key concepts of structural linguistics- Sign, signifier and signified, langue and parole, synchrony and diachrony, paradigmatic and syntagmatic relations.

c) Historicism; Functionalism; Generativist approach and Universal Grammar; Cognitive approach and Usage-based theories in linguistics.

Module II: Branches of Linguistics and its key concepts (30 Hours)

a) The branches of linguistics and its scope; the development of grammar- descriptive and prescriptive grammars; language universals.

b) Phonetics and Phonology: The organs of speech, articulatory phonetics, phonemes (IPA) and allophones, phonetic and phonemic transcription; distinctive features and suprasegmental phonology, phonological structure.

c) Morphology: Free and bound morphemes- prefix, suffix, infix and circumfix; content words and function words; inflectional and derivational morphology; word formation processes.

Suggested Readings List:

1. Balasubramanian, T. *A Textbook for English Phonetics for Indian Students*, Macmillan, New Delhi. 2000.
2. Wood, F. T. *An outline history of the English language*, Macmillan, New Delhi. 1941.
3. Yule, George. *The Study of Language*, 4th edition, Cambridge University Press. New Delhi. 2010
4. Fromkin, Victoria. *Introduction to Language*. 7th Edition. Wadsworth Publication. 2003
5. Lyons, John. Language and Linguistics: An Introduction. 19th Edition. Cambridge University Press. 2009

CO Mapping:

COs	Module I	Module II
CO1		H
CO2	H	H
CO3	H	H
CO4	H	
CO5		H
CO6	H	H

EGNE0031: UNDERSTANDING INDIA'S NORTH EAST

Credits: 2 (2-0-0) 30 Hours

Course Outcomes:

1. Defining the greater identity and consciousness called the North East through a study offacets related to the shared history and geography of the region (Remembering)
2. Understanding the question of identity assertion of various communities and theirnationalistic aspirations. (Understanding)
3. Identifying the methods of identity exertion, in folk and urban popular platforms(Applying)
4. Analysing cultural ethos of the seven states through diverse elements of culture, religion,language and belief systems. (Analysing)
5. Assessing the problems and prospects of North East India with critical understanding of itsmulti-cultural ethos (Evaluating)
6. Discussing the idea of the New Indian, with an understanding of the reality of the regionand its place in the national imagination (Creating)

Module 1: The North East: Assertion of Identity (10 hours)
Geography and History; Migration and Assimilation; Reality and Imagination; the new Indians;Status of Women; Ecological Consciousness

Module 2: Cultural Diversity and Unifying Elements (10 hours)
Ethnic Communities of the states; Religion and Animism; Language and dialects; Popularrepresentation of diversity; Popular festivals and fairs

Module 3: Tangible and Intangible Cultural Practices (10 hours)
Migration memories; Classical art forms from the region; Popular theatre; Folksongs; Origin Myths;Legends; Folk rituals; Customs and festivals

Suggested Readings:

1. Hazarika, Sanjoy, "Introduction: Disputed Borders, Divided Peoples" in Strangers No More:New Narratives from India's Northeast. Aleph Book Company. 2018
2. Hazarika, Sanjoy, "Strangers No More: The New Indians" in Strangers No More: NewNarratives from India's Northeast. Aleph Book Company. 2018
3. Datta, Birendranath, Handbook of Folklore Material of North East India. ABILAC. 1994
4. Baruah, Sanjib, Durable Disorder: Understanding the Politics of North East India. Oxford.2007
5. Das, BM, North East India: Its People and Culture. Ethnographic and Folk Culture Society.1990

EGEH0032: ENVIRONMENTAL HUMANITIES AND CLIMATE CHANGE FICTION

Credits: 2 (2-0-0) 30 Hours

Course Outcome:
At the end of this course, the students are able to:

- CO 1: Define the genre of Climate fiction and the concepts of environmental humanities(Remembering)
- CO 2: Distinguish the evolution of the climate change fiction (Understanding)
- CO 3: Classify and apply the theories and concepts of ecocriticism and environmental humanities inthe study of the climate change fiction (Application)
- CO 4: Analyse the theme of eco-disaster and environmental ethics in the selected climate fiction(Analysis)
- CO 5: Evaluate the significance of climate change fiction and its relevance in the contemporary worldof environmental depletion (Evaluation)
- CO 6: Discuss, Summarise and critically appreciate the thematic aspects of the climate fiction understudy (Creation)

Module 1: Environmental Humanities: Concepts And Theories (10 Hours)
Definition: Environment, Ecology, Environmental Pollution, Environmental Literature, Cli-fi, Ecocinema

Key Concepts: Nature/Culture, Nature Writing, Climate Change, Deep Ecology,Environmental imagination, Environmental Ethics, AnthropoceneTheories: Ecocriticism, Ecofeminism, Post-humanism, Environmental Humanities

Module 2: Selected Climate Change Fiction (20 Hours)
J. G. Ballard- The Drowned World (1962)
Octavia Butler- Parable of the Sower (1993)
Jeff Vandermeer- Annihilation (2014)

Suggested Reading:
1. The Routledge Companion to Environmental Humanities. Edited By Ursula Heise, Jon Christensen,Michelle Niemann. Routledge: USA. 2017
2. The Cambridge Companion to Literature and Climate: Edited by Adeline Johns Putra and KellySultzback. CUP: India. 2022
3. Climate Crisis and The 21St-Century British Novel by Astrid Bracke. Bloomsberry Academic. 2019
4. Climate Fiction and Cultural Analysis: A New Perspective on Life in the Anthropocene by AndersenGregers. Routledge, 2019
5. The Environmental Imagination by Lawrence Buell Harvard University Press. USA. 1996
6. The Anthropocene Reviewed by John Green. Ebury Press: UK. 2021

CO Mapping:

CO	Module I	Module II
CO1	H	M
CO2	M	H
CO3		H
CO4	M	H
CO5	H	H
CO6	M	H

DEPARTMENT OF MASS COMMUNICATION

VISION:
To be a centre of excellence in teaching, learning and research committed to mould ethical and socially responsible media professionals and entrepreneurs who can deliver professional content for diverse media platforms.

MISSION:
The Department of Mass Communication seeks to:
- Achieve excellence in teaching, learning and research.
- Promote critical thinking and problem-solving skills.
- Equip learners by combining the theoretical aspects with creative innovation and entrepreneurship practices.
- Mould ethical and socially responsible media professionals and entrepreneurs.
- Provide knowledge base and consultancy services to the community in the field of media and communication.

M.A. MASS COMMUNICATION
The M.A Mass Communication programme of Assam Don Bosco University is a two-year (four semesters) programme consisting of theory and practical components, taught and learned through a combination of lectures, hands-on training, seminar, guest lecture, industry-academia interface and project execution. The programme offers specialization in the area of Print Media, Electronic Media and Communication for Development.

PROGRAMME OUTCOMES – MA MASS COMMUNICATION
PO 1: **Critical Thinking**: Gain conceptual and theoretical knowledge and learn to critically think and analyze the dynamics and contemporary phenomenon of mass communication.

PO 2: **Scientific Temper:** Develop logical and creative thinking for the solutions in Print media, electronic media and Communication for development.

PO 3: **Effective Communication**: Develop the communication skills, theoretical and practical knowledge among the students in print, digital and development communication.

PO 4: **Social Interaction**: Elicit views of others, mediate disagreements and help reach conclusions in group settings.

PO 5: **Ethics**: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

PO 6: **Effective Citizenship**: Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through service learning and social commitment.

PO 7: **Environment and Sustainability**: Understand the environment issues and promote sustainable development goals.

PO 8: **Self-directed and Life-long Learning**: Engage in higher studies, research and professional work and be a life- long learner in context of media studies.

PROGRAMME SPECIFIC OUTCOME: MA MASS COMMUNICATION
PSO 1: **Understanding Communication and its Concepts:** An ability to define the meaning, purpose of communication and demonstrate the theoretical knowledge in the field of mass communication.

PSO 2: **Application of Knowledge**: Apply communication skills and practices in context of social and cultural milieu of the North-eastern region.

PSO 3: **Developing Critical Aptitude:** An ability to test and analyze research findings by demonstrating critical thinking and problem-solving skills.

PSO 4: **Enhancing Professional Skills:** An ability to develop professional skills and use in the field of print media, electronic media and development communication.

PSO 5: **Creating Multimedia Content:** An ability to create media programmes for varied media audience needs.

MAPPING OF COURSES TO PO/PSO
MA Mass Communication

Sl. No	Name of Paper	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
1.1	History and Development ofCommunication	L	H			L	M		H	M	L	L	M
1.2	Philosophy of Communication	H	M	L	M	H	H		H	H	L	M	M
	Theoretical Perspectives of Communication	H	H	H	M	L			H	H	L	M	
1.3	Principles andPractices of Journalism	H	H	H	H	M	M	L	H	H	H	M	H
1.4	Media Literacy	H	H	H	H	M	H		H	M	L	L	L
1.5	Journaling	H		H	M	M	H		L	L	M	H	L

1.6	Techniques of Photography andImage Editing	H	H	M		M	M		H	M	H	H	H
1.7	Service Learning	H	H	H	H	H	H	H	H	H	H	H	H
2.1	Investigative andData Journalism	H	H	H	H	M	H	L	H	H	H	M	H
2.2	Theories of Development Communication and Social Chang	H	H	M	M	L	L			H	H	L	L
2.3	CommunicationResearch Methodology	H	H	H	L	M	L		M	H	H	H	H
2.4	Digital Media	H	L	L	L	M	L		M	M	L	M	M
2.5	Rural Communication	H	H	H	H	L	N	H	L	H	H	L	L
2.6	Dissertation Phase – I	H	H	H	M	H	L		M	H	M	H	M
2.7	Audio-videoProduction	M	M	H	M	L	L		H	H	M	H	H
2.8	Service Learning – Community Media	H	H	H	H	H	H	M	H	H	H		M
3.1	Media Laws, Ethicsand Social Responsibility	M	H	M	M	H	H	M	H	M	H	H	H
3.2	Advertising, Marketing and Public Relations	H	M	H	H	M	M	M	H	M	H	M	H
3.3	Dissertation Phase – II	H	H	L	L	H	M	L	H	M	H	H	H
	Specialization – Electronic Media												
3.2.1	Audio-VideoEditing	M	H	H	M	M	M	M	H	M	M	H	H
3.2.2	Television and Video Production	M	H	H	M	M	M	M	H	M	M	M	H
3.2.3	Sound for Media	M	H	H	M	M	M	M	H	M	M	H	H
	Specialization – Print Media												
3.3.1	Political Communication	H	H	M	M	H	H	M	H	H	H	H	M
3.3.2	News Reportingand Editing	H	H	H	H	H	H	M	H	H	H	H	H
3.3.3	Health and Environmental Communication	H	H	H	M	H	H	H	H	H	H	H	M
	Specialization – Communication for Development												
3.4.1	Programme Management	H	M	H	H	H	M	L	H	M	M	M	H
3.4.1	Situation Analysisfor Communication Strategy	H	H	H	H	M	H	M	M	H	H	H	H
3.4.1	Planning Modelsand Communication Approaches	H	H	H	H	M	H	H	M	H	H	H	H
4.1	Media and CulturalStudies	H	M	H	H	M	H	M	H	H	H	H	M
4.2	Internship	H	H	H	H	H	H	H	H	H	H	H	H
	Specialization – Electronic Media												
4.2.1	Film Appreciation	H	H	M	M	H	M	L	H	M	M	H	M
4.2.1	Final Project	H	H	H	H	H	H	M	H	M	M	M	H
	Specialization – Print Media												
4.3.1	Business Journalism	H	H	H	H	H	M	M	H	H	H	H	H
4.3.2	Final Project	H	H	H	H	H	H	M	H	M	H	H	H
	Specialization – Communication for Development												
4.4.1	Project Monitoringand Evaluation	H	H	H	H	H	H	M	H	M	H	H	H
4.4.2	Final Project	H	H	H	H	H	H	M	H	M	H	H	H

VALUE ADDED COURSES (MA)

Sl. No	Name of Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
1.1	CommunicationSkills	H	H	H	M	M	L	H	H	H	M	H	L
1.2	Creative Writing	H	H	M	L	M	L	H	H	H	M	H	M
1.3	Event Management	H	H	H	H	H	M	H	M	H	H	H	M

DETAILED SYLLABUS
MA MASS COMMUNICATION

MCRC0026: RURAL COMMUNICATION (3-0-0)

COURSE OBJECTIVES

CO1 Define the meaning and concept of community and rurality (Remembering)CO2 Explain the role of communication in rural development (Understanding) CO3 Apply communication channels for rural development (Applying)
CO4 Analyse the social, economic, political and cultural framework of rural communication (Analysing)CO5 Evaluate the need for media and communication for rural development (Evaluating)
CO6 Design communication programme for rural development (Creating)

Module 1: Rural Communication and Participation (9 Lectures)
Community and Rurality: Concept and Definition, Meaning of Rural Communication, Communication Structure in Rural Settings-Folk and Traditional Media, Radio in Rural Communication, Community Media for Participatory Communication, Media and Communication Habits among Rural Communities, Media Penetration and Changing Rurality, Rural Communication Channels - Village Meetings; Village Market; Village fair, ICT and Rural Governance.

Module 2: Documenting Development in Rural Settings (9 Lectures)
Role of Communication in Rural Development, Documenting and Analysing Rural Development, Communication Agenda, Rural Health and Communication, Crisis and Natural Disaster Communication, Communicating Education and Agriculture, Communication and Extension Activities in Rural Settings.

Module 3: Evaluating Communication Needs in Rural Areas (9 Lectures)
Media and Communication Awareness among the Rural Mass, Assessing the Urban-Rural Divide, Communication Divide-Knowledge and Infrastructure, Need for Media and Communication Literacy, Communication Research in Rural Context-Participatory Action Research-Survey, Natural Resource Management, and Human Rights.

Module 4: Channelizing Development in a Rural Context (9 Lectures)
Contextualising Paulo Freire in the Process of Rural Development and Rural Communication, Context Specific Communication-Local Culture, Tradition, Language and Folk-Art Forms, Intercommunity Communication, Utilising Intra- community Communication Channels, Disseminating Community Specific Information and Disbursing Local Knowledge, Participatory Action and Rural Development.

Module 5: Practicum (9 hours)
As part of this module, students are required to conduct community outreach programmes in rural areas on issues of rural development or design communication programmes for rural development.

Suggested Readings

1. Communication for Rural Development, M. Acunzo, 2014, FAO
2. Communication for Development: Theory and Practice for Empowerment and Social Justice, 3rd Edition, Srinivas RajMelkote, Sage India
3. Communication Efficiency and Rural Development in Africa: The Case of Cameroon, Emmanuel K. Ngwainmbi, 1994, University Press of America
4. Community Communications: The Role of Community Media in Development. F. J. Berrigan, F. J, 1979. UNESCO
5. Framework on Effective Rural Communication for Development, R. D, Castello, 2006, FAO
6. Pedagogy of the Oppressed, P. Freire, 1970, Continuum
7. Strategic Communication for Rural Development. World Bank, F. M. Santucci, 2005

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO1	M				
CO2		H			
CO3			H		
CO4			M	M	
CO5	H		H		
CO6					H

MCML0027: MEDIA LITERACY (3-0-0)

COURSE OBJECTIVES

1. Define the concept, meaning and characteristics of the media industry (Remembering)
2. Explain the functions of communication (Understanding)
3. Choose appropriate media channels for effective communication (Applying)
4. Distinguish different types of media (Analysing)
5. Assess the emerging trends in the communication industry (Evaluating)

Module 1: Introduction to Media Literacy (12 Lectures)
Understanding media landscape, Meaning and definition, Importance of Media literacy, Media audience, media literacy approach, Types and Role of Media, Ownership Pattern and Control of Mass Media, Communication and Information Industry, Information Society, New Media Culture.

Module 2: Digital Media (7 Lectures)
Information and Communication Technology (ICT), Digital file types: documents, picture, video and audio, Editing Software: Print, Audio and video, creating digital media content with mobile phone.

Module 3: Computer Mediated Communication (8 Lectures)
Internet, Websites, online social media, User Generated Content in social media, SEO, Blogging, Live Streaming, E- Governance, Digital Marketing.

Module 4: Convergence Media (7 Lectures)
E-newspaper and web-edition, Internet and Satellite radio, TV: Internet Television, YouTube Channel, MOJO, Interactive Learning, IT Act, 2000.

Module 5: Confronting Issues (10 Lectures)
Digital divide, Cyber Security, Cyber Crime, Cyber Bullying, Digital Privacy and Piracy, Digital investigation, Misinformation and Disinformation, Propaganda and fake news, Physical and emotional effects of Digital Media.

Suggested Readings

1. Beginners' Guide to Journalism: Effective Guide to Write Well, Influence People and Remain in News, Roy Barun, 2019,V&S Publishing
2. Convergence in Broadcast and Communications Media, John Watkinson, 2001, Routledge
3. Handbook of Journalism and Mass Communication, Virbala Aggarwal, 2012, Concept Publishing Company Ltd.
4. How the Web Was Won, Paul Andrews, 1999, Broadway
5. Media Literacy, James W. Potter, 2013, Sage Publications
6. Navigating Social Journalism: A Handbook for Media Literacy and Citizen Journalism, Martin Hirst, 2018, Routledge.
7. Theories of the Information Society, F. Webster, 2014, Routledge.
8. The Rise of the Network Society, Manuel Castells, 2009, Wiley-Blackwell

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO1	H				
CO2			H		
CO3		H	M		
CO4				H	
CO5				H	

MCHD0028: HISTORY AND DEVELOPMENT OF COMMUNICATION MEDIA (3-0-0)

COURSE OBJECTIVES

1. Demonstrate an understanding of the history of media and the evolution of the mediated environment(Understanding)
2. Organize a historical survey of media and diachronic analysis of a variety of mediated forms especially in the contextof India (Applying)
3. Identify the rich folk heritage of India and its role in grass-root communication (Applying)
4. Evaluate the relationship between media and development in Indian culture, politics and society (Evaluating)

Module 1: Early history of Communication and the Printing Era (15 Lectures)
Communication in prehistoric era, Development of language and the oral tradition, Development of writing and record keeping, Development of printing in Europe and India, Development of newspapers and magazines, History of the Press in India: Colonial Period, National Freedom Movement, Post-Independence Era, Emergency and Post Emergency Era, Changing Readership, Print

Cultures, Language Press.

Module 2: Development of Electronic Media (15 Lectures)
Development of Radio as a medium of mass communication, History of radio in India, Evolution of AIR Programming, Penetration of radio in rural India, Commercial Broadcasting, FM Radio, Overview of community radio, Development of Television as a medium of mass communication, History of Television in India, Television and the State 's Development Agenda; Prasar Bharati, Doordarshan, Cable and Satellite Television in India; Commercialization of Programming, The Coming of Transnational Television.

Module 3: Development of Visual Media and Folk Media (15 Lectures)
The early years of Photography, Development of film as a medium of communication, History of Films in India, Issues and Problems of Indian Cinema Types of folk media, use of folk media, Advantages of folk media, Folk Media and communication, Role of folk media in promoting – health, education, Women's issues and Community development, Folk vs electronic media.

Suggested Readings
1. The History of the Future: Oculus, Facebook, and the Revolution That Swept Virtual Reality, Blake J. Harish, 2019, HarperCollins.
2. Mass Communication in India, K. J Kumar, 2017, Jaico Publishing House.
3. The Handbook of New Media, L. A Lievrouw and Sonia Livingstone, 2005, Sage Publications
4. Traditional folk media in India: Practice & Relevance, Shyam Parmar, 2016, Bharati Prakashan.
5. The Story of Human Communication: Cave Painting to Microchip, Wilbur Schramm, 1988, Harpercollins College Div.
6. India's Communication Revolution: From Bullock Carts to Cyber Marts, Arvind M. Singhal, 2000, Sage Publications.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO1	H	H	H
CO2		H	
CO3			H
CO4		H	

MCPC0029: PHILOSOPHY OF COMMUNICATION (3-0-0)

COURSE OBJECTIVES
CO1 Define the concept of communication (Remembering)
CO2 Infer analytical reasoning on communication (Understanding)
CO3 Identify the philosophical and sociological bases of communication (Applying)CO4 Analyse critically the purpose of human communication (Analysing)
CO5 Interpret and decode media contents wisely (Evaluating)
CO6 Discuss the idea of knowledge and psychological understanding of media text (Creating)

Module 1: Concept of Communication (10 Lectures)
Elements of Communication, Process of Communication, Role; Scope and Need of Communication in Society, Barriers to Communication, Types of Communication, Types and Characteristics of Mass Media Audiences, Functions of Mass and Social Communication.

Module 2: Philosophy and Knowledge (20 Lectures)
Epistemology, Ontology, Dialectic – Hegelian and universal, Buddhist philosophy of communication, Positivist and Post-positivist, Locke's account of knowledge, Phenomenology, Hyper-realism, Hegemony, Political economy and Frankfurt School, Marxist Media Theory, Propaganda model.

Module 3: Psychoanalysis of Communication (15 Lectures)
Philosophy of the unconscious, Oedipus concept, Id, Ego, Superego, Sexuality, Idea of myth.

Suggested Readings
1. An Essay concerning human understanding, John Locke, 1997, Penguin
2. Capital, Karl Marx, 2016, Fingerprint Publishing
3. Mythologies, Roland Barthes, 1972, Hill and Wang, Vintage
4. Manufacturing Consent: The Political Economy of the Mass Media, Noam Chomsky, and Edward S. Herman, 2002, Knopf Doubleday Publishing Group
5. The Unconscious, Antony Easthope, 2003, Routledge Publication
6. The Ego and the Id, Sigmund Freud, 1962, Martino Fine Books

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO1	H		
CO2		H	
CO3	H		
CO4	H	M	
CO5			H
CO6		H	

MCTC0030: THEORETICAL PERSPECTIVES OF COMMUNICATION (4-0-0)

COURSE OBJECTIVES

1. Define the concept of semiotic theory and practice (Remembering)
2. Explain the intersection between communication, in its many forms, and society and culture (Understanding)
3. Apply communication theories and models in communication programmes and research (Applying)
4. Analyse the link between major theoretical understandings of communication and the socio-cultural setting they have developed in (Analysing)
5. Test the various models and theories of communication in real-world situations (Creating).

Module 1: Theories and Models of Communication (15 Lectures)
Normative Theories, Democratic Participation Theory, Shannon-Weaver's Mathematical Model, Aristotle's definition of Rhetoric, Berlo's SMCR Model, Westely and MacLean's Conceptual Model, Newcomb's Model of Communication, George Gebner's Model, Schramm's Interactive Model, Harold D. Laswell, De Fleur Model.

Module 2: Media Effects Theory, Psychological & Sociological Theory (15 Lectures)
Magic Bullet Theory, Two-Step Flow and Multi-Step Flow, Gate-Keeping Theory, Cognitive Dissonance Theory, Selectivity Theory, Cultivation Theory, Uses and Gratification Theory, Media Dependency Theory.

Module 3: Powerful Effects of Media (15 Lectures)
Dominant Paradigm, Spiral of Silence, Diffusion of Innovation, Agenda Setting, Marshall McLuhan's Medium Theory.

Module 4: Semiology and Postmodern Theories (15 Lectures)
Semiotic theory and practice - historical context and doctrinal perspectives in semiotics, Models of the Sign and types of Codes, Structuralism; Formalism and Post-Structuralism.

Suggested Readings

1. A History of Communication Study, Everett M Roger, 1997, Free Press
2. Communication Theory and Models, N Andal, 2004, Himalaya Publishing House
3. Mass Communication Theory: Foundations, Ferment, and Future (6th Ed), Stanley J Baran, J. and Dennis K. Davis, 2015,Wadsworth
4. Mass Communication Theory: An Introduction, Dennis McQuail, 2005, Sage Publications
5. The Medium is the Massage: An Inventory of Effects, Marshall McLuhan, 2008, Penguin Books
6. The Media of Mass Communication, J Vivian, 1999, Boston: Pearson Understanding Media: The Extension of Man, MarshallMcLuhan, 2008, Routledge

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H	H		
CO2	M	M		
CO3			H	
CO4				H
CO5		M		

MCPJ0031: PRINCIPLES AND PRACTICES OF JOURNALISM (4-0-0)

COURSE OBJECTIVES

1. Define the concept, meaning and function of journalism (Remembering)
2. Explain the role and responsibilities of a journalist. (Understanding)
3. Apply the concepts and techniques of journalism in news reporting (Applying)
4. Analyse the role of news media in society (Analysing)
5. Write, report and edit news stories (Creating)

Module 1: News & News Writing Principles (15 Lectures)
Concept of News, Types of News, News Values, Ethics, Concept of Reporting, Types of Reporting, Qualities of a Reporter, Roles and responsibilities of media journalists, Sources of news, Cultivation of sources, Emerging trends in journalism.

Module 2: News and Features format (12 Lectures)
News format vs. Features Format, Lead writing, Types of lead, Editorial, Feature, Column, Middle, Interviews, Reviews and Special Articles, Letter to Editors, Writing Headlines, Types of Headlines.

Module 3: Organisational Structure and Regulating Bodies (9 Lectures)
Editorial, Advertising, Marketing, Circulation, Accounts and Finance, News Production Hierarchy, Readership, Case study ofnews organisations, Registrar for Newspaper of India (RNI), Journalists' Union, Editors' Guild of India, Audit Bureau of Circulation (ABC), Press Information Bureau, Press Council of India (PCI), News Agencies.

Module 4: Editing and Layout (9 Lectures)
Meaning, Purpose, Tools & Techniques, Media language, Editing Symbols, Style Sheets, copy testing, Proofreading, Page Layout – modular; horizontal; vertical; photo placements; photo-caption; use of artwork; breaking the layout, Agency Copy Editing, Page design – innovations in the edit page.

Module 5: Practicum (15 hours)
Basic of design, Introduction to page layout software, Field reporting and publication

Suggested Readings

1. Beginners' Guide to Journalism: Effective Guide to Write Well, Influence People and Remain in News, Roy Barun, 2019, V&S Publishing
2. Here is the News: Reporting for Media, R. Parthsarathi, 2009, New Delhi: Sterling Publishers
3. News Reporting and Editing, K.M. Srivastava 1995, Sterling Publishers
4. Social Meanings of News – A Text Reader, Dan Berkowitz, 1997, Sage Publication
5. Sociology of News, Michael Schudson, 2003, W.W. Norton & Company
6. The Twenty-First-Century Media Industry, Economic and Managerial Implications in the Age of New Media, John A. Hendricks, 2011, Lexington Books
7. The Rise of the Network Society, Manuel Castells, 2009, Wiley-Blackwell

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO1	H	H			
CO2			H		
CO3	H	H			H
CO4			H	H	
CO5					H

MCID0032: INVESTIGATIVE AND DATA DRIVEN JOURNALISM (3-0-0)

COURSE OUTCOMES

1. Define the meaning and concept of investigative and data journalism (Remembering)
2. Demonstrate how to conduct news investigation (Understanding)
3. Plan and execute investigative news reporting methodically and ethically (Applying)
4. Analyse different sets of data and information (Analysing)
5. Assess the risk involved in investigative reporting (Evaluating)

Module 1: Basics of Investigative Journalism (10 Lectures)
Concept, meaning and definition of Investigative Journalism, types and history, Sources, Research, Fact checking and editing, Role of investigative reporting in a democratic society, Trends in Investigative Reporting, Investigative techniques,

Case studies, Associations of Investigative Journalists, The soul of the investigative reporter, ethics of investigativereporting.

Module 2: Digital Investigation (8 Lectures)
Understanding Digital Investigation, Computer Assisted Reporting, Web research and data collection, Data Literacy, Data Mining Tools, Open-Source Intelligence Tools (OSINT), Social Media Auditing, Online Fact Checking and Verification.

Module 3: Data Journalism (8 Lectures)
Concept, meaning, definition of Data Journalism, Data-driven Storytelling, Data Acquisition, Data Analytics, Reporting with Data, Public, Private and Open-Source Database, Overcoming Information Overload.

Module 4: Tools and Techniques of Data Driven Journalism (8 Lectures)

Analysis and Design, Tools and Techniques, Challenges with Data: Finding and Cleaning, Statistical Tools and Methods, Open-Source Software.

Module 5: Practicum (11 hours)
Develop an investigative pitch/plan for a major investigative story, Data Visualisation, Online Fact Checking, and Social Auditing.

Suggested Readings
1. Computer-Assisted Reporting: A Practical Guide, Brant Houston, 2003, Routledge
2. Data Literacy: A User's Guide, David Herzog, 2015, Sage Publication
3. Data Smart: Using Data Science to Transform Information into Insight, John Foreman, 2013 Wiley
4. Data Journalism: Past, Present and Future, John Mair, Richard Keeble and Megan Lucero, 2017, Theschoolbook.com
5. Data-Driven Storytelling, Nathalie H. Riche, Nicholas Diakopoulos, Christophe Hunter and Seelagh Carpendale, 2018, AKPeters/CRC Press
6. Investigative Journalism: Proven Strategies for Reporting the Story. William C Gaines, 2007, CQ Press
7. The Functional Art: An Introduction to Information Graphics and Visualization, Alberto Cairo, 2012, New Riders
8. The Investigative Reporter's Handbook: A Guide to Documents, Databases and Techniques. Brant Houston, 2002, Bedford/St. Martins
9. The Data Journalism Handbook, Jonathan Gray Liliana Bounegru, and Lucy Chambers, 2012, Shroff/O'Reilly
10. Visualization Analysis and Design, Tamara Munzner, 2014, AK Peters/CRC Press.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO1	H		H		
CO2		H			
CO3	M		H		H
CO4		H		H	H
CO5	H				H

MCTS0033: THEORIES OF DEVELOPMENT COMMUNICATION AND SOCIAL CHANGE (4-0-0)

COURSE OBJECTIVES
1. Define the basic terms related to development & development communication (Remembering)CO2
2. Explain different models and approaches of development (Understanding)
3. Develop communication strategy for development (Applying)
4. Examine role of media in socio-economic development and social change (Analysing)
5. Assess situation for communication intervention (Evaluating)
6. Create advocacy and initiate behaviour change through communication channels (Creating)

Module 1: Introduction to Development (15 Lectures)
Meaning, definition and process of Development, Growth and Development, Characteristics of Developing and Underdeveloped countries, Regional Development, Development Challenges, Emerging Issues in Development.

Module 2: Theories, Models and Approaches of Development (15 Lectures)
Basic Needs Model, Theories and Paradigms of Development – Unilinear, Non-unilinear, Dominant, Alternative and New paradigms of development, Dependency Model, Marxist concept of stages of society, Social Responsibility Theory, Top Down (Trickle Down) Approach, Growth Pole Approach, Bottom Up (Grass Roots) Approach, Neoliberalism, New Millennium Development Goals.

Module 3: Concepts, Theories and Models of Development Communication (15 Lectures)
Origin, Meaning, Concepts, Definition Media and Modernization, ICT and Development, Participatory Communication, Approaches to Communication for Development: Diffusion of Innovation, Magic Multiplier, Development Support Communication.

Module 4: Social and Behaviour Change Communication (15 Lectures)
Concepts of SBCC, Managing information for social change; individual level behavioural change, Models of Change: persuasion model; health belief model; stages of trans-theoretical model; socio-ecological model, Communication planningmodels: ACADA Model; P-Process; COMBI Model and Integrated Communication, Case studies.

Suggested Readings
1. Communication for Development and Civil Society, V.S. Gupta, 2004, Concept
2. Communication for Development in the Third World, Srinivas Melkore & Steeve, 2001, Sage India

3. Communication and Development-The Challenges of the Twenty-First century, VS Gupta, 2000, Concept Publishing
4. Development Theory: Deconstruction/Reconstruction, Nederveen Jan Pieterse, 2001, Vistaar.
5. Development Theory, PW Preston, 1997, BlackwelL
6. Diffusion of Innovations, Everett M. Roger, 2003, Free Press
7. Kiran Prasad, 2009, Information and Communication Technology: Reinvesting Theory and Action, BRPC
8. Media, Communication and Development: Three Approaches, Linje Manyozo, 2012, Sage
9. Media in Development Arena, RK Ravindran, 2000, Indian Publishers Distributors
10. Other Voices: The Struggle for Community Radio in India, Paravala V and Malik K V., 2007, Sage India

Mapping of CO to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H			
CO2		H		
CO3			H	M
CO4			H	H
CO5				H
CO6				H

MCRM0034: MEDIA AND COMMUNICATION RESEARCH METHODOLOGY (4-0-0)

COURSE OBJECTIVES

1. Define meaning, scope, objectives and significance of media research (Remembering)
2. Demonstrate appropriate methods for collecting and analysing research data (Understanding)
3. Apply research methods related to the disciplinary areas of communication and media (Applying)
4. Assess and appraise relevant literature (Evaluating)
5. Conduct research, write research reports and projects (Creating)

Module 1: Meaning and Objectives of Research (15 hours)

Media Research – Meaning; Scope; Objectives and Significance, Research Process, Formulation of Research Problem, Literature Survey, Research Design, Collection of Data, developing a Questionnaire, Aids for Writing Research Reports – Bibliography; Footnote and Reference; Synopsis and Abstracts, Writing of Report; Summary; Executive Summary; Conclusion and Recommendation.

Module 2: Research Methods and Applications (20 hours)

Techniques of Data Collection – Observation; Questionnaire and Interview; Content Analysis, Qualitative Methods - Field Experiments; Ethnography; Focus Groups; Case Studies, Quantitative Research Methods - Experimental Research; Survey Research; Content Analysis, Audience Research in Print and Electronic Media.

Module 3: Statistical Applications in Communication Research (25 hours)

Statistics – Definitions; Uses and Limitations, Classification and Tabulation of Data, Univariate and Bivariate, Diagrammatic and Graphical Presentations, Sampling - Types of Sampling; Guiding Principles of Sampling, Test of Hypothesis – Basics; Probability distribution; normal distribution; t-test; Chi- square test; Measures of Central Tendencies, Measure of Variability, Correlation - Computation of Product Moment; Correlation Coefficient; Spearman’s Rank; Coefficient Correlation, Scaling Techniques – Arbitrary; Thurstone; Likert-Scale.

Suggested Readings

1. Communication research for Development: The ISRO Experience, Binod C. Agarwal and S.R. Joshi and Arbind Sinha, 1986,New Delhi: Concept Publishing Company.
2. Media Research Techniques, Asa A. Berger, 1998, Thousand Oaks: Sage Publication.
3. Media Analysis Techniques, Asa A. Berger, 1998, Beverly Hills: Sage Publications. 1998.
4. MLA Handbook for Writers of Research Papers, Joseph Gibaldi and Achtert S. Walter, 1994 New Delhi: Affiliated East-West Press Pvt. Ltd.
5. Research Methodology Methods and Techniques, R. C Kothari, C.R, 2019, New Age International Publishers
6. Mass Media Research: An Introduction, Roger D. Wimmer, 2015, Cengage Learning
7. Writing your thesis, Paul Oliver, 2008, Sage Publications

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO1	H		
CO2		H	

CO3			H
CO4		H	
CO5	H		

MCDM0035: DIGITAL MEDIA (3-0-0)

COURSE OBJECTIVES

1. Define new media and information society (Remembering)
2. List the characteristics of new media (Remembering)
3. Show their ability to engage in contemporary debates on the implications of digital culture (Understanding)
4. Demonstrate the ability to deal critically with social analysis of popular media (Understanding)
5. Analyse key issues emerging from recent development into digital culture (Analysing)

Module 1: Digital Communication (12 Lectures)
New Media and Information Society, The Characteristics of New Media, Hyper-textuality and Hyper- Mediacy, New Media and Visual Culture, Interactivity, Mobile journalism (MOJO).

Module 2: The Internet and the Public Sphere (10 Lectures)
Online News; Digital Economics, Access and the Digital Divide, Economics and Networked Media Culture, The social form of New Media, Globalisation; neo-liberalism and the Internet.

Module 3: Media, Culture, Technology and Society (13 Lectures)
Relationship between Space and Identity, Ideological Connotation of the new Cyber and Participatory Culture, Intensity of Change; Intensifying Process of Globalization, Cyber-Culture, Fragmentation and Convergence.

Module 4: Online Media Praxis (10 Lectures)
Challenges and Opportunities for Journalists - Readers as Publishers, New Media Journalism; Online Edition of Newspapers- Management and Economics, Security Issues in Using Digital Technology (Malware, Phishing, Identity Thefts), social media and Citizen Journalism, E-governance, Internet and Live Streaming.

Suggested Readings

1. A Networked Self: Identity, Community and Culture in social Networking Sites, Papacharissi, Z. (Ed.,), 2011, Routledge
2. Critique, social media and the Information Society, Christian Fuchs and Marisol Sandoval (Eds.,), 2006, Routledge
3. Digital Cultures: Understanding New Media, Glen Creeber, and Royston Martin (Eds.,), 2009, Open University Press
4. Handbook of New Media, Leah Lievrouw and S. Livingstone, 2006, London: Sage
5. New Media Language, J. Aitchison, 2003, Routledge
6. New Media: A Critical Introduction, J. Dovey, 2009, Routledge
7. New Philosophy for New Media, Mark B. N. Hansen, Mark B. N., 2004, MIT Press.
8. New Media: A Critical Introduction, Martin Lister, Jon D., Seth Giddings, Iain Grant, Kieran K, 2009, Routledge,
9. The New Media Handbook, Andrew Dewdney, Andrew and Peter Ride, 2006, Routledge
10. The New Media Book, Dan Harries Dan, 2002, Palgrave MacMillan

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H			
CO2	H			
CO3			H	
CO4		H	H	
CO5			H	H

MCML0037: MEDIA LAWS, ETHICS AND SOCIAL RESPONSIBILITY (3-0-0)

COURSE OUTCOMES

1. Define the salient features of media laws and ethics (Remembering)
2. Explain the essential features of the Indian Constitution in the context of press freedom (Understanding)
3. Examine the purpose and role of media professionals in society (Applying)
4. Analyse the legal issues pertaining to the media (Analysing)
5. Evaluate the relative merits and demerits of the ethical questions pertaining to the media (Evaluating)

Module 1: Legal System in India (10 Lectures)
Introduction to the Legal System: Jurisprudence, Sources of law: custom; precedent; statute, Types of law: criminal; civil; tort, History of media laws in India.

Rights, Rules and Laws: Justice and law; laws and society
Judicial Systems in Relation to Media: Basic features of the Indian Constitution, Structure of Judicial System in India – Supreme Court, High Court, Lower courts.
Constitutional Obligations: Freedom of Speech and Expression, Freedom of the Press, Right to Information Act, 2005.

Module 2: Media Laws (15 Lectures)
Laws Related to Media Profession: Introduction to Indian Penal Code, Press Council of India; Press Council Act, 1965, 1978, Cinematographic Act, 1952.
Public Interest Litigation and Defamation: Civil and Criminal law of defamation, Libel and Slander, Public Interest Litigation.
Media Laws relating to Women & Children: Laws relating to Obscenity, Indecent Representation of Women (Prohibition)Act, 1986, The Children Act 1960, Juvenile Justice Act.
Freedom and Accountability of the Media: Freedom and Responsibility, Contempt of Court 1971, Protection of Civil Rights Act 1955, Parliamentary Proceedings Act 1971.

Module 3: Media Ethics (10 Lectures)
Ethics and Journalistic Professionals: Introduction to Ethics, Press Council's Norms of Journalistic Conduct, AIR News Policy for Broadcast Media; Broadcasting Code
Media and Social Responsibility: Media and pressure groups, Prasar Bharati Act 1990, The Broadcast Code Governing AIR
Rights and Duties of Media Professionals: Politics and Elections, Investigative Reporting, Court Reporting

Module 4: Issues in Reporting (10 Lectures)
Media and Conflict Reporting: Conflict Scenario in North-East India, Ethical Issues in Conflict Reporting, International Humanitarian law
Cyber Laws: Information Technology Act 2000, Cyber Crimes, Cyber Crimes relating to Women and Children
Intellectual Property Rights: Copyright Act 1957, Design Act 1911, Trade and Merchandise Marks Act 1958, Patent Act 1970

Suggested Readings:
1. A Compendium of Codes of Conduct for Media Professional, Prabhakar M, et al., 1999, University Book House
2. Ethics, Frankena K. William, 2002, Prentice Hall India
3. Introduction to Ethics, Lillie William, 2003, Allied Publishers
4. Media Law and Ethics, Neelamalar M, 2010, PHI Learning Pvt. Ltd.
5. Media, Ethics and Laws, Singh P.P. et al., 1998, Anmol
6. Media Ethics, Paranjoy Guaha Thakurta, 2011, Oxford University Press
7. Media Laws and Ethics: An Introduction to legal and ethical issues, Vartika Nanda, 2018, Kanishka Publishers
8. Social Media Communication: Concepts, Practices, Data, Law and Ethics, 3rd Edition Jeremy Harris Lipschultz, 2020, Routledge

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H	H	H	
CO2	H			
CO3			H	
CO4		H	H	
CO5		H	H	H

MCAM0038: ADVERTISING, CORPORATE COMMUNICATION & PUBLIC RELATIONS (3-0-0)

COURSE OBJECTIVES
1. Define the key terms related to advertising, public relations and corporate communication (Remembering)
2. Explain the different models and approaches of advertising, public relations and corporate communication (Understanding)
3. Develop public relations and corporate communication strategies for public & private enterprises (Applying)
4. Plan and execute ethically sound and socially responsible advertising strategies and public relations campaigns(Evaluating)
5. Produce multimedia ads for varied audiences (Create)

Module 1: Advertising (15 Lectures)
Need and Impact of Advertising: National and global scenario, Integrated marketing communication, Persuasion, retention and recall, Process of Advertisement Creation: media planning, visualization, copywriting, Brand Management: Concept and evolution, components of brands, image and personality.

Module 2: Corporate Communication (15 Lectures)

Defining corporate communication strategies, corporate communication in public sector, private sector and multi- nationals, strategic corporate communication and management, proactive and reactive media relations, media selection, symmetrical and asymmetrical models in handling crisis, Role of corporate communication in crisis and disaster management, use of media in crisis management.

Module 3: Public Relations (15 Lectures)
Definition and concept: Public relations, External and internal, Vertical and horizontal, Promotion of products and services, Image building, social marketing, Campaigns, Press Conferences and press releases, Conferences and conducted tours, staging of special events, Use of Various Media: Print, electronic, media and web, Outdoor media and exhibitions, Newsletters/brochures/video and audio material, Traditional media.

Suggested Readings:
1. Advertising and Promotion: An Integrated Marketing Communications Perspective, Belch, George E, and Michael A. Belch,2004, McGraw-Hill.
2. Advertising Management, J. Jethwaney and S. Jain, 2012, Oxford University Press
3. Communication in Organisations, Fisher, D., 1999, Jaico Publishing House
4. Corporate Communication: Principles and Practice, Jaishri Jethwaney, 2018, Sage Publications
5. Crisis Communication Strategies: How to Prepare in Advance, Respond Effectively and Recover in Full, 1st Edition, AmandaColeman, 2020, Kogan Page
6. Ogilvy on Advertising, Ogilvy David, 1997, Prion Books, London
7. Public Relations Management, Jethwaney, J and Sarkar, N. N, 2015, Sterling
8. Strategic Brand Management, 4th Edition, Keller, Parmaeswaran and Jacob, 2015, Pearson Education

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO1	H	H	H
CO2	H	H	H
CO3		H	H
CO4	H	H	
CO5			H

MCAV0039: AUDIO-VIDEO EDITING (3-0-0)

COURSE OUTCOMES
1. Identify the importance of Sound and Sound SFX (Remembering)
2. Understand the techniques of audio recording and editing (Understanding)
3. Execute video and audio tracks with effects (Applying)
4. Differentiate between the different techniques of Video Editing (Evaluate)
5. Plan, design and create digital video projects incorporating audio and video elements (Creating)

Module 1: Audio Editing (20 Hours)
Configuration of a PC for sound recording, Motherboards, Processor, Sound Card, Graphic card, Monitors, Recorders: Analog, Digital, Tape Based & Tapeless, Digital Audio Workstations (DAW's), Set up an audio editing software, The user interface, Waveform editing, Effects, Audio Restoration, Mastering, Sound design, Creating and recording files, Multitrack sessions, Multitrack session editing, Automation, Video soundtracks, The essential sound panel, The multitrack mixer, Creating music with sound libraries, Recording and output in the multitrack editor.

Module 2: Video Editing (25 Hours)
Installing video editing software, Optimizing performance of system and software, Performing non-linear editing, Understanding the user interface of the software, Setting up a project, Importing media, organizing media, Mastering the essentials of video editing- using the source monitor; viewing video on a second monitor; using a numerical keyboard; editing from the project panel; navigating the timeline panel; using essential editing commands; setting the duration for still images, Working with clips and markers, Adding transitions, Advanced editing techniques- performing four-point editing; changing playback speed; replacing clips and footage; nesting sequences; multi-camera editing, Putting clips in motion, Editing and mixing audio, Adding video effects, Colour correction and colour grading, Compositing techniques, Creating graphics, Exporting the timeline.

Suggested Readings:
1. Adobe Audition: Operation Manual, 2021, Adobe Press
2. Adobe Premiere Pro: Operation Manual, 2021, Adobe Press
3. Film Art: An Introduction, David Bordwell and Kristin Thompson, 2003, McGraw-Hill (first published 1979)

4. Film Editing: Great Cuts Every Filmmaker Should Know, Gael Chandler, 2009 Michael Wiese Productions
5. Grammar of the Edit Roy Thompson, Christopher J. Bowen, 2014, Focal Press (first published January 1st 2009)
6. In the Blink of an Eye: A Perspective on Film Editing, Walter Murch, August 1st 2001, Silman-James Press
7. Mixing Audio, Bob Katz 8. Mixing Audio, Roey Izhak, 2007, Focal Press
8. Modern Recording Techniques, David Miles Huber, 2005, Focal Press (first published in 1986)
9. Practical Recording Techniques, Fifth Edition 2009, Elsevier

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2
CO1	H	
CO2	H	
CO3	H	H
CO4		H
CO5		H

MCTV0040: TELEVISION AND VIDEO PRODUCTION (3-0-1)

COURSE OUTCOMES

1. Identify different genres of television production (Remember)
2. Understand the intricacies and nuances of screenwriting (Understanding)
3 Distinguish various equipment and tools required for television and video production (Analyse)
4. Assess the importance of cinematography in television and video production (Evaluate)
5. Produce television programmes for various audiences (Creating)

Module 1: Writing for Television: (10 Lectures)

Preparing to Think Visually: Diving Into the Screenwriter's Mind, Approaching Screenwriting as a Craft - Mise-en-Scene; Breaking Down the Elements of a Story, Structure of Story & Screenplay: Beginning, Middle, End; Dynamics of Characterization: Character Building, Constructing Dynamic Dialogues, Finalizing the Script: Maintaining an Audience's Trust, Turning Your Story into a Script, Rewriting Your Script, Adaptation and Collaboration: Two Alternate Ways to Work; Intro to Storyboarding/Visual Storytelling & Storyboards; Storyboarding Techniques: Drawing the components of the storyboard, Indicating motion in the storyboard.

Module 2: Genres and Audience (15 Lectures)

Nature of drama in television: Various shows, formats and genres, telecast patterns, audience viewership performance, Building the story, herd culture, Creating niche television programming: Importance of niche content, niche content channels, Differentiation of infotainment, edutainment, entertainment, lifestyle genres, Differentiation of genres, Specialty of different genres, popularity of genres, content on demand.

Module 3 Television and Video Formats (10 Lectures)

Digital Recording Formats SD, HD, 2K, 4K - Editing and compression - Digital sampling and storage - Technical formats of video- PAL, NTSC, SECAM, Digital television formats- ATSC, DVB, ISDB, DTMB, IPTV, Recording formats; "Time Code" in Video Recording.

Module 4: Lighting Equipment and Techniques (15 Lectures)

Understanding of colour, use of colour, Capturing the emotion; Role of light, Lighting techniques - Concept of lighting various planes; Understanding Various types of lights; Lighting accessories, grey card, Metering, Colour temperature meter, Camera filters, Types of lighting - Studio lighting for three cameras set up, Outdoor lighting, Lighting for documentary, Mood Lighting & Colour Lighting Theory and Practice.

Module 5: Lenses, Camera Movements and Techniques (10 Lectures)

Lenses: Type of Lenses, Power of Lenses, Understanding the shot requirement and usage of a lens, Lens and perspective: Depth of Field, Depth of focus, Focus pulling; Camera Movements, Camera angles, Usage and need of Track and trolly, Crane, Jimmy Jib, Poll Cam, Managing Movements, Single camera Setup, Multi camera setup and Continuity Exercise.

Suggested Readings

1. Before You Shoot: A Guide to Low Budget Film and Video Production, Helen Garvey, 1995, Shire Press
2. Breaking into Film by Kenna McHugh, 1998, Peterson Nelnet Co
3. Camera Terms and Concepts, David Elkins, 1993, Focal Press
4. Fundamentals of Film Directing, David K. Irving, 2010, McFarland & Company
5. How not to write a screenplay: 101 common mistakes most screenwriters make by Denny Martin Flinn, 1999, Lone Eagle
6. Motion Picture Camera and Lighting Equipment, David Samuelson, 1986, Focal Press (first published 1977)
7. Screen Adaptation: A Scriptwriting Handbook, Kenneth Portnoy, September 8th 1998, Routledge (first published 1998)

8. Screenplay: The Foundations of Screenwriting, Syd Field, 2005, Delta (first published 1979)
9. The Camera Assistant, Doug Hart, 1995, Routledge
10. Writing, Directing, and Producing Documentary Films and Videos, Alan Rosenthal, 2007, Southern Illinois University Press(first published in 1990)

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO1		H			
CO2	H				
CO3				H	
CO4			H	H	H

MCSM0041: SOUND FOR MEDIA (3-0-1)

COURSE OUTCOMES:

1. Define the key terms related to sound (Remembering)
2. Explain the basic principles of sound production (Understanding)
3. Develop sound recording skills for visual media (Applying)
4. Distinguish between analogue sound and digital sound (Analysing)
5. Assess the acoustic quality of a room for sound production (Evaluating)
6. Produce audio programmes (Creating)

Module 1: Introduction to Sound (15 Lectures)
Understanding sound, Human hearing process, Air pressure, Characteristics of sound: wavelength; amplitude; frequency; phase, Components of sound: pitch; volume; timbre; harmonics; rhythm; tempo; attack; sustain and decay, Propagation of sound waves, Mono and stereo sound, Hi-fi vs low-fi sound, Sound perspective, Sound texture, Natural sound: Ambience; speech; dialogue etc., Sound creation: studio sound; inventing sounds and sound creation in software.

Module 2: Analogue and Digital Sound (17 Lectures)
Meaning of analogue and digital, Analogue sound, Characteristics of analogue sound: phase; frequency response; signal- to-noise ratio, Digital sound, Characteristics of digital sound: sampling; quantization; bit rate; dither; jitter, Compression and audio codec: audio file types/formats; open and proprietary formats, file compression.

Module 3: Sound Recording (15 Lectures)
Microphones: construction and polar pattern, recording practices: location recording; studio recording; equipment for location recording; equipment for studio recording, Music and Sound effects, Creating soundscape, Off-screen; on-screen and non-diegetic sound, Sound for video: news stories; documentaries; internet videos, Audio cable and connectors.

Module 4: Studio Acoustics (13 Lectures)
Meaning and definition of acoustics, Studio acoustics, Noise sources, Sound isolation, Sound absorption, Noise control: acoustic treatment; technical requirement for construction of studio.

Suggested Readings:

1. Digital Audio, Dobrian Christopher (n.d.), Retrieved from https://music.arts.uci.edu/dobrian/digitalaudio.htm
2. Sound Design: The Expressive Power of Music, Voice and Sound Effects in Cinema, Sonnenschein David, 2001, Michael Wiese Productions.
3. The Sound Effects Bible: How to Create and Record Hollywood Style Sound Effects, Viers Ric, 2008, Michael Wiese Productions.
4. Transmedia Directors: Artistry, Industry and New Audiovisual Aesthetics, Vernallis Carol, 2020, Bloomsbury Academic.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H	H		
CO2			H	
CO3			H	
CO4		H		
CO5				H

MCPC0042: POLITICAL COMMUNICATION (3-0-0)

COURSE OBJECTIVES:

1. Define the key terms in political communication (Remembering)
2. Understand the different techniques of political communication (Understanding)
3. Critically analyse the relationship between media and politics (Analysing)
4. Develop a critical understanding of the role of communication in politics (Evaluating)

Module 1: Introduction to Political Communications (15 Lectures)
Political Communication: Concept, Theoretical Approaches, Theories and Political communication paradigm, Channels of Political Communication, communication and civic engagement.

Module 2: Media and Politics (15 Lectures)
Media Coverage of Politics, Framing, Opinion Polls, Election Coverage, Political Advocacy, The transmission of political information (Print/TV/SM), Media Bias, Campaign Advertising & Political Participation, Case Studies.

Module 3: Media, Power and Ideology (15 Lectures)
Constructing Ideology: Consensus as ideology; manufacturing consent; Ideology & hegemony, Identity formation and political mobilization, State and Information, Political process and Governance in India, Gauging Public Opinion, Public Opinion and Public Policy, Political Polarization.

Suggested Readings:
1. Media, Markets and Democracy, E Baker, 2004, Cambridge University Press
2. Necessary illusions: Thought control in democratic societies, N. Chomsky, 1995, House of Anansi.
3. The Press and American Politics, 3rd Edition, Richard, Davis, 2001, Prentice Hall. Ch. 2-3, pp. 25-86
4. Mediated Politics: Communication in the Future of Democracy, Robert M Entman, (Eds), 2001, Cambridge University Press
5. Manufacturing Consent: The Political Economy of the Mass Media, Edward,Herman and N. Chomsky, 1998, PantheonBooks
6. A Virtuous Circle: Political Communications in Post industrialist Societies, Pippa Norris, 2000, Cambridge University Press.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO1	H		
CO2	H	H	H
CO3		H	
CO4			H

MCNR043: NEWS REPORTING AND EDITING (3-0-1)

COURSE OUTCOMES
1. Define the meaning and concept of news reporting and editing (Remembering)
2. Understand the organisational structure of a newsroom (Understanding)
3. Develop editing skills for the print media (Applying)
4. Differentiate between news reporting and editing (Analysing)
5. Assess the quality of an editor in publishing a newspaper (Evaluating)
6. Design print media publications (Creating)

Module 1: News Gathering Process (15 lectures)
Principle of News Reporting, Elements of Reporting, Types of Reporting, Role and Importance of Sources, Cultivating, Verifying and Dealing with Sources of News, Attribution, Qualities of a good Reporter, Ethical aspects of Sourcing news & Reporting, Risk in reporting.

Module 2: Different Formats of News Report (15 lectures)
Factual and Routine news, Analytical News, Interpretative & Descriptive News, Investigative News and research based or in-depth news, Sequential News, Breaking News.

Module 3: The Editing Process (15 lectures)
Structure of a Newsroom, Editorial desk, Functions of Editorial Desk, Nature and need for editing, Principles of Editing, Role, objectives and tools of editing; process of editing; Editing symbols; language in editing; Objectives of copy editing; editing agency copies; handling wire and correspondents' copy; Ensuring News value and other criteria; Checking facts, language, style, clarity & simplicity; Editing/revising press releases and handouts; Relevant graphics for copy, Style sheets and house styles; Photo Editing; Newsroom terminology in electronic editing; Magazine editing, Headline Writing: Principles, types and techniques.

Module 4: Practicum (15 hrs)

News editing: Hard news, soft news, Opinion and Analytical Pieces), News selection and placement; Preparing dummies; Graphics; Use of editing software; Photo editing and caption writing; Production of Lab Journal.

Suggested Readings:

1. News Writers' Handbook by M L Stein, Susan F Paterno, R Christopher Burnett, 2006, Blackwell Publications
2. Practical Newspaper Reporting, David Spark and Harris Geoffrey, 1997, Routledge Publishers
3. Writing and Reporting News: A Coaching Method by Carole Rich, 1993, CENGAGE Publications.
4. News Writing, George Hough, 2006, Kanishka Publishers
5. The Unwritten Rules of Copy Editing, 2nd Edition, Dominic Gettins, 2006, Kogan Page Publications
6. Reporting for Journalists. Chris Frost, 2001, Routledge
7. News Agencies: From Pigeon to Internet, PTI Style Book, M Shrivastava, 2007, New Dawn Press, Modern Journalism: Reporting and Writing, Diwakar Sharma, 2005, Deep and Deep Publications
8. Feature Writing for Journalists. Sharon Wheeler, 2009, Routledge Publications.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H	H	H	
CO2			H	
CO3			H	
CO4	H	H	H	
CO5			H	
CO6				H

MCHE0044: HEALTH AND ENVIRONMENT COMMUNICATION (3-0-1)

COURSE OUTCOMES

1. Define the key terms in health and environment communication (Remembering)
2. Explain different models and approaches of health and environment communication (Understanding)
3. Develop communication strategy for public health and environment protection (Applying)
4. Examine the role of media in social change (Analysing)
5. Assess the situation for communication intervention (Evaluating)
6. Report news on health and environmental issues (Create)

Module 1: Health Communication (15 Lectures)

Introduction to Health Communication: Meaning of health communication, Conceptions of health, Health Communication issues, illness and well-being, Ethics of Health Communication, Health communication in public health, Enhancement of the quality of life, soliciting co-operation from stakeholders, Facilitating adoption process.

Module 2: Theories and Approaches to Health Communication (15 Lectures)

Health communication theories, Health Communication approaches and action areas: Persuasive approaches, Cultural perspectives, Emotional perspectives, public relations and public advocacy, Community mobilization, Planning, implementation and evaluation of public health communication campaign - Health communication planning process, Situation analysis and audience profile, Identifying programme objectives and strategies.

Module 3: Environment Communication (15 Lectures)

Environment journalism: emergence, rise of environment activism, role of the state, developments in India, relevant laws, UN initiatives, environment protection and the role of Media, Environmental journalism today, Skills for environmental journalism.

Module 4: Environmental Communication and Challenges (15 Lectures)

Media theory basics for the environmental journalist: Objectivity, Framing-News values, Agenda setting, Advocacy journalism, the media as environmental watchdog, Challenges for investigative environmental journalism. Writing an environment feature, environment research.

Suggested Readings:

1. Communicating Health: A Culture-centered Approach, Mohan J Dutta, 2008, Polity
2. Communication, Media and Environment, A Hansen, 2011, Routledge
3. Environment Journalism, H Bodker and I Neverla (Eds), 2013, Routledge
4. Health Communication – From Theory to Practice, Renata Schiavo, 2007, Wiley
5. Health Communication: Richard K Thomas,2006, Springer
6. Health Communication: Strategies and Skills for A New Era, Claudia Parvanta, 2018, Jones and Bartlett Publishers
7. Journal of Health Communication, Tailor & Francis

8. Risk Communication and Public Health, Peter Bennet and Kennet Calman, 2001, Oxford Medical Publications
9. The Routledge Handbook of Environment and Communication, 2015, Routledge.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H		H	
CO2		H		H
CO3		H		H
CO4		M	M	H
CO5		H		H
CO6	H	H	H	H

MCPM0045: PROGRAMME MANAGEMENT (3-0-0)

COURSE OUTCOMES
1. Understand the meaning and concept of project proposal writing (Understand)
2. Identify the principles and approaches of programme management (Analyse)
3. Undertake critical review of C4D projects (Evaluate)
4. Prepare development project management plans and programmes (Creating)

Module 1: Project Formulation and Appraisal (15 Lectures)
Overview of project management, Feasibility and technical analysis, Market and demand analysis, Economic and financial analysis, Formulation of Detailed Project Report (DPR).

Module 2: Project Planning, Writing and Scheduling (15 Lectures)
Meaning and concept of project planning, Need assessment and project feasibility, Rationale, Project components: Executive summary, Statement of need, Project goals, Project description, Budgeting, Organizational information, Materials and equipment, Human resources, Project costing and financing, organisation structures in project.

Module 3: Project Implementation, Budget and Results (15 Lectures)
Project team and competencies, Coordination and communication, Review Mechanism, Tracking project milestones, Report writing, production and supervision of key inputs, capacity strengthening activities/training, team building activities, Advance and contingency planning, Fund management, project-life-cycle, Results-based Management - outputs, outcomes and higher-level goals or impact, Cost-Benefit Analysis (CBA), Sensitivity Analysis, Project management information system, material and equipment,, financial aspects, project Sustainability, Closing a project, Reviewing a project.

Suggested Exercise
Literature Review, Case Study, Field Survey, Project Writing, Project Reviews, PRA

Suggested Readings:
1. Gower Handbook of People in Project Management (Project and Programme Management Practitioner Handbooks), Lindsay Scott and Dennis Lock, 2013, Routledge
2. How to change the world: Social Entrepreneurs and the Power of New ideas, 2004, David Bornstein, OUP USA
3. Integrated Planning Process: Project Design & Proposal Writing, American Red Cross, 2006
4. IDRC. 2010. Resource Mobilisation a Practical Guide for Research and Community Based Organization http://www.idrc.ca/EN/Programs/Donor_Partnerships/Documents/ Donor-partnership-guide-hyperlinked.pdf
5. Impact Assessment of ICT-for Development Projects: A Compendium of Approaches, Richar Heeks and Alemayehu Molla,2009, IDRC. http://www.sed. manchester.ac.uk/idpm/research/publications/wp/di/documents/di_wp36.pdf
6. Results Based Management - https://unhabitat.org/?rbm-handbook=1-1-what-is-resultsbased-management
7. Social Entrepreneurship: What Everyone Needs to Know, Bornstein David and Susan Davis, 2010, Oxford University Press
8. World Bank. 2009. Resource Mobilisation. http://siteresources.worldbank.org/INTBELARUS/Resources/Resource_Mobilisation.pdf

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO1	H	H	
CO2		H	
CO3			H
CO4		H	H

MCSA0046: SITUATION ANALYSIS FOR COMMUNICATION STRATEGY (3-0-1)

COURSE OUTCOMES

1. List the basic models and steps of communication strategy planning (Remembering)
2. Understand the techniques of development communication planning (Understanding)
3. Assess the situation for development communication and intervention (Evaluating)
4. Examine the role of media in socio-economic development and social change (Analysing)
5. Prepare develop communication strategy and plans (Creating)

Module 1: Socio-Ecological Framework and Situation Analysis

Underlying causes of development problems, Socio-Ecological Framework, Situation Assessments: Motivation- Opportunity-Ability (MOA) Model, Case and project feasibility study, SWOT Analysis. Participatory Approach: PRA, Community Mapping, Social Auditing, Transect walk, Auto-photography.

Module 2: Literature Review and Formative Research

Research on current knowledge, attitudes, experiences, practices and beliefs among the participants groups, Understanding Local knowledge, Formative Research, Participatory Research, Participatory Rural/Urban Appraisal (PRA), Participatory Learning and Action (PLA), Most Significant Change (MSC), Appreciative Inquiry, Case study on C4D.

Module 3: Synthesising, Analysing and Reporting Data

Data synthesis, reporting, identifying long-term goals, determining preconditions needed to achieve the goals, linking interventions to results, identifying indicators of results and producing a narrative to summarize changes, issues and challenges.

Suggested Readings:

1. Communication for Development and Civil Society, V.S. Gupta, 2004, Concept
2. Information and Communication Technology: Reinvesting Theory and Action (2Volumes), Kiran Prasad, 2009, BRPC
3. Media, Communication and Development: Three Approaches, Linje Manyozo, 2012, Sage
4. Participatory Communication: Working for Change and Development, S.A. White, 1994, Sage
5. Participatory Communication Paolo Mefalopulos and Thomas, Tufte, 2009, World Bank Working Papers
6. Participatory Communication for Social Change (Communication and Human Values), Jan Servaes, Tom Jacobson andShirley a White, 1996, Sage Publications
7. Participatory Video: Images that Transform and Empower, A Shirley White, 2003, Sage India

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO1	H		
CO2		H	
CO3		M	H
CO4			
CO5	H	H	H

MCCA0047: PLANNING MODELS AND COMMUNICATION APPROACHES (3-0-1)

COURSE OUTCOMES

1. Identify the steps in communication strategy development (Remembering)
2. Explain the basic principles and development planning models (Understanding)
3. Analyse the relevance of theoretical frameworks of communication for development (Analyse)
4. Critically analyse the key components of communication strategies (Evaluate)
5. Design and implement C4D programmes (Creating)

Module 1: C4D Planning Models (20 Lectures)

Understanding communication planning, Planning Models: ACADA Model, P-Process, COMBI Model and Integrated Communication, Individual Level Behavioural Change Models: Persuasion Model, Health Belief Model, Stages of Trans-theoretical Model, Issues and Challenges of Social and Behaviour Change Communication (SBCC).

Module 2: Communication Approaches (20 Lectures)

Defining Objectives: Programme Objectives, Behavioural Objectives and Communication Objectives, Dialogue-based approaches, Participatory communication, Communication Plan, Audience Mapping, Segmentation, Channels, Message design–Human-Centric Design (HCD), Message appeal, Message Testing, Material production and Toolkits.

Module 3: Communication Intervention and Strategy (20 Lectures)

Identifying key stakeholders, Preparation of Partnership Plan, Management Plan, Operation Guidelines, Levels of Intervention: Macro, Mezzo and Micro levels, Establishing objectives at multiple levels, Key steps leading to change, Logical Frame, Communication strategy: Advocacy: Effective advocacy, Media Advocacy, Celebrity Advocacy, Legal Advocacy &

Executive/Legislative and Regulatory Advocacy), Social Marketing, Entertainment Education, Peer Education, Capacity and Capability Strengthening, Project Implementation, Feedback and Review.

Suggested Readings:

1. Community Dialogue Toolkit - Supporting Local Solutions to Local Challenges, https://ccednet-rcdec.ca/en/toolbox/community-dialogue-toolkit-supporting-local-solutions-local
2. Celebrity Advocacy and International Development (Rethinking Development, Dan Brockington, 1st Edition, 2014, Routledge
3. Hands-on Social Marketing: A Step-by-Step Guide, Kline Nedra Weirnriech, 1999, Sage
4. Media, Communication and Development: Three Approaches, First Edition, Linje Manyozo, 2012, Sage Publications
5. Methods to support human-centric design, M. Maguire, 2001, International Journal of Human-Computer Studies, 55(4),pp.587-634
6. Social Marketing-Changing Behaviour for Good, Nancy R. Lee and Philip Kotler, 2015, Sage Publications
7. The Limits of Media Advocacy, Communication, Culture and & Critique 3(1):44-65
8. Theory and Principles of Public Communication Campaign, C.K. Atkin and R.E Rice, 2012, Sage
9. The Role of Message Tailoring in the Development of Persuasive Health Communication Messages, in Christina Beck,Editor, Communication Year Book 33, S.M. Noar, G.G Harington and R.S. Aldrich, 2009
10. Writing Health Communication: An Evidence Based-Guide, Charles Abraham and Marieke Kools, 2011, Sage
11. Writing a communication strategy for development programmes, UNICEF, 2007, https://sites.unicef.org/cholera/Chapter_7_communications/UNICEF_Writing_a_Comm_Strategy_for_Dev_Progs.pdf

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO1			H
CO2	H		
CO3	H	H	
CO4			H
CO5	H	H	H

MCMC0048: MEDIA AND CULTURAL STUDIES (4-0-0)

COURSE OBJECTIVES

1. Describe the key concepts of cultural and media studies (Remembering)
2. Understand the cultural dynamics of society with the help of contemporary theory (Understanding)
3. Examine the role of media in mediation of social identity (Analysing)
4. Assess the diverse media and cultural practices (Evaluating)

Module 1: Media and Culture (15 Lectures)

Concept of Culture - meaning; dimensions, Basic theoretical framework - Critical Cultural Theory; Frankfurt School; Chicago School, Mass media and postmodern culture, Culture industries, Popular and mass culture, Multiculturalism and subcultures, Mediated culture, cultural hybridity.

Module 2: Media and Society (15 Lectures)

Media Manufacturing of Culture, Pluralism and Counter-Culture, Mediated Culture, Media & Margins, Media influence on culture, Gender; culture and space, Media and gender.

Module 3: Media, Culture and Identity (15 Lectures)

Identity and Culture, Mediated Identity, Gender, Body and the Culture of Modernity, Contesting Cultures, Techno-Culture, Cyberculture, Media Representations, Under-Representation, Gendered Representation, Visual Pleasure, Internet as a Cultural Platform.

Suggested Readings:

1. Cultural Studies: Texts and Contexts, First Edition, Prantik Banerjee, 2021, Dattsons
2. Communication as Culture, James W. Carey, 2008, Routledge
3. Media and Culture: An Introduction, Campbell, Richard, Martin, Christopher R, and Fabos Bettina, 2011
4. Media and Cultural Studies: Key Works, Gigi Meenakshi Durham and Douglas M. Kellner (eds.), 2006, Blackwell
5. Questions of Cultural Identity, Stuart Hall and Paul Du Gay (ed), 1996, Sage Publications
6. Representation: Cultural Representations and Signifying Practices - Vol. 2 (Culture),1997, Stuart Hall, Sage
7. Sociology of Indian Culture, D.P. Mukerji, 1979, Rawat Publishers
8. What is Cultural Studies? A Reader., John Storey (Ed), John Storey, 2009, Hodder Education

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO1	H	H	H
CO2	H		H
CO3			H
CO4	H	H	

MCFA0049: FILM APPRECIATION (3-0-1)

COURSE OUTCOMES

1. Trace the origin and growth of cinema (Remembering)
2. Explain film structure and film language (Understanding)
3. Differentiate story, plot and subplot (Understanding)
4. Analyse cinema critically (Analysing)
5. Critique various film theories (Evaluating)
6. Develop skills to write film reviews and criticism (Creating)

Module 1: Growth and Development of Cinema (15 Lectures)
Origin and evolution of film - Meaning of cinema, Cinema and society, National and International perspective on cinema, Origin and evolution of film, Thomas Alva Edison, Lumiere Brothers, George Melies, Edwin S. Porter, D.W. Griffith.
Global history of cinema **-** Beginning of cinema in America and Europe, Emerging of Hollywood studios, Growth of cinema in Japan and Latin America, Alternative cinema.
History of Indian cinema **-** Beginning of cinema in India, Hindi cinema, regional cinema, Parallel film movements, Crossover cinema.
History of cinema in Northeast **-** Status of cinema in different states of Northeast, Cinema in Assam, Cinema in Manipur.

Module 2: Film Language, Structure and Narrative (15 Lectures)
Film Structure – Form and content of film, Structure: camera movement, lighting, editing, acting, sound, ComputerGenerated Imagery (CGI), Special effects.
Film Language - Semiotic theory of cinema, signs, symbols, codes, iconography, Mise- en-scene, Montage, Connotative and Denotative meanings.
Film Narrative - Fictional and non-fictional narrative, Significance and structural elements of narrative, Story and plot, Sub-plots, Deviant plot structure, Principles of plot construction.

Module 3: Film Movements, Theories and Genre (15 Lectures)
Film Movements **–** Soviet formalism, Avant garde, German expressionism, Italian neorealism, French new wave, Indian new wave.
Film Theories **–** Auteur theory, Psychoanalytic model, Feminist model, Cognitive model, Ideological model
Film Genre **–** Meaning and functions, Film genre and their characteristics, Classical Hollywood genre, Indian formula films.

Module 4: Technology and Film Criticism (15 Lectures)
Film and technology – Digital technology and cinema, YouTube
Film Criticism – Aesthetics of film, Writing film review and criticism, Film as art, Film Analysis, Textual and contextual analysis of films.

Suggested Readings:

1. Gokulsing, K. Moti & Dissanayake. *Handbook of Indian Cinemas* (Routledge, 2018)
2. Hill, John & Gibson, Pamela Church. *Film Studies* (Oxford Univ. Press, 2000).
3. Ray, Satyajit. *Our Films Their Films* (Orient Publishers, 1993).
4. Roberts, Graham & Wallis, Heather. *Introducing Film* (Arnold Publishers, 2003).
5. Stam, Robert. *Film Theory: An Introduction* (Blackwell Publishers, 2000).
6. Saran, Renu. *History of Indian Cinema* (Diamond Books).

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H			
CO2		H		
CO3		H		
CO4			H	H
CO5			H	H

CO6				H

MCBJ0050: BUSINESS JOURNALISM (3-0-0)

COURSE OBJECTIVES
1. Describe the key terms related to business and finance (Remembering)
2. Understand different forms of business journalism (Understanding)
3. Write business news articles (Creating)

Module 1: Introduction to Business and Financial System (15 Lectures)
Basic knowledge of financial system and institutions, Gathering, distribution and allocation of revenue vis-à-vis Central Government and State Governments; finance commission/department, Central and State budgets: budget-making exercise, how to read a budget, concept of zero deficit budget, importance of Public Accounts Committee, Introduction to Tax Laws, Essential Commodities Act, MRTP, FERA, SEBI, RBI, IMF, Industry Bodies and other Financial Regulatory Bodies, Economic Policies.

Module 2: Basics of Business Journalism (15 Lectures)
Business journalism: Global and Indian context, types of business journalism, media and new trends in business journalism, international money market and new information technology, commercial database, ethics in business reporting – business journalism, servant or watchdog.

Module 3: Writing Business News (15 Lectures)
Sources of news on business, finance and industry – governments, chambers of commerce and industries, corporate, trading and industrial executives, share markets, commodities markets, money markets etc. Government policy decision, company reports, RBI reports; analysis of decisions, reports and statements, Data visualisation tools and presentation, ethics in business journalism.

Suggested Readings
1. Business Newspapers: Economic Times, Financial Express, Business Standard, Observer of Business and Politics, BusinessLine.
2. Business Journalism: A Critical Political Economy Approach, 1st Edition, Ibrahim Seaga Shaw, 2015, Routledge
3. Indian Economic Yearbook, National, Agarwal, A.N. & Verma H.O. New Delhi
4. Business Journalism: How to Report on Business and Economics, 1st Edition, Keith Yayes, Apress
5. Periodicals: Business India, Business World, Business Today, The Economist, Dalal Street Journal, Advertising & Marketing(A & M), Far Eastern Economic Review, EPW
6. Reporting Technical Information, Kennet Houp & Thomas Pearsall, 1984, Macmillan
7. Writing About Business: The New Knight-Bagehot Guide to Economics and Business Journalism, Revised Edition, TerriThomson, 2000

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO1	H		
CO2		H	
CO3			H

MCPM0051: PROJECT MONITORING AND EVALUATION (3-0-1)

COURSE OUTCOMES
1. Identify the data-gathering techniques of communication projects (Remembering)
2. Describe the project monitoring and evaluation processes (Understand)
3. Undertake critical analysis of evaluation data (Analyse)
4. Prepare monitoring and evaluation plans, write reports and communicate findings (Create)

Module 1: Programme Monitoring, Evaluation and Promotion (20 Lectures)
Concept of project Monitoring and Evaluation (M&E), Project cycle, Distinction between M&E, evaluation and impact evaluation, Role of logic models, M&E Plan, Different types of evaluations, Monitoring Outcomes and Assumptions, Measurement of progress, Indicators of change, Impact assessment, Stakeholder Analysis Networks Analysis, Social Support & Recognition, Positionality and ethics, Outcome mapping, Strengths and weaknesses, Promotion of changed/adapted behaviour/results, Testimonial Reminders, Repetition.

Module 2: Data-gathering and Analysis (20 Lectures)
Quantitative and qualitative approaches, survey, community dialogues, interviews, data analysis, use of statistical tools,

Baseline Data, Information Management, interpretation, data visualisation, assessing validity and reliability and determining generalisability of the data, Learning and accountability.

Module 3: Reporting and Documentation of M&E Data (20 Lectures)
Interpretation of M&E data, understand its uses, data preparation, documentation, Types of Records: Process, Narrative and Summary, Problem-oriented Recording, formulating recommendation, Reporting Project Progress and Findings, practicum, Reflective practice - Learning Lessons, Adapting the Plan, Continuous Improvement Communicating the Results.

Suggested Readings:
1. Can we know better? Reflections for development, Chambers, R, 2017, Rugby: Practical Action Publishing
2. How Change Happens, 2016, Oxford: Oxford University Press
3. Outcome Mapping: Building Learning and Reflection into Development Programs, Earl, S., Carden, F. and Stymulo, T., 2001,IDRC
4. Program Evaluation theory and Practice 2nd Edition, D.M. Mertens and Wilson, A. T., 2019, The Guildford Press
5. Planning, monitoring and evaluation in development organisations: sharing training and facilitation experiences, De Coninck, J. 2008, Sage
6. Ten Steps to a Results-Based Monitoring and Evaluation System, Kusek, J. Z. and Rist, R. C, 2004, The World Bank
7. The use and abuse of the logical framework approach, O. Bakewell and A Garbutt, 2005, Sida
8. The ‘Most Significant Change’ (MSC) Technique: A Guide to Its Use, R. Davies and J Dart, 2005

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO1		H	
CO2	H		
CO3	H	H	
CO4	H		H

MCTP6015: TECHNIQUES OF PHOTOGRAPHY AND IMAGE EDITING (0-0-2)

COURSE OUTCOMES
1. Show working knowledge of digital SLR cameras (Remembering)
2. Demonstrate an understanding of composition and image design process (Understanding)
3. Apply image editing and output techniques (Applying)
4. Analyse and critique one’s own artistic output (Analysing)
5. Determine safe and responsible work practices (Evaluating)
6. Create photographic work of acceptable standard (Creating)

Description:
To equip the learners with skills and knowledge about the art of digital photography, to enable the learners to professionally handle DSLR cameras, understand technical concepts from the different shooting modes to aperture and shutter speed; and apply composition techniques from finding effective backgrounds to rule of the thirds., To provide hands-on training on outdoor photography as well as studio photography.
Recommended Assignments:

Suggested Practicum:
Street photography, Landscape photography, Action Photo story, Cityscapes, Studio portrait, Building a Photography portfolio.

Suggested Readings
1. Basics of Digital Images. OIT Academic Computing, PDF.
2. Fundamentals of Photo Composition, Paul R. Comon, Sterling Publications.
3. The DSLR Cinematography Guide, R. Koo, Creative Commons, e-book.
4. Langford’s Basic Photography, Michael Langford, Anna Fox and Sawdon Rechard Smith, Focal Press.
5. Understanding Exposure, Bryan Peterson, Amphoto Books.
6. Mastering Digital Cameras, Al Judge, Createspace Independent Pub.

MCJG6016: JOURNALING (0-0-1)

COURSE OUTCOMES
1. Demonstrate the ability to explore different options for handling daily experiences (Understanding)
2. Develop self-awareness, self-learning and communication skills (Applying)
3. Apply contextual and experiential learning in their everyday lives (Applying)

4. Improve creativity and imagination (Creating)

Description

During these 30 hours of the Course, students are required to maintain a daily reflective journal, using the Visible Thinking Routine as a critical structure for guiding their journal writing. Students are required to do journaling once a week and submit the journal to the assigned faculty member every Friday for analysis. Grades will be awarded for this course on the basis of the journal entries and a presentation at the end of the semester.

Suggested Readings

1. The principal's role in mentor programs, B. Brock, 1999, London: Kogan Pag.
2. Visible thinking: Unlocking causal mapping for practical business results, J. M. Bryson, 2004, Chichester, J. Wiley.
3. Journaling During Research, Kay Debra Logan, 2005, Library Media Connection; Vol. 23 Issue 6, p12
4. Journaling: Telling your professional "story," D. Miller, 2003, Library Media Connection
5. Social Behaviour and Personality, Hung-Yuan Lin and Chi-Hsian Chiang, 2013, In international journal, Volume 41, Number1, 2013, pp. 113-122(10) Scientific Journal Publishers.

MCDI6017: DISSERTATION PHASE – I (0-0-2)

Description

Through this practicum students will be taught the different methods for conducting academic research. It will also teach students to conduct review of literature, prepare synopsis outline, format or structure of report. They will also learn how to add Appendices, such as references to sources of data, instruments of data collection; give Bibliography and footnotes.

The Exercise:

During this 60-hours course, students will have to choose a research topic of their choice, conduct a literature review with bibliography, and develop a research proposal which will be submitted in partial fulfilment for the requirement of Master's degree in Mass Communication. Students will also write and present a research paper.

Recommended Readings

1. Introduction to Mass Communication Research, Natziger, Ralph O. and David M. White. Baton Rouge: Louisiana StateUniversity Press, 1981.
2. Mass Media research: An Introduction, Wimmer, Roger D. and Joseph R. Dominick. Belomnt: Wadsworth.
3. MLA Handbook for Writers of Research Papers, Joseph Gibaldi and Walter S. Achtert New Delhi: Affiliated East-West PressPvt. Ltd., 1994.
4. Research Methods – The Basics, Nicholas Walliman, Routledge, 2011
5. Research Methodology Methods and Techniques, C.R Kothari
6. Research Methods in Social Sciences, O.R Krishnaswamy
7. Research Methods in Mass Communication, Stempel, Guido H. (III) and Bruce H. Westley (Ed). Englewood Cliffs: Prentice- hall Inc, 1981
8. Writing Your thesis, New Delhi: Sage Publications, 2008

MCAV6018: AUDIO-VIDEO PRODUCTION (0-0-2)

COURSE OBJECTIVES

1. Show awareness of safe and responsible work practices (Remembering)
2. Demonstrate an understanding of the audio-video production process (Understanding)
3. Experiment with different types of audio and video production tools (Applying)
4. Develop competency in editing and output techniques (Creating)
5. Create different formats of audio and video programmes (Creating)

The Exercise:

Basics of audio editing, Basics of video editing, Principles of scripting, Audio recording techniques and equipment, Radio Talk show, Radio Commercials, Studio recording, Outdoor recording, Hands-on training on Camera techniques and accessories, Framing and Shot sizes, Lighting techniques for video, Commercials, Video Interview, Live recording techniques.

Suggested Readings

1. Single-Camera Video Production, Robert B Musburger and Michael R. Ogden, 2014, Focal Press
2. Techniques of Radio Production, Robert Mcleish, 2015, Focal Press
3. The Videomaker Guide to Digital Video and DVD Production, Stephen Muratore and Matt York, Focal Press.
4. Video Production Handbook, Jim Owens, 2011, Routledge
5. Writing for Radio and Television in India, Krishnan K. Kedia, Cyber Tech Publications.

MCDP6019 DISSERTATION PHASE – II (0-0-2)

Project Description

During this practicum course students will complete data collection, analysis, preparation of research report and submit the final dissertation. The dissertation has to be systematically structured following proper methodology of communication research. Phase - I of the course is carried out in the 2nd Semester where students work upon research proposals, literature review and research methodology. Students will have to ensure that the dissertation is preparedkeeping in view Intellectual Property Rights, maintenance of research ethics and avoidance of plagiarism. Students are required to make a presentation of the dissertation submitted to the department on the date set by the department.

Suggested Readings:

1. Research Methodology: Methods and Techniques, 4th Edition C.R. Kothari and Gaurav Garg, 2019, New Age InternationalPublishers
2. Methodology of Research in Social Sciences, O.R. Krishnaswamy and M. Ranganatham, 2016, Himalaya Publishing House
3. Writing Your Thesis, Paul Oliver, 2014, Sage Publications, New Delhi
4. Research Methods in Mass Communication, III Stempel, Guido H. and Bruce H. Westley, 1988, Prentice-Hall.
5. Mass Media Research: An Introduction, Roger D. Wimmer and Dominick R. Joseph, 2005, Wadsworth Publishing Co. Inc.
6. Writing Successful Reports and Dissertations (Student Success) 1st Edition, Lucinda Becker, 2014, Sage Publications

MCIP6020 INTERNSHIP (5 Credits – 90 hours)

Description

Students will undertake 4-weeks internships in media and communication organizations during the winter vacation between third semester and fourth semester. They will discuss the choice of media and communication organization with their respective mentors and obtain the consent of the head of the department. Before going for the internship, an *Internship Agreement Contact* form from the concerned organization will be submitted by the student to their respective mentors. After completion each student will submit a copy of the *Internship Completion Certificate* to their mentors from the designated authority of the concerned media and communication organization.

The final evaluation will be on the basis of the following criteria:

a. Journal – 30%
b. Portfolio and Presentation – 50%
c. Written evaluation by the employer – 20%

Journal: Each student will keep a daily journal with an entry for each day spent doing work for the internship. This journal should be e-mailed to the mentor at the beginning of each work week. In this journal the students should summarize the activities and assignments on which the student worked. The student should also keep track of the number of hours for each week.

Portfolio: At the end of the internship, each student is required to prepare a professional portfolio that contains examples of the students' work during the internship. The portfolio will additionally contain a written evaluation of the media organization, employer evaluation of the student, a copy of the internship completion certificate, a one-page summary of the internship.

Employer Evaluation: At the end of the internship the supervising employer will be asked to submit a written evaluation of the student's performance.

Student Evaluation: At the end of the internship the student will be asked to submit a written evaluation of the employer.The department will issue the following to the students:

a. Internship Application Form – to be submitted to the mentor prior to internship.
b. Internship Agreement Contract – to be submitted to the mentor prior to internship.
c. Student Evaluation of the Internship – to be included in the portfolio
d. Employer Evaluation of Intern – to be included in the portfolio

Last date of Internship: To be notified by the department

Portfolio Submission and Presentation: To be notified by the department

MCFP6021 FINAL PROJECT(5 Credits – 90 hours)

Project Description:

Each student is required to submit a project based on her/his area of specialization or any other relevant areas of Journalism and Mass Communication/Advertising/Public Relations etc. They are required to choose the topic of their Final Project in consultation and supervision of the teacher/Mentor of the department and duly approved by the Head of the Department. The

Final Project has to be submitted (two printed in bound form and a soft copy) as per the schedule duly notified by the department.

Suggested Project:
Designing and publication of newspapers/magazines/publicity posters/brochure

Project Evaluation Criteria
- Project activity assessment: 20%
- Evaluation of final project: 60%
- Viva-Voce: 20%

Last date of project submission: To be notified by the department

Portfolio Submission and Presentation: To be notified by the department

VALUE ADDED COURSES

MCCS6122 COMMUNICATION SKILLS (1-0-1)

COURSE OBJECTIVES
1. Identify the different styles of communication (Remembering)
2. Understand how to develop effective speaking skills (Understanding)
3. Evaluate various communication needs (Evaluating)
4. Develop professional oral & written communication skills (Applying)

Module 1: Basics of Communication (5 Lectures)
Essentials of effective Communication, Types & techniques of communication: Verbal & Non-Verbal Communication, Communication in organization, Communication Network in an Organization: Personal Communication, Internal Operational Communication, External Operational Communication.

Module 2: Oral Communication (13 Lectures)
Language in Communication, Phonetics, Spelling, Pronunciation, and Accent, Speech Drills, Oral Communication Skills: Seeking and giving information/suggestions/advice, Offering and responding to offers, Requesting and responding to requests, Congratulating people, Expressing condolences, Asking questions and responding politely, Apologizing and forgiving, Giving instructions, Seeking and giving permission, Expressing opinions, Group discussion, Seeking explanations, Expressing sympathy, Reading Skills: Skimming and Scanning, Levels of Reading, Reading Comprehension, Academic Reading Tips, Listening and speaking skills, Contextualised speaking.

Module 3: Written Communication (12 Lectures)
Writing Skills, Elements of Writing: Sentence, Phrases and Clauses, Forms of Written Communication, Formal & Informal Writing, Letter Writing, Notices, Summary, Note-making, Job application, Preparing a CV/Resume and Effective Profiling, Preparation of Cover letters, preparing for and Facing a Job Interview, Preparing a Presentation, Preparing Agenda and Minutes for Meetings, Writing Notices and Memos, Drafting an E-mail, Correspondence with Government Authorities/institutions, Office Orders, Enquiries and Replies, audience analysis.

Suggested Readings:

1. Business Communication, Meenakshi Raman and Prakash Singh, 2012, Oxford University Press
2. Oxford English Grammar, Sydney Greenbaum, 1996, Oxford University Press
3. Effective Technical Communication, M. Ashraf Rizvi,2005, Tata McGraw Hill
4. Business Communication, Anjanee Sethi & Bhavana Adhikari, Tata McGraw Hill
5. Working in English, Leo Jones,2001, Cambridge University Press
6. Speaking Personally, Gillian Porter Ladousse,1983, Cambridge University Press
7. Communication Skills. Leena Sen, 2007, PHI Learning
8. English phonetics and phonology paperback with audio CDs (2): A practical course, P. Roach, 2009, Cambridge university press.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO1	H	H	H
CO2		H	
CO3	H		
CO4		H	H

MCCW6123 CREATIVE WRITING (1-0-1)

COURSE OUTCOMES
1. Demonstrate understanding on various forms of creative writing (Understanding)
2. Apply the techniques of creative writing for storytelling (Applying)
3. Write contents for various purposes (Creating).

Module 1: Introduction to Creative Writing (10 lectures)
Writing as an Art, Types of writing, Principles of writing, Characteristics of Good Writing, Elements of Writing: Form, Content, Audience, Style & Structure, Meaning of creative writing, Creative process and abilities for writing, Challenges in Creative Writing.

Module 2: Process and Techniques of Creative Writing (10 lectures)
Finding the ideas, sketching the plot, characterization, conflict, climax, resolution, Action Description, Point of View, Dialogue,

setting atmosphere, Using technology in process of writing.

Module 3: Writing Exercises (10 Hours)
Content Writing, Reviews writings, Blogging, Feature and Opinion Pieces, Creative Writing, Short Story, Poetry, Fiction, Essay, Adventure Story, Reflective Writing, Persuasive Writing – Commercials, Figurative Writing, Travel Writing.

Suggested Readings:

1. Creative Writing – How to Unlock your Imagination, develop your writing skills – and get published, 7th Edition, AdeleRamet, 2007, Howtobooks
2. Creative Writing Course Book, Paul Mills, 2006, Routledge
3. The Cambridge Companion to Creative Writing, South Asian Edition, Morley, 2012, Cambridge University Press
4. The Five Minutes Writer, Margret Geraghty, 2007, HowToBook
5. The Cambridge Introduction to Creative Writing, David Morley, 2007, Cambridge University Press
6. The Psychology of Creative Writing, Scott Barry Kaufman and James C. Kaufman (Ed), 2009, Cambridge University Press
7. Word Power: A guide to creative writing, Julian Birkett, 2016, Bloomsbury Academic India
8. Writing on Both Sides of the Brain: Breakthrough Techniques for People Who Write, Henriette A Klauser, 1987, HarperOne

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO1	H	H	
CO2	H	H	
CO3			H

MCEM6124 EVENT MANAGEMENT (1-0-1)

COURSE OUTCOMES

1. Understand the relevance of event management as a professional skill and career option (Understanding)
2. Demonstrate an in-depth understanding of the intricacies of managing an event (Applying)
3. Examine individual and team orientation in event planning and management (Analysing)
4. Plan and organise an event (Creating)

Module 1: Introduction to Event Management (6 lectures)
Concepts and types of events, Understanding and Introduction to the events landscape, Idea generation, Conceptualisation: Techniques/Methods.

Module 2: Event Planning and Administration (8 lectures)
Developing event vision/mission, objectives and goals, Event proposal, Strategic planning techniques: Action Plans; Event Group Sustainability methodologies, Logistics and operations: Use of work plan structures; time-plans; worksheets; Gantt Charts, Legal frameworks: Licenses and Permissions, Event administration strategies, Resource Mobilisation and techniques, financial management.

Module 3: Event Marketing (8 lectures)
Target Group Segmentations: Concepts and Strategies, Strategic and Integrated Marketing Communications for events, Event Branding, Digital marketing and audience building for events, Marketing plan creation; strategies and implementation, Skills for event managers and planners: negotiation and networking skills; image management; leadership.

Module 4: Post Event Documentation and Evaluation (8 lectures)
Documentation: aims; methods and techniques, Event evaluation methodologies, Audience feedback and review mechanisms, developing event follow-up strategies and action plans, Developing the Event Planners Journal.

Suggested Readings:

1. Event Management and Marketing: Theory, Practical Approaches and Planning, 1st Edition, Anukrati Sharma and ShrutiArora, 2018, Bharti Publications
2. Events Management: An Introduction C. Bladen, J. Kennel, 2012, Routledge
3. Event Marketing: How to Successfully Promote Events, Festivals, Conventions and Expositions, Leonard H. Hoyle, 2002,John Wiley and Sons Inc
4. Event Planning, 2nd Edition, J. Allen, 2009, Wiley
5. Event Planning: The Ultimate Guide, J. Allen, 2000, Wiley and Sons.
6. Planning Special Events, J. S. Armstrong, 2001, Josse Bass Wiley
7. Public Relations Campaigns and Techniques, F.R. Matera & R.J. Artigue, 2000, Allyn & Bacon
8. Special Events: A New Generation and the Next Frontier, 6th Edition, J. Goldblatt, 2010, Wiley.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	H			
CO2	H	H	H	H
CO3		H		H
CO4	H	H	H	H

SERVICE LEARNING

MCLS0100: COMMUNITY MEDIA (2-0-0)

COURSE OUTCOMES
1. Define and explain service learning and participatory approach to social development (Remembering)
2. Classify the different types of community media (Understand)
3. Utilise community media for social change and development (Applying)
4. Analyse storytelling formats and content about development issues (Analyzing)
5. Identify opportunities for discussing development issues using community media (Evaluating)
6. Produce content for community media (Creating)

Module 1: Introduction to Service-Learning (5 Lectures)
Concept of Service Learning— definition, principles, models of different Higher Education Institution Service Learning; Service Learning as a medium of social change.

Module 2: Understanding Community and Community Participation (5 Lectures)
Understanding Community, Participatory approach to social development; Principles of community participation; Participatory Rural Appraisal.

Module 3: Community Media and Community Engagement (5 Lectures)
Understanding Community Media, Types, Purpose, Relevance and Significance, Skills, tools and Techniques of community media, Practices of Community Media, Participatory communication, socio-cultural media, Communication for Social and Behaviour Change, ethical issues.

Module 4: Community Practicum and Learning Activities (15 Lectures)
Internship, Community Mobilisation, Awareness/Advocacy campaign, folk performances, community meetings, rural reporting, community radio programmings, community video, case studies.

Suggested Readings:
1. A to Z in Projects Cycle Management: A Results Based Approach, P. J. Lukose, 2015, Media House Publications, New Delhi
2. Community Media: International Perspectives, Kinda K. Fuller, 2007, Plagrave Macmillan
3. Community Media: People’s, Places, and Communication Techniques, Kevin Howley, 2005, Kindle Edition
4. Hand Held Vision: The Impossible Possibilities of Community Media, D. D. Halleck, 2002, Fordham University Press
5. Media, Communication and Development: Three Approaches, Linje Manyozo, 2012, Sage India
6. Methods for community participation: A Complete Guide for Practitioners, S. Kumar, 2002, New Delhi: Vistaar
7. Other Voices: The Struggle for Community Radio in India, Vinod Pavarala and Kanchan K Malik, 2007, Sage Publications
8. Participatory Development Practice: Using Traditional and Contemporary Frameworks, A Kelly and P. Westoby, 2018,London: Practical Action Publishing
9. Rural development: putting the last first, R. Chambers. R, 1983, New Delhi: Routledge
10. Service learning in higher education: concepts and practices, B. Jacoby, 2010, Michigan: Jossey-Bass Publishers
11. Service-learning: History, Theory and Issues, B. W. Speck and S. L Hoppe, 2004, Connecticut: Greenwood Publishing Group

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO1	M			
CO2		M	M	
CO3			H	H
CO4			H	H
CO5			H	H
CO6			H	H

DEPARTMENT OF PSYCHOLOGY

VISION

To be a centre of excellence in teaching, learning, research and in the practice of psychological counselling, thereby promoting community mental health and psychosocial competence in order to foster cohesion in the society.

MISSION

1. Department of psychology and counselling Assam Don Bosco University seeks to:
2. Achieve excellence in teaching, learning, research, practice and extension activities.
3. To nurture and develop the counselling skills of the students.
4. To prepare competent counsellors who are socially committed and culturally sensitive and are bound by the ethics of the profession.
5. To create an environment committed to promoting the application of science of psychological counselling to real world situation.

PROGRAM OUTCOMES – MSC PROGRAMME

PO 1: Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO 2: Effective Communication: To build on effective inter and intra personal communications skills including empathy. Open mindedness, mutual respect, Confidence, effective listening, non-verbal communication, clarity and concision.

PO 3: Scientific Temper: To build essential skills of different ways of life including questioning observing, physical reality, testing, hypothesizing, analyzing and communicating

PO 4: Effective Citizenship: Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO 5: Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

PO 6: Environment and Sustainability: Building a contemporary state of art model using the theories of social sciences for sustainable development of the campus/environment.

PO 7: Gender Sensitization and Social Commitment: To bring about a change in behavior and attitude and to instill empathy in the students to raise awareness about the gender equality concerns and to imbibe the sense of social responsibility for self and community to envisage ethical framework, obligation to work and cooperate with other individuals and organizations for the benefit of the society at large

PO 8: Self-Directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes

PROGRAM SPECIFIC OUTCOMES – MSC PSYCHOLOGY

PSO 1: Knowledge and Attitude: To develop budding counselling psychologists who will be able to understand and demonstrate behavior, have attitudes in the basic areas of professional counseling.

PSO 2: Research and Analytical Skills: Will be able to demonstrate competence in analysis and critically anlayse scholarly work in areas of research, consultancy and counseling practice.

PSO 3: Application: To equip students with knowledge in the fundamentals of psychology and counseling so that they

PSO 4: understand the application of the field relating to different issues in psychology.

PSO 5: Core Competency Skills: To enhance the core counseling skills, such as active listening, empathy, unconditional positive regard, congruence and so on and empowering the process of human development.

PSO 6: Ethics: To demonstrate the technical skills and ethical decisions appropriate for the holistic professional development in the field.

MAPPING OF COURSES WITH POS/PSOS

Sl. No.	Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5
1.1	Theories of Personality	H	H	L	H	H	M	H	H	H	L	H	H	H
1.2	Concepts of Mental Health and Illness-I	M		M		M	H		L	M		M	M	M
1.3	Research Method and Statistics in Social Sciences		H	M	M			M	L	H		H	H	M
1.4	Cognitive Psychology	H	H	H	M	M		H	M	H	H	H	H	M

1.5	Eastern Approaches to psychology and Counseling	M	L	M	L	M	L	L	L	H	M	H	H	M
1.6	General Psychology	M	L	H	L	M	L	M	M	H	M	L	M	M
1.7	Practicum-I	H	L	H	M	H	l	M	M	H	M	H	H	H
1.8	Personal Growth	M	H		M	M	H	M	L		L	L	M	
2.1	Concepts of Mental Health and Illness-II		M	L	L	H	M	H	H	H	L	H		M
2.2	Bio-psychology	H	L	H	L	M	L	L	L	H	M	L	M	H
2.3	Psychological Testing	H	L	H	L	H	L	L	M	M	H	M	L	H
2.4	Health Psychology	H	L	M	L		L	M	M	M	M	L	H	M
2.5	Introduction to Social Psychology	M	H	M	H	M	M	M	L	M	M	M	H	M
2.6	Practicum-II	H	L	H	L	M	L	M	M	H	M	H	M	H
2.7	Field Work	H	H	M	H	M	H	M	H	H	M	H	H	H
2.8	Psychological First Aid	M	M	M	L	M			L	L	L	M	M	M
	Counselling Psychology Specialization													
3.1	Foundations of Counselling Psychology	M	M	M	L	H	L	L	M	H	M	M	H	M
3.2	Child and Youth Counselling	M	L	M		L		M	M	H	M	M	H	M
3.3	Disability and Rehabilitation Psychology	M	H	M	L	H	L	H	M	H	M	H	H	H
3.4	Practicu m-III	H	L	H	L	M	L	M	M	H	M	H	M	H
3.5	Summer Internship ip	H	H	M	H	H	H	M	H	H	M	H	H	H
3.6	Study Tour	M	H	L		M	M	H	H	H	L	H	M	M
3.7	Supervised Internship I	H	H	M		M	M			H	M	H	M	
3.8	Research Project Phase I	M		M					M		H	M		L
4.1	Addiction and Trauma Counselling	H	M	M	L	M	L	M	M	H	M	H	H	H
4.2	Marriage and Family Counselling	M	L	M	M	M		M		L	L	M	H	M
4.3	Practicum-IV	H	L	H	L	M	L	M	M	H	M	H	M	H
4.4	Supervised Internship II	M		L		M			M	L			M	
4.5	Research Project Phase II	H		H		H			M		M	L		M
	Clinical Psychology Specialization													
3.1	Foundations of Clinical Psychology	M	M	M	L	H	L	L	M	H	M	M	H	M
3.2	Psycho diagnostics	M	L	M		L		M	M	H	M	M	H	M
3.3	Forensic Psychology	M	H	M	L	H	L	H	M	H	M	H	H	H
3.4	Practicum-III	H	L	H	L	M	L	M	M	H	M	H	M	H
3.5	Summer Internship	H	H	M	H	H	H	M	H	H	M	H	H	H
3.6	Study Tour	M	H	L		M	M	H	H	H	L	H	M	M
3.7	Supervised Internship I	M	H	M	M	H	L	H	M	H	M	H	H	H
3.8	Research Project Phase I	H		H		H	M		M		M	L		M
4.1	Psychotherapy	H	M	M	L	M	L	M	M	H	M	H	H	H
4.2	Neuropsychology	M	L	M	M	M		M		L	L	M	H	M
4.3	Practicum-IV	H	L	H	L	M	L	M	M	H	M	H	M	H
4.4	Supervised Internship II	M	H	M	M	H	L	H	M	H	M	H	H	H
4.5	Research Project Phase II	H		H		H	M		M		M	L		M

MSc PSYCHOLOGY –DETAILED SYLLABUS

PCSP0006: INTRODUCTION TO SOCIAL PSYCHOLOGY

(3 Credits – 45 hours)

Course Outcomes

1. Define the basic concepts of social psychology in different contexts. (Remembering)
2. Explain different concepts of social processes, social influence, group dynamics and group influence. (Understanding)
3. Apply the theoretical concepts of social psychology into real life settings. (Applying)
4. Analyze the difference between social perception and social cognition as well as prejudice, stereotype, discrimination. (Analyzing)
5. Compare different types of groups and their functional systems. (Evaluating)
6. Discuss various social problems in light of the theoretical concepts of social psychology. (Creating)

Module I: Introduction (8 hours)

Social Psychology - Definition, Nature, Origin and Development, Social Psychology in Indian context.

Module II: Social Processes (12 hours)

Social perception or cognition, interpersonal attraction, social motives, social learning, socialisation and social roles, pro-social behaviour, aggression and violence.

Module III: Social Influences (12 hours)

Persuasion, attitude, prejudice, discrimination and stereotypes - nature and differences among them. Factors in the formation of attitudes, measuring attitudes, factors in attitude change.

Module IV: Group Dynamics and Group Influence (13 hours)

Formation of groups, structure and functions, types, group communication, group norms, conformity behaviour, co-operation and competition, social facilitation, leadership, group effectiveness, decision making, problem solving, group conflict and resolution.

Suggested Readings

1. Baron, R., A., Byrne, D., Social Psychology, New Delhi: Prentice Hall,10th Edition (2006).
2. Mc David and Harai, Social Psychology; Individuals, groups, societies, Harper and Row (1968).
3. Moghaddam, F.M., Social Psychology: Exploring Universals Across Cultures, Freeman and Company (1997).
4. Dalal, Ajit K., A. Misra, Girishwar (Eds)., New Directions in Indian Psychology, Social Psychology, New Delhi: Sage(2001).
5. Eckes, Thomas and Trautner, Hanns M. (Eds.), The Developmental Social Psychology of Gender, Mahwah: Lawrence Erlbaum Associates, Publishers (2000).
6. Hogg, Michael A. and Cooper, Joel (Eds), The Sage Handbook of Social Psychology, Concise Student Edition, Los Angeles: Sage (2007).
7. Misra, Girishwar (Ed.), Applied Social Psychology in India, New Delhi: Sage (1990).
8. Pandey, Janak (Ed.), Psychology in India Revisited – Developments in the Discipline, Vol. 3: Applied Social and Organisational Psychology, New Delhi: Sage (2001)
9. Sharan, A.K. Social Psychology, New Delhi: Commonwealth Publishers (1999).
10. Linda steg, Abraham p. Buunk, applied social psychology: Understanding and managing social problems

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2	M	M	M	
CO 3		H	H	H
CO 4			H	H
CO 5		H	H	H
CO 6	H			

PCEC0013: EASTERN APPROACHES TO PSYCHOLOGY AND COUNSELLING

(3 Credits-45 Hours)

Course Outcomes

1. Define the basic terms related to the different eastern approaches of psychology. (Remembering)
2. Classify among Indian/Chinese/Japanese approaches to psychology. (Understanding)
3. Make use of the appropriate Indian/Chinese/Japanese approaches to psychology in applied settings. (Applying)

4. Examine ancient and contemporary eastern approaches of psychology. (Analysing)
5. Recommend the suitable approach in applied settings. (Evaluating)
6. Develop a clear understanding of eastern and western approaches to Psychology. (Creating)

Module I: Introduction (7 hours)
Definitions, nature, differentiation of concepts-eastern, indigenous and Indian psychology; relationship between culture and psychology, emergence of non-western and indigenous perspectives to psychology.

Module II: Major Schools of Indian and Eastern Psychology (20 hours)
Indian approaches to Psychology-Upanishads, Sankhya, Dvaitha and Advaitha schools; current areas of research in Indian psychology. Chinese approaches to psychology - Taoism and Confucianism, Japanese approaches to Psychology -Morita and Naikan therapies.

Module III: Self and Consciousness (10 hours)
Viewpoints of Upanishads, Bhagavadgita, Buddhism and Jainism and other Eastern schools of thought.

Module IV: Indian and other Eastern Approaches to Health and Wellbeing (8 hours)
Yoga, Ayurveda, goals of life-concept of purusharthas, personality development-concept of Ashramas

Suggested Readings

1. Bankart, C. P. (1996). Talking cures: A History of Western and Eastern Psychotherapies. Pacific
2. Grove, CA: Brooks/Cole.
3. Ajaya, S. (1983). Psychotherapy East and West. Honesdale (PA): Himalayan International Institute.
4. Berry, J. W., Poortinga, YpeH. And Pandey, J. (1997). Handbook of cross-cultural psychology, T" Edition, Vol.1 Theory and method. Boston: Allyn and Bacon. (Chapters3,4and8byJ.G.Miller,D. Sinha, P.M. Greenfield)
5. Jones-Smith, E. (2012). Theories of counselling and psychotherapy: An integrative approach.
6. Thousand Oaks, CA: Sage.
7. Garg, Pulin K. K. and Parikh, I. J. (1995). Crossroads of culture: a study in the culture of transience, New Delhi: Sage.
8. Kakar.S.(1982). Shamans, mystics and doctors: A psychological enquiry into India and its healing traditions. Bombay: Oxford University Press.
9. Paranjpe, A. C. (1998). Self and identity in modern psychology and Indian thought. New York: Plenum.
10. Dunn, B. R., Hartigan, J. A., and Mikulas, W. L. (1999). Concentration and mindfulness meditations: Unique forms of consciousness? Applied Psychophysiology and Biofeedback, 24 (3), 147-165.
11. Kuyken, W., Byford, S., Taylor, R. S., Watkins, E., Holden, E., White, K., Barrett, B., Byng, R., Evans, A., Mullan, E., and Teasdale, J. D. (2008). Mindfulness-based cognitive therapy to prevent relapse in recurrent depression. Journal of Consulting and Clinical Psychology, 76(6), 966-978.
12. Segal, Z. (2008). Finding daylight: Mindful recovery from depression. Psychotherapy Networker, (Jan/Feb).

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	H	H	H
CO 2		H	M	H
CO 3		H	M	H
CO 4	H	M	M	M
CO 5		H		H
CO 6	H			

PCTP0020 THEORIES OF PERSONALITY
(4 Credits- 60 hours)

COURSE/LEARNING OUTCOMES

At the end of this course students will be able to:
1. Define personality. (Remembering)
2. Explain the rationale behind the theories of personality. (Understanding)
3. Identify the impact of environment and genetics in development of personality. (Applying)
4. Analyse modifications of self in perceiving environment. (Analysing)
5. Assess the relation between cultural and personality. (Evaluating)
6. Compare and contrast various perspectives of personality. (Creating)

Module I: Introduction to Personality (10 hours)
Definition and Nature of personality; Trait and Type Theories of Personality; Determinants of personality: Biological and socio-

cultural- Hans Eysenk, Gray and Cloninger.

Module II: Classical approaches to Personality Development (20 hours)
Pre- Freudian (Structuralism- any two theorists; Functionalism- any two); Psychoanalytic; Post Freudian (Erikson; Eric Fromm); Neo- Freudian (Adler; Horney; Jung); Ego Psychology (Anna Freud; Hartmann; Rapapport)

Module III: Learning, Cognitive and Humanistic-Existential Approaches (20 hours)
Learning Approaches: Bandura
Cognitive Approaches: Rotter, Mischel
Humanistic–Existential Approaches: Frankl, Rollo May, Maslow, Rogers.

Module IV: Assessment of Personality (10 hrs)
Projective Tests- Ink blot test, Thematic Apperception Test, Sentence Completion TestObjective Tests; MMPI-II, 16PF, EPQ

Suggested Readings

1. Atkinson, R. L., Atkinson, R. C., Smith, E. E., Bem, D. J. and Hilgard, E. R. (1990).
2. Introduction to Psychology. New York: H. B. J. Inc.
3. Sternberg, R. J. (2010). Cognitive Psychology. New York: Cengage Learning
4. Passer, M.W. and Smith, R.E.(2010). Psychology: The Science of Mind and Behavior. New Delhi: Tata McGraw-Hill.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	H	H	M
CO 2	H	H	H	M
CO 3		M	M	
CO 4	M	H	H	H
CO 5	M	H		M
CO 6			M	H

PCMH0021 CONCEPTS OF MENTAL HEALTH AND ILLNESS-I

(4 Credits - 60 hours)

COURSE OUTCOMES

1. Define mental health and illnesses and list categories of mental illness as specified in DSM and ICD (Remembering)
2. Classify and categorise mood disorders, obsessive compulsive and related disorders, anxiety disorders(Understanding)
3. Apply diagnostic criteria of mood disorders, obsessive compulsive and related disorders, anxiety disorders to diagnose individuals with mental illnesses and select the appropriate psychological intervention for different childhood, adolescent and adult mental health related issues (Apply)
4. Analyse the distinction between normality and abnormality. Distinguish clinical features of different mental illnesses. (Analysing)
5. Evaluate Bio Psycho Social models and other models of mental health and illness. (Evaluate)
6. Create a management plan for patients on the basis of clinical features, diagnosis criteria and therapist competence. (Creating)

Module I: Introduction (10 hours)
Definition of mental illness and mental health. Historical review and changes in the concept of mental illness and mental health. Introduction to classification systems (DSM and ICD)

Module II: Models of Psychopathology (15 hours)
BioPsychosocial, Psychoanalytic, Behavioristic, Cognitive- Behavioral, Humanistic, Diathesis-Stress Model

Module III: Mood Disorders (Symptoms, Etiology and Treatment (15 hours)
Unipolar Depressive Disorders in different population. Bipolar and Related Disorders in different population.

Module IV: Anxiety and Related Disorders (Symptoms, Etiology and Treatment) (10 hours)
Phobias in different population: specific phobia and social phobia. Generalised Anxiety Disorders in different population. Obsessive Compulsive and Related Disorders in different population: Obsessive Compulsive Disorder, Body Dysmorphic Disorder, Hoarding Disorder, Trichotillomania

Module V: Somatic Symptoms and Dissociative Disorders (Symptoms, Etiology and Treatment) (10 hours)
Somatic Symptom Disorder, Functional Neurological Disorder, Factitious Disorder, Dissociative Disorder: Dissociative Identity Disorder, Depersonalisation Disorder, Derealisation Disorder

Suggested Readings

1. Diagnostic and Statistical Manual of Mental Disorders (DSM-5), 2013 American Psychiatric Association.
2. Robert C.Carson, James N. Butcher, Susan Mineka, Jill M. Hooley, Abnormal Psychology, Pearson 13th edition,
3. Sarason, Irwin G. a. Sarason Barbara R. Abnormal Psychology. The Problem of Maladaptive Behaviour. New Delhi: PHI Learning Private Limited, 11th Edition, (2009).
4. Ahuja, Niraj, A Short Textbook of Psychiatry,New Delhi: Jaypee, 6th Edition, (2006).
5. Antony, John D., Mental disorders, Encountered in Counselling, A Textbook of clinicalPsychology Based on DSM IV, Dindigul: Anugraha Publications, (2006).
6. Chaube, S.P., Developmental Psychology, New Delhi: Neelkamal, (2007).
7. Gilbert, Paul, Psychotherapy and Counselling for Depression, Los Angeles: Sage, 3rd Edition (2007).
8. Humphrey, Geraldine M. A. Zimpfer David G. Counselling for Grief and bereavement. 2nd Edition. Los Angeles: Sage, (2008).
9. Korchin, Sheldon, J., Modern Clinical Psychology, Principles of Intervention in the Clinic and Community. New Delhi: CBS Publishers and Distributors, (1986).
10. Kumar Updesh and Mandal Manas K. (Eds)., Suicidal Behaviour, Assessment of People-at- Risk. Los Angeles: Sage, (2010).
11. Patel, Vikram. Where There is No Psychiatrist. A mental health care manual. Glasgow: Gaskell, (2003).
12. Patel, Vikram A. Thara. R. (Eds.). Meeting The Mental Health Needs of Developing Countries. NGO Innovations in India. New Delhi: Sage, (2003).

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H				
CO 2			M	M	
CO 3			H		H
CO 4		H			
CO 5		H			
CO 6	H				H

PCRM0022: RESEARCH METHODOLOGY AND STATISTICS IN SOCIAL SCIENCE

(4 Credits- 60 hours)

COURSE/LEARNING OUTCOMES

1. Define the basic concepts of research and recognize the philosophical foundations of research. (Remembering)
2. Understand the steps in conducting research and the major research designs. (Understanding)
3. Analyse the collected data in research using different statistical measures. (Analysing)
4. Apply research design, tools and statistical measures to carry out research in social sciences. (Applying)
5. Compare natural and social sciences as well as the different approaches and research designs most commonly used in social sciences research. (Evaluating)
6. To create a research proposal using indicating appropriate research design method of data collection and statistical computation. (Creating)

Module I: Introduction to Research (10 hours)

Philosophical Foundations of Research. Natural and social science research-characteristics and scientific attitude. Scope of social science research-basic and applied research; Ethical concerns in Counselling research.

Module II: Research designs, approaches and types (12 hours)

Research designs: Descriptive, Exploratory, and Experimental: meaning, scope, characteristics, application in social work setting. Research Approaches: Qualitative and Quantitative Research: meanings, scope, methods, steps, sampling, data collection, analysis, interpretation and reporting. Strengths and weaknesses.

Evaluative research: Programme and projects evaluation: concept, types, steps, reports. Participatory research and action research: concepts, scope, application and steps.

Module III: Steps in Research Process (20 hours)

Problem Formulation: Identifying research issue, formulating research topic and problem, review of literature (library work), theoretical framework, formulating objectives, clarifying concepts, variables- conceptual and operational, formulating hypothesis.

Population and Sampling: Inclusion and exclusion criteria of population, the logic of sampling size and techniques: probability and non-probability sampling.
Tools for data collection: Levels, types of measurements, reliability, and validity of tools.
Constructing tools for data collection: questionnaire, interview schedule, scales. Quantification of qualitative data.
Sources, collection, and analysis of data: Secondary and primary sources. Data collection, data editing, coding, mastersheet, analysis, report writing, using computer for data analysis: coding, analysis- graphs and results.
Professional report writing

Module IV: Introduction to Statistics (18 hours)
Statistics: Definitions, uses, and limitations. Classification, and tabulation of data, univariate and bivariate, diagrammatic and graphic presentations. Measures of central tendencies, Mean, Median, and Mode and their uses. Measures of variability range, variance, and standard deviation.
Correlation: Meaning and computation of coefficient of correlation as product moment, Spearman's Rank Correlations, interpretation of correlations.
Test of Hypotheses: Basics, Probability distribution, normal distribution. t-test, Chi-Square test and ANOVA.

Suggested Readings

1. Ahuja, R. (2001). *Research Methods*, Jaipur:Rawat.
2. Alston, M. Bocoles, W., (2003). Research in Social Workers: An Introduction to the Methods (Indian ed.), Jaipur:Rawat.
3. Baker, T. L. (1994). *Doing Social Research*, Singapore: McGraw Hill.
4. Goode, W. J. and Hatt, P. K. (1981). *Methods in Social Research*, Singapore: McGraw Hill.
5. Gupta, S. C. (1997). *Fundamentals of Statistics*, Delhi: Himalaya Publishing House.
6. Gupta, S.P. (1997). *Statistical Methods*, New Delhi: Sultan Chand and Sons.
7. Jacob, K.K., Methods and Fields of Social Work in India, Asia Publishing, Bombay, 1996
8. Kothari, C. R. (2004). *Research Methodology: Methods and Techniques*, (2nd ed. reprint), New Delhi: New AgeInternational.
9. Laldas, D.K. (2000). *Practice of Social Research*, Jaipur: Rawat.
10. Mikkelsen, B. (2005). *Methods for Development Work and Research-A New Guide for practitioners,* New Delhi: Sage.
11. Sarantakos, S. (2005). Social Research, New York: Palgrave Macmillan.

Mapping of COs to Syllabus

Course Outcomes	**Module I**	**Module II**	**Module III**	**Module IV**
CO 1	H	M	M	
CO 2		H		
CO 3				H
CO 4			H	
CO 5		H		
CO 6		M	H	M

PCCP0023 COGNITIVE PSYCHOLOGY

(4 Credits-60 Hours)

Course Outcomes

1. Define the basic concepts of cognitive psychology, identify major theoretical foundations and recognize the historical background of cognitive psychology. (Remembering)
2. To understand the relationship between mind, brain and behaviour. (Understanding)
3. To analyse the scope and application of cognitive psychology. (Analysing)
4. To use measures of cognitive psychology in research and practice. (Applying)
5. To evaluate different cognitive methods, tools and their appropriate applicability. (Evaluation)CO6 To develop an understanding of the scope and application of cognitive psychology. (Creating)

Module I: Introduction to Cognitive Psychology (10 Hours)
Definition, history of cognitive psychology and emergence of cognitive science, current trends.
The Brain and Cognition: Basic neuroanatomical principles, modern techniques for exploring cognition (EEG, fMRI, PET), cognitive experiments, Emotional Intelligence, Artificial Intelligence.

Module II: Memory Processes (15 Hours)
Sensory Memory, Short Term and Long-Term Memory- types, coding and retrieval;Working Memory: Nature, Theories,

Educational Applications.

Semantic and Episodic Memory: Semantic vs Episodic Memory; Level of Processing and Hierarchical Network model.
Prospective Memory: Types and Common Failures of Prospective Memory in Everyday life. Forgetting: Incidental and Motivated

Forgetting.

Module III: Attention & Perception (20 Hours)
Basic Concepts of Attention: Divided Attention, Selective Attention, Visual Attention and Auditory Attention. Bottleneck and Capacity theories, Automatic and Controlled Processing, Brain and Attention.
Modularity of Perception: Visual Perception (Form and Pattern), Space Perception and Cognition, Auditory Perception, Multimodal Perception, Synesthesia, Perception and Action.
Subliminal Perception; Gestalt Approach of Perceptual Organisation, Time Perception: Fourth Dimension, Pattern Recognition: Bottom Up and Top-Down Approach, Perceptual Learning, Depth Perception.

Module IV: Thinking, Problem Solving and Decision Making (15 Hours)
Types of thinking, Components of thinking: images, concepts, Creativity.Decision Making: Complex, Uncertain Decision Making; Human Problem Solving: Strategies and Heuristics.

Suggested Readings
1. Galotti, K.M. (2013). Cognitive Psychology In and Out of the Laboratory (5th ed.). Sage Publications Inc.
2. Kellogg, R.T. (2007). Fundamentals of Cognitive Psychology. Sage Publication.
3. Matlin, M. W. (2006). Cognition. John Wiley & Sons, Inc.
4. Riegler, G.L.R. (2008). Cognitive Psychology: Applying the Science of the Mind. Pearson Education.
5. Jahnke, J.C., & Nowaczyk, R.H. (1998). Cognitive Psychology. Prentice Hall.
6. Matlin, M. W. (1995). Cognition. Prism Book.
7. Reed, K.S. (2000). Cognition: Theory and Applications. Wadsworth.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	H	H	H
CO 2	H	H	M	M
CO 3	H		M	M
CO 4	M	H	H	
CO 5	M	M	M	
CO 6	H			M

PCGP0024: GENERAL PSYCHOLOGY
(3 credits – 45 hours)

Course/Learning Outcomes
1. Define psychology, name the different fields of psychology, list the different areas in which psychology is applicable. (Remembering)
2. Understand how the visual and auditory systems work. (Understanding)
3. Apply the theories of learning to modify behavior and application of different strategies for memory improvement. (Applying)
4. Analyse the strengths and weaknesses of the important theories of psychology. (Analysing)
5. Evaluate the contribution of psychology in different fields. (Evaluating)
6. Create a basic idea of personality and the important theories of personality. (Creating)

Module I: Introduction to Psychology (6 hours)
Introduction - Definition, nature, history, scope, purpose, and sub-fields of psychology Applications of psychology - stress and stress management, coping, well-being, resilience

Module II: Biological Basis of Behavior (10 hours)
Nervous System: Neuron and its structure, types of nervous system,Endocrine system: Hormones and their functioning Sensory systems: Structure and function of eye and ear.

Module III: Cognitive Processes (11 hours)
Learning: Classical Conditioning, Operant Conditioning, Latent, Insight, Observational learning.
Memory: Models of memory - Atkinson & Shiffrin, and Craik and Lockhart, Mnemonics, Forgetting - decay and interference
Intelligence: Spearman's, Sternberg's, and Gardner's theories of intelligence

Module IV: Conative and Affective Processes (10 hours)
Emotion: Definition and theories of emotions (James-Lange, Cannon-Bard and Schachter-Singer).
Motivation: Motivational Cycle, types of motives (sociogenic and psychogenic), theories of motivation (Content theories: Maslow, and Herzberg's 2 factor theory; Process theories: Bandura's self-efficacy theory, and Vroom's expectancy theory).

Module V: Theories of Personality (8 hours)
Trait & Type approaches, Psychoanalytic, Neo-Freudian (Jung, Adler), Existential (Frankl), and Humanistic theories (Rogers).

Suggested Readings:

1. Baron, R. A. & Misra, G. (2014). *Psychology (5th ed.,),* New Delhi: Pearson Education.
2. Ciccarelli, S. K., White, J. N., and Misra, G. (2018). *Psychology*, New Delhi: Pearson Education.
3. Morgan, C. T., King, R. A., Weisz, J. R., and Schopler, J. (2017). *Introduction to Psychology (7th ed.,)*. New Delhi: Tata McGraw-Hill.
4. Nolen-Hoeksema, S., Fredrickson, B. L., Loftus, G. R. and Lutz, C. (2015). *Atkinson and Hilgard's Introduction to Psychology (16th ed.,)*. New York: Harcourt Brace Jovanovich.

Mapping of COs to Syllabus

Course Outcomes	**Module I**	**Module II**	**Module III**	**Module IV**	**Module V**
CO 1	H				
CO 2		H			
CO 3			H		
CO 4		H	H	H	H
CO 5	H				
CO 6					H

PCCM0025: CONCEPTS OF MENTAL HEALTH AND ILLNESS-II

(4 Credits – 60 Hours)

Course Outcomes

1. Define mental illnesses. (Remembering)
2. Classify and categorise developmental disorders, schizophrenia, personality disorders, substance related disorders,eating disorders and neurocognitive disorders. (Understanding)
3. Apply diagnostic criteria categorise developmental disorders, schizophrenia, personality disorders, substance related disorders, eating disorders and neurocognitive disorders to diagnose individuals with mental illnesses. (Applying)
4. Analyse the distinction between normality and abnormality. Distinguish clinical features of different mental illnesses. (Analysing)
5. Explain the causal factors of mental health and illnesses. (Evaluating)
6. Create a management plan for patients on the basis of clinical features, diagnosis criteria and therapist competence. (Creating)

Module I: Introduction (10 hours)
Causal Factors of abnormal behavior: Causes and Risk Factors for Abnormal BehaviorClinical Assessments and diagnosis and treatment

Module II: Developmental Disorders (Symptoms, etiology and treatment) (15 hours)
Intellectual Disability
Autism Spectrum DisordersADHD
Learning Disabilities

Module III: Major Psychological Disorders (Symptoms, etiology and treatment) (15 hours)
Schizophrenia Spectrum Disorders
Personality Disorders

Module IV: Substance related and eating disorders (Symptoms, etiology and treatment) (10 hours)
Substance Related Disorders
Eating Disorders

Module V: Neurocognitive and Sexual Disorders (Symptoms, etiology and treatment) (10 hours)
Delirium
Dementia
Sexual dysfunctions

Suggested Readings:

1. Barlow D.H. and Durand V.M. (2005). Abnormal Psychology: An Integrated Approach (4th Ed.).Wadsworth: New York. Bennett,P. (2006). Abnormal and Clinical Psychology: An introductory textbook. New York: Open University Press.
2. Carson, R.C., Butcher,J.N.,Mineka,S.& Hooley,J.M. (2008). Abnormal Psychology. New Delhi: Pearson.
3. Kearney, C. A. & Trull, T. J. (2012). Abnormal Psychology and Life: A dimensional approach. New Delhi : Cengage

learning.
4. Kring,A.M.,Johnson,S.L.,Davison G.C. & Neale J.M. (2010). Abnormal Psychology (11th Ed.).NY: John Wiley
5. Diagnostic and Statistical Manual of Mental Disorders (DSM- IV TR), 2000 American Psychiatric Association.
6. Robert C.Carson, James N. Butcher, Susan Mineka, Jill M. Hooley, Abnormal Psychology, Pearson 13th edition.
7. Sarason, Irwin G. a. Sarason Barbara R. Abnormal Psychology. The Problem of Maladaptive Behaviour. New Delhi: PHI Learning Private Limited, 11th Edition, (2009).
8. Ahuja, Niraj, A Short Textbook of Psychiatry,New Delhi: Jaypee, 6th Edition, (2006).
9. Antony, John D., Mental disorders, Encountered in Counselling, A Textbook of clinicalPsychology Based on DSM IV, Dindigul: Anugraha Publications, (2006).
10. Chaube, S.P., Developmental Psychology, New Delhi: Neelkamal, (2007).
11. Gilbert, Paul, Psychotherapy and Counselling for Depression, Los Angeles: Sage, 3rd Edition (2007).
12. Humphrey, Geraldine M. A. Zimpfer David G. Counselling for Grief and bereavement. 2nd Edition. Los Angeles: Sage, (2008).
13. Korchin, Sheldon, J., Modern Clinical Psychology, Principles of Intervention in the Clinic and Community. New Delhi:CBS Publishers and Distributors, (1986).
14. Kumar Updesh and Mandal Manas K. (Eds)., Suicidal Behaviour, Assessment of People-at- Risk. Los Angeles: Sage, (2010).
15. Patel, Vikram. Where There is No Psychiatrist. A mental health care manual. Glasgow: Gaskell, (2003).
16. Patel, Vikram A. Thara. R. (Eds.). Meeting The Mental Health Needs of Developing Countries. NGO Innovations inIndia. New Delhi: Sage, (2003).

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H				
CO 2	M	M	M		
CO 3		H	H	H	H
CO 4			H	H	
CO 5		H	H	H	H
CO 6	H				H

PCBP0026: BIO-PSYCHOLOGY

(3 Credits- 45 hours)

COURSE OUTCOMES

At the end of this course students will be able to:
1. Identifying biological bases of behavior. (Remembering)
2. Associating the role of the nervous system with behavior and emotions. (Understanding)
3 Examining the impact of bio chemicals in behavior and mental health at a conceptual level. (Applying)
4. Mapping the biological markers of individual difference. (Analyzing)
5 Reflecting on genetic and chromosomal bases of psychopathology. (Evaluating)
6. Develop conclusions on biological assessment of behavior. (Creating)

Module I: Introduction to Bio-psychology (7 hours)

History and scope; Major theoretical perspectives: Rene Descarte, Phinaes Gage, Charles Darwin. Nature versus Nurture controversy; Sub disciplines and allied fields; Methods in Bio Psychology.

Module II: Neurons and Genetic bases of behavior (10 hours)

Structure of neuron; Nerve impulse and Synaptic transmission; Neurotransmitters; Types of neuron.
Genetic bases of behavior: Structure of a gene, DNA and Chromosomes, Types and Functions of Genes, Genotype and Phenotype.

Module III: Nervous System (10 hours)

Central Nervous System: Brain and Spinal Cord.
Peripheral Nervous system: Division; Role of nervous system in controlling behavior.

Module III: The Endocrine System and behavior (10 hours)

Endocrine glands; Hormones; Role of endocrine system on emotions and behavior.

Module IV: Neuropsychological diseases (8 hrs)

Parkinson’s disease, Huntington’s disease, Alzheimer’s disease, Chromosomal anomalies.

Suggested Readings:

1. Carlson, N. R. (2012). Foundations of physiological psychology. (Sixth Edition). Delhi: Pearson Education.
2. Passer, M.W. and Smith,R.E.(2010).Psychology:TheScienceofMindandBehaviour.NewDelhi: Tata McGraw-Hill
3. Breedlove, S. M., Rosenzweig, M. R., & Watson, N. V. (2007) Biological Psychology: An introduction to behavioral, cognitive, and clinical neuroscience, 5th Edition. Sinauer Associates, Inc., Sunderland, Massachusetts.
4. Green, S. (1995). Principles of biopsychology. UK: Lawrence Erlbaum Associates Ltd.
5. Pinel, J. P. J. (2011). Biopsychology, 8th Edition. Pearson Education, New Delhi.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	H	H	
CO 2		H	M	
CO 3		H	H	M
CO 4	H	M	H	H
CO 5	H			H
CO 6	H		M	

PCPT0027: PSYCHOLOGICAL TESTING

(4 Credits - 60 hours)

Course Outcomes

1. Define the basic concepts of psychological testing. (Remembering)
2. Classify the group and individual techniques of psychological testing. (Understanding)
3. Make use of different statistical concepts in data analysis. (Applying)
4. Examine the results of the statistical data analysis. (Analysing)
5. Recommend the suitable tool for data collection/interview in applied settings. (Evaluating)
6. Test the psychometric properties of a tool and develop a psychological tool using appropriate norms of toolconstruction. (Creating)

Module I: Introduction to Psychological Testing (9 hours)

History of Psychological Testing; Definition and Purpose and relevance of Psychological testing, Types of tests, Principles, Applications and Issues, Ethical and Social Considerations in Testing

Module II: Test Construction (15 hours)

Steps in test construction, Item Writing: types of items, General guidelines for item writing, Characteristics of a good psychological test:Objectivity, Standardization, Reliability:Meaning,Types of Reliability and Factor influencing Reliability. Validity: Meaning,Type of validity and Factors influencing validity. Norms: Norm referenced and criterion referenced tests, Types of Norms and Test Scales.

Module III: Assessment of Cognitive Abilities (13 hours)

Measurement of Intelligence:Types of Intelligence tests, Individual intelligence tests, Other broad range intelligence tests, Group intelligence tests, Psychological issues in intelligence testing Longitudinal studies, Problems in cross cultural testing

Module IV: Assessment of Personality (13 hours)

Measurement of Personality: Meaning and Purpose,Tools of Personality Assessment, Measurement of Interests, Values and Attitudes,Projective Techniques:Meaning and Types of Projective Techniques, Classification and Evaluation of Projective Techniques

Module V: Assessment of Aptitude and Achievement (10 hours)

Aptitude and Achievement:Distinction between Aptitude and Achievement Tests, Types of Aptitude tests, Types and selection of standardized Achievement Tests, Achievement test batteries.

Suggested Readings

1. Anastasi, A. and Urbina, S.Psychological testing. N.D.: Pearson Education (1997)..
2. Kaplan, R.M. and Saccuzzo, D.P.Psychological Testing: Principles, Applications, and Issues. Australia: Thomson Wadsworth (2007).
3. Gregory, R.J.Psychological testing: History, principles and applications. New Delhi: Pearson Education (2005).
4. Singh, A.K.Tests, Measurements and Research Methods in Behavioural Sciences. Patna: BharatiAiken, L.R., and Groth Marnat, G. (2006). Psychological Testing and Assessment. Boston, MA: Pearson (12th ed.) (2006).

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5

CO 1	H	H			
CO 2			H	M	H
CO 3		H			
CO 4		H			
CO 5		M	H	H	H
CO 6	M	H			

PCHT0028: HEALTH PSYCHOLOGY

(3 Credits 45 hours)

COURSE/LEARNING OUTCOMES

At the end of this course students will be able to:

1. Define the basic terms related to the field of health psychology. (Remembering)CO2 Learn the approaches to changes in health behavior(Understanding)
2. ake use of psychological research methods, theories, and principles to enhance biopsychosocial approaches forhealth promotion and illness prevention. (Applying)
3. Examine the stressors and its impact on the etiology and course of many health related problems. (Analyzing)
4. Estimate the management of various health related disorders. (Evaluating)
5. Devise policies of health care delivery system beneficial to the public. (Creating)
6. Develop awareness about the stressful impact of disabling/life-threatening illness on the patient and their familymembers as well as the health care providers. (Creating)

Module I: Introduction to Health Psychology (10 Hours)

Definition and emergence of health psychology. Need for health psychology. Research in health psychology: Experiments, Correlational Studies, Prospective and Retrospective Designs, Role of Epidemiology

Module II: Models of Health Behavior (8 Hours)

Health Belief Model, Cognitive Behavioral Approaches, Transtheoretical Model of Behavior Change

Module III: Health conditions and its Psychological Management (15 Hours)

Post Traumatic Stress Disorder, Cancer, COVID-19, Pain

Module IV: Heath Care Services (12 Hours)

Health Care Delivery System: Developing vs. Developed nations. Patient-Provider Communication and Patient in Hospital Setting: Adults, children and children with special needs. CAM treatment (Prayer, Meditation, Guided Imagery) and Placebo Effect. Wellbeing of healthcare providers.

Suggested Readings

1. Taylor, S. E. Health Psychology (8th Edition). New York: McGraw Hill. (2012).
2. Ghosh, M. Health Psychology-Concepts in Health and Well-being. New Delhi: Dorling Kindersley (India) Pvt. Ltd. (2015).
3. Khatoon, N. Health Psychology. New Delhi: Dorling Kindersley (India) Pvt. Ltd. (2012).
4. Taylor, S. E., & Sirois, F. M. Health psychology. Toronto: McGraw-Hill Ryerson. (2012).
5. Baum, A., Revenson, T. A., & Singer, J. E. (Eds.). Handbook of health psychology. Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers. (2001).

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2		H		
CO 3	H			
CO 4			H	
CO 5				H
CO 6				M
CO 7				H

PCFP0029: FOUNDATIONS OF COUNSELLING PSYCHOLOGY

(4 Credits, 60 Hours)

Course Outcomes

1. Define the basic concepts of counselling psychology, identify major theoretical foundations and recognize thehistorical background of counselling psychology. (Remembering)
2. To understand the professional therapist-client relationship in a therapeutic setting. (Understanding)
3. To analyse the scope and application of counselling psychology. (Analysing)
4. To use the therapeutic skills of counselling psychology in practice. (Applying)
5. To evaluate different counselling models, therapeutic skills and their appropriate applicability. (Evaluation)
6. To develop an understanding of counselling skills, therapies and ethical guidelines of counselling practice. (Creating)

Module I: Introduction (10 Hours)
Meaning, Definition & Goals, Historical Background, Mental health development & the guidance movement, Difference between Counselling and other associated helping professions (psychotherapy, psychiatry, social work, guidance), Modern Trends in Counselling.

Module II: Counselling Process (10 Hours)
Settings for counselling, Steps in counselling, Therapeutic relationship: The importance of relationship, components of relationship, Facilitative conditions for the counselling relationship.

Module III: Counselling Approaches & Therapeutic Techniques (25 Hours)
Psychodynamic Approach: Psychoanalytic, Adlerian approach. Humanistic Approach: Existential, Client-Centered, Gestalt Therapy. Behavioural Approach: Operant-Conditioning, Classical-Conditioning.Cognitive Approach: Cognitive Therapy, Rational emotive therapy.
Other Approaches: Narrative Therapy, Expressive Therapy, and Biofeedback.

Module IV: Counselling Practice (15 Hours)
Ethical Issues: Professional Codes, Divided loyalties, Areas of ethnical difficulty, Legal considerations. Conception of a professional Counsellor, Academic preparation, practical skills.
Special Areas in Counselling: Family group consultation – Counselling with families, children as well as parents, Adoption, Marriage & Pre-marital Counselling.
Counselling diverse population: Gender, counselling for geriatric clients, the ethnic minorities, and the physically challenged.

Suggested Readings
1. Ladany, N. & Inman, A. (2008) Handbook of Counseling Psychology, (4th ed.). John Wiley & Sons.
2. Warters, J. (1964): Techniques of Counselling, (2nd ed.), MacGraw Hill Book Company.
3. Steffler, B. (Ed.) (1965): Theories of Counselling, New York: MacGraw Hill Book Company.
4. Alam, Shah (2012). Modern Concept of Guidance & Counseling. Gyananda Prakashan.
5. Bordin, E. S. (1985): Psychological Counselling. Appleton Century Crofts, Inc.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H		H	
CO 2		M		H
CO 3	H	H	M	M
CO 4			H	M
CO 5			H	M
CO 6			H	H

PCCY0030: CHILD AND YOUTH COUNSELLING
(4 Credits- 60 hours)

Course/Learning Outcomes
1. Define the basic concepts and goals of child counseling (Remembering)
2. Understand the specific issues faced by children and youth, especially pertaining to education, and career. (Understanding)
3. Apply the skills and techniques of counselling in child and youth-counselor relationship (Applying)
4. Compare and contrast among the major learning styles models and theories in counseling (Analyzing)
5. Appraise the significance of the child-counsellor relationship, and major theories in the counseling process.(Evaluating)
6. Build on the traditional views of learning styles models and improve counselling skills. (Creating)

Module I: Introduction (12 hours)
Definitions and goals of counseling for children and youth; Children and Youth-counsellor relationship, attributes of a counsellor, historical background and contemporary ideas about counselling

Module II: Academic Development (12 hours)
Learning-styles: VAK Model, Kolb's Experiential Model, MBTI Pattern, Honey and Mumford Model, Hemispheric Dominance Model, Gregorc Model, Gardner's Multiple Intelligence Model.
Study skills: reading, writing and note-making skills, studying skills and study habits, time management
Cognitive issues: causes and factors affecting attention, concentration, remembering, forgetting, experimental evidences and cognitive training

Module III: Major Theories in Counselling Children (14 hours)
Learning, Behavioural, Cognitive Behavioural Modification, Expressive therapy (play, art and drawing, drama, metaphor, storytelling)

Module IV: Counselling Children with specific problem (12 Hours)
Children and trauma: child abuse (physical, sexual, emotional), HIV/ AIDS, specific issues in educational settingsTechniques of assessment: Cumulative record, Anecdotal Record, Case Study, Sociometry

Module V: Career Counselling (10 hours)
Basic aspects: Nature, scope and importance of career counselling, role of counselor in career preparation, career decision making, career exploration techniques
Career development theories: Holland, Ginzberg, and Super
Career counselling with diverse population: children, adolescents, college students, women and adults.

Suggested Readings

1. Asch, M. (2000). *Principles of guidance and counselling* (1 ed.). New Delhi: Sarup and Sons.
2. Bowe Frank, G. (2000). *Birth to Five – early Childhood special education*, New York, Delmar Publishers Inc.
3. Butler, G., and Hope, T. (1997). Managing your mind: The mental fitness guide. Oxford University Press.
4. Cohen, L. G., and Spenciner, L. J., (2003). Assessment of Children and Youth with Special Needs. Boston: Allyn and Bacon.
5. Mangal S. K. (2008). Essentials of Educational Psychology, New Delhi, Prentice Hall of India Pvt ltd.
6. Santrock, J.W. (2003). *Educational Psychology*. Boston: McGraw-Hill.
7. Woolfolk, A. (2007). *Educational psychology (10th ed*.). Boston, MA: Allyn and Bacon.

Mapping of COs to Syllabus

Course Outcomes	**Module I**	**Module II**	**Module III**	**Module IV**	**Module V**
CO 1	H				
CO 2	M			H	
CO 3					H
CO 4		H			
CO 5			H		
CO 6	M	H	M		M

PCDR0031: DISABILITY STUDIES AND REHABILITATION PSYCHOLOGY
(4 Credits - 60 hours)

COURSE OUTCOMES
1. Define the concept of rehabilitation and list the methods of assessment and interventions for various disabilities (Remembering)
2. Illustrate the scope of rehabilitation psychology (Understanding)
3. Plan assessments and interventions for various learning, intellectual and physical disabilities and apply the models of rehabilitation in practice (Applying)
4. Analyse the general functions of rehabilitation psychology (Analysing)
5. Compare and conclude on the prevention and early intervention for various disability (Evaluating)
6. Modify the flaws in the successful implementation of various acts related to disability (Creating)

Module I: Introduction (15 hours)
Definition and models of disability. Definition and functions of rehabilitation (general and specific functions). Historical background of Rehabilitation Psychology. Behavioral problems and adaptive behavior

Module II: Cognitive and Academic disability (18 hours)
Intellectual Disability: review of terminology, diagnostic criteria, causes, prevalence, prevention, assessments, intervention and rehabilitation.
Learning disabilities: diagnostic criteria, types, causes, prevalence, prevention, assessments, intervention and rehabilitation.

Autism Spectrum Disorder: diagnostic criteria, types, causes, prevalence, prevention, assessments, intervention and rehabilitation.
Psychotic disorders: diagnostic criteria, types, causes, prevalence, prevention, assessments, intervention and rehabilitation.

Module III: Physical Disability (15 hours)
Hearing impairment: types, causes, prevalence, prevention, assessments, intervention and rehabilitation. Visual impairment: types, causes, prevalence, prevention, assessments, intervention and rehabilitation. Orthopaedic impairment: types, causes, prevalence, prevention, assessments, intervention and rehabilitation.

Module IV: Legal issues (12 hours)
The Mental Health Act, 2017: historical background and challenges. RPWD Act, 2016: historical background and challenges. RCI Act, 1992 : historical background and challenges. National Trust Act, 1999: historical background and challenges. Issues of certification

Suggested Readings
1. Tom Meehan Chris Lloyd, Robert King,, Handbook of Psychological Rehabilitation, Blackwell Publisher (2007)
2. Sonnenmeier. R, Mirenda. P,Autism spectrum Disorder and AAC (2008)
3. The professional Practice of rehabilitation counselling, Springer Publication company, 2011
4. Jeanne. B. Patterson,Foundations Of Rehabilitation Counselling with Person who are blind or visually impaired,American foundation for the blind, U.S (1997)
5. James K. Luiselli, Dennis C. Russo, Walter P. Christian, Effective Practice for children with Autism: Educational and Behavioural support Intervention that work (2008)
6. KimEtheringon, rehabilitation counselling in physical and mental health, Jessica Kingsley publication
7. David. R. Cox, Speciality Competencies in Rehabilitation Psychology (2002)
8. T. F. Rigger, Handbook of Rehabilitation Psychology.
9. Jules M. Rothstein, Serge H. Roy, Steven L. Wolf, The rehabilitation specialist 's Handbook (2005).
10. Chaturvedi, T.N. Administration for the Disabled: Policy and Organisational Issues. New Delhi : I.I.P.A (1981).
11. Mani, R.D. The Physically Handicapped in India Policy and Programme New Delhi: Ashish Publishing (1988).

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2		H	H	
CO 3	M			
CO 4			M	
CO 5				
CO 6				H

PCAT0032 ADDICTION AND TRAUMA COUNSELLING
(3 Credits- 45hours)

COURSE OUTCOMES
1. Define substance related disorders according to the classification of DSM 5/ICD-10. (Remembering)
2. Compare and contrast different psychological interventions for addiction related psychological disorders.(Understanding)
3. Categorize the sources of trauma and trauma intervention. (Analysing)
4. Apply psychological interventions and techniques on trauma victims. (Applying)
5. To evaluate the effectiveness of Psychodynamic approach, CBT, MET, Group intervention in dealing with substance addiction. (Evaluating)
6. Create need based and behavioral management plan for patients with addiction and trauma survivors. (Creating)

Module I: Addiction Counselling (8 hours)
Definition, DSM-V diagnostic category – classification of drugs of abuse, stages of addiction

Module II: Treatment Methodology (15 hours)
Psychodynamic approaches, cognitive-behavioural therapies, motivational enhancement therapy. Problem-oriented treatment, solution-focused treatment, group therapy, family therapy and community based interventions.

Module III: Psychological Trauma (12 hours)
Introduction to Trauma: Definition, types of trauma, historical context of trauma, theoretical contexts of trauma counselling. Ethical perspective on trauma work, trauma and supervision.

Module IV: Trauma Intervention (10 hours)

Assessment in psychological trauma: Methods and intervention, models for trauma intervention, strategies and techniques for counselling survivor of trauma.

Suggested Readings

1. Rasmussen, S. (2000). Addiction treatment: Theory and Practice. London: Sage.2) DSM-V (2013)
2. Wright, H. N. (2003). *The new guide to crisis and trauma counseling*. Gospel Light Publications.
3. Levers, L. L. (2012). *Trauma counseling: Theories and interventions*. Springer Publishing Company.
4. Trauma counselling - Theories and Interventions,LopezLevers, Lisa
5. Spiers, T. (Ed.). (2018). *Trauma: a practitioner's guide to counselling*. Routledge.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2		H	M	H
CO 3			H	H
CO 4			M	H
CO 5		H		
CO 6		H		H

PCMF0033: MARRIAGE AND FAMILY COUNSELLING

(4 Credits – 60 hours)

Course Outcomes

1. Define the basic concepts of marriage and counselling. (Remembering)
2. Classify different developmental and emotional issues in different family life stages. (Understanding)
3. Identify the classical schools of marriage and family counselling. (Applying)
4. Analyse the Bowen's intergenerational approach. (Analysing)
5. Explain different therapeutic approaches of marriage and family counselling. (Evaluating)
6. Discuss the processes of counselling couples with special issues/problems. (Creating)

Module I: Introduction (10 lectures)

Historical evolution of Family and Marriage therapy; Goals of Family therapy; current trends in Family therapy; Fundamental concepts in Family therapy(Cybernetics and Systems theory, Social Constructivism) Stages of marriage, Divorce and remarriage, Marriage and Divorce: Role of Family Courts.

Module II: Family Across a Lifespan (16 lectures)

The family life cycle, stages of family life cycle. Key developmental and emotional issues in different stages: Young adulthood. Newly married, Child bearing, Families with preschool children, Families with school age children. Families with teenage children, Launching stage, Middle aged adult, Retirement

Module III: Classical Schools (12 lectures)

Bowen's Intergenerational Approach; Structural Family Therapy; Strategic Family Therapy; Experiential and Humanistic Family Therapies; Psychoanalytic and Cognitive Behavioural Family therapy.

Module IV: Recent Developments (12 lectures)

Postmodernism, Feminist and contextual work, Solution focused therapy, Narrative therapy, Integrative models. Application and evaluation of Family therapy. Skill development: Genograms. The stages of Family therapy: Planning; Assessment; Disengaging or recontracting.

Module V: Counselling Couples with Special Issues (10 lectures)

Treating sexual abuse and physical abuse issues in family; Counselling of alcoholics and drug-addicts; Counselling the terminally ill and patients with HIV/AIDS.

Data Communications and Networking, 4th Edition, Behrouz A Forouzan, 2007, TMH

Suggested Readings

1. Family Therapy – concepts and methods,7th edition, Nichols, P.M and Schwartz C.R. Allyn and Bacon, Boston,2006, Pearson education, Inc.Press,Inc .
2. Family Therapy: History, Theory, and Practice, 4th Edition, Gladding, S.T. , 2006,Pearson/Merrill Prentice Hall.
3. Essential Skills in Family Counselling, JoEllen Paterson, et al. 2009, New York, New York, Guilford Press.
4. Mastering Competencies in Family Therapy: A Practical Approach to Theory and Clinical Case Documentation ,3rd Edition, Gehart,D.R., 2018,Cengage Unlimited.
5. Transformational Systemic Therapy, 4th Edition, Satir.V. Satir, 2008, Science and Behaviour Books .

6. Patterns of Brief Family Therapy: An Ecosystemic Approach, 5th Edition, Steve de Shazer., 1982, GuilfordPublications.
7. Transformational Systemic Therapy, Satir.V. Satir, 2008, Science and Behaviour Books.
8. The Family Crucible: The Intense Experience of Family Therapy, Napier, A.Y and Whitaker, C. , 1988,

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	M				
CO 2		H			
CO 3			M	H	
CO 4					
CO 5	M				H
CO 6		H			

PCFC0034 FOUNDATION OF CLINICAL PSYCHOLOGY

(4 Credits-60 hrs.)

Course Outcomes

1. Definition of clinical psychology, acquire knowledge and understanding the philosophical roots and historical events that have shaped the field of clinical psychology (Remembering)
2. Explore the underlying philosophical assumptions, individual contributors, and various forces that served to shape the emerging field of clinical psychology (Understanding)
3. Demonstrate familiarity with scientific, ethical, legal, and practice-oriented issues in the field (Applying)
4. Acquire a basic understanding of western (and, to an extent, Indian) philosophical thought, to articulate a philosophyof their own, and apply that philosophy to their professional work in field of clinical Psychology (Applying)
5. Think critically about the science of psychology, analyse psychological theory, research, and practice in a historicalcontext, and develop ideas, critiques, and conclusions of their own (Analysis)
6. Adapt and develop a basic understanding about assessment and interventions in the context of clinical psychology (Creating)

Module-I- (12 hours) Basic Introduction to Clinical Psychology

Definition, Historical background: Early & Recent history; Nature and scope of the discipline: Theory and research; Developing a professional identity: Education & training, professional activities, ethical issues and employment settings.

Module – II (12 hours) Major theoretical models in clinical psychology

The role of theory; and theoretical models; Psychodynamic; Cognitive-Behavioural; Humanistic; Family systems.

Module- III (18 hours) Diagnostic Techniques

Nature and purpose of clinical interview, mental status examination; Observing behaviour, clinical judgement; communication strategies, diagnosis and assessment, Behavioural assessment, Psychological Assessment: Cognitive and Personality Assessment and case study

Module- IV (18 hours) Competencies in Clinical Psychology

The core competencies: Assessments, Evaluation, Formulation, Intervention, Communication/consultation, and service delivery, Therapeutic Models (Behavioural approaches, cognitive therapy and cognitive-behaviour therapy, Psychodynamic therapy, Systemic and group approaches, Eclectic and integrative approaches)

Suggested Readings

1. Hecker, J. E., & Thorpe, G. L. (2011). Introduction to Clinical psychology: Science,
2. practice, and ethics, 4th ed. India: Dorling Kindsley.
3. Korchin, J. S.( ). Modern clinical psychology: Principles of intervention in the clinic
4. and community. CBS Publishing
5. Pomerants, A. M. (2008). Clinical Psychology: Science, practice and culture. New Delhi: Sage publication
6. Gregory, R. J. (2000). Psychological testing: History, principles, and applications (3rd Ed.). Boston: Allyn & Bacon.
7. Wolman, B.B. (1965). Handbook of clinical psychology. N.Y: McGraw Hill INC
8. Groth-Marnat, G. (1999). Handbook of psychological assessment, 3rded. New York: John Wiley & Sons, Inc.

Course outcomes (COs) Mapping

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M		
CO 2	M	H	M	M
CO 3	M		H	

CO 4	M	H	H	
CO 5		H	M	H
CO 6	M	H	H	H

PCPG0035: PSYCHODIAGNOSTICS

(4 Credits: 60 hours)

COURSE OUTCOMES

1. Define the concept of assessment (Remembering)
2. Gather the significance and scope of psychological assessment in diagnosis and intervention (Understanding)
3. Apply various approaches of assessment in practice (Applying)
4. Estimate the appropriate assessments for different population as per the diagnoses. (Analysing)
5. Assess the socio-cultural factors in various assessments aiding in the diagnoses. (Evaluating)
6. Design psychopathology formulation which will impede the process of effective therapeutic sessions. (Creating)

Module I: Introduction to psychological assessment (15 hours)

Traditional approaches to assessment. Stages in psychological assessment. DSM 5 and ICD-10: Similarities and differences. Screening and Diagnostic tools

Module II: Clinical Interviewing (15 hours)

Types of Clinical Interview. Rapport formation and communication strategies. Diagnostic Interviewing. Interviewing with children and cultural issues

Module III: Intellectual and Neuropsychological assessment (15 hours)

Theories of intelligence, issues and controversies. Tests batteries: WAIS, WISC, MISIC, BKT. Approaches to neuropsychological assessment. Test batteries: Halstead-Reitan, Luria-Nebraska, PGI-BBD, AIIMS Comprehensive Neuropsychological Battery

Module IV: Behavioral and Personality Assessment (15 hours)

Development of Behavioral Assessment. Functional Analysis and other methods of behavioral assessments (Questionnaires, Self-monitoring, Analogue techniques etc.). Objective methods of personality assessments: MMPI-2, MCMI-III, EPQ-R. Projective methods of personality assessments: Rorschach, TAT, Projective drawings

Suggested Readings

1. Hecker,J.E., & Thorpe,G.L. (2005). Introduction to clinical psychology: Science, practice, and ethics (Low Price Edition). Delhi: Pearson Education.
2. Pomerantz, A.M. (2008). Clinical Psychology: Science, practice, and culture. Sage Publications: New Delhi
3. Trull,T.J., & Phares,E.J. (2001). Clinical psychology: Concepts, methods, and profession (6th ed.). Belmont,CA: Wadsworth/Thomson
4. Arun Kumar, (ed.), Clinical Psychology, Anmol Publication Pvt. Ltd., 2000.
5. Freedman, A.M., Kaplan, H.I. and Sadock, B.J., Comprehensive Text Book of Psychiatry (IIIrd Edition) Vol. 1.2. William and wilkins, Batrmore, London, 1989.
6. Anastasi, A., & Urbina, S. (2005). Psychological Testing. 7th ed. Pearson Education: New Delhi, India.
7. Barlow, D.H. & Durand, V.M. (2005). Abnormal psychology: An Integrative Approach (4th ed.). Wadsworth/Thompsons. Belmont CA.
8. Butcher J.N; Mineka Susan; and Hooley Jill M. (2014) Abnormal Psychology (15th Ed.) Dorling Kindersley Pvt. Ltd. of Pearson Education. New Delhi, India.
9. Sundberg, N.D., Winebarger, A.A.& Taplin, J.R. (2002). Clinical psychology: Evolving theory, practice and research. Prentice-Hall. New Jersey.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2			H	
CO 3			H	
CO 4		H		H
CO 5		H		
CO 6		H		H

PCRP0036 FORENSIC PSYCHOLOGY

(3 credits – 45hours)

Course Outcomes
1. Define forensic psychology and the role of a Forensic Psychologist. (Remembering)
2. Illustrate on the nature of crime. (Understanding)
3. Examine the social, psychological theories of crime. (Analysing)
4. Apply the methods of forensic psychological investigation. (Applying)
5. Explain the concept of Juvenile delinquency, sexual offenders and serial offenders. (Evaluating)
6. Create an idea about the importance of Forensic psychological assessment into practice. (Creating)

Module I: Introduction (11 hours)
Meaning, nature and definition of Forensic Psychology, Historical background, training of a Forensic psychologist, Ethical concerns in Forensic Psychology.

Module II: Theories of crime (12 hours)
Need for scientific understanding of crime, psychoanalytical conceptualization of crime, Eysenck's biosocial theory of crime social learning theory of crime, frustrated induced criminality, Neuropsychological theories of crime

Module III: Juvenile offenders and Sexual offenders (10 hours)
Nature and definition of Juvenile offenders, sexual offenders and serial offenders, Social risk factors, Psychological risk factors, family background, Intelligence and delinquency

Module IV: Forensic Psychological Investigation methods (12 hours)
Methods in Forensic Investigation-Polygraph, Brain electrical Oscillations Signature, Narcoanalysis, Applicability of Rorschach Inkblot Test, MMPI-II, Draw-a-Person Test in forensic settings.

Suggested readings

1. Nagel.Y.K.,Srivastava K.,Gupta A (2014) Handbook of Forensic Psychology. Author house UK ltd 1663 Liberty Drive. Bloomington, IN 47403. USA
2. Horton N.A., Heritage.C.L.(2010). Handbook of forensic Neuropsychology. Springer Publishing company. New York

Mapping of COs to Syllabus

Course Outcomes	Module-1	Module-2	Module-3	Module-4
CO1	H			
CO2	H	H		
CO3	H		H	
CO4			H	
CO5	M			H
CO6				H

PCPC0037: PSYCHOTHERAPY
(4 Credits – 60 hours)

Course Outcomes
1. Define psychotherapy. (Remembering)
2. Classify and categorise major disorders with respect to psychotherapy. (Understanding)
3. Apply psychotherapeutic concepts and constructs to diagnose and intervene individuals with mental illnesses.(Applying)
4. Analyse the distinction among different types of psychotherapy. (Analysing)
5. Evaluate the applicability different types to psychotherapy to mental health and illnesses. (Evaluating)
6. Create a psychotherapeutic intervention plan for patients on the basis of clinical features, diagnosis criteria andtherapist competence. (Creating)

Module I: Introduction (8 hours)
Historical background of psychotherapy; Principles and goals of psychotherapy; Professional training and ethics in clinical practice

Module II: Psychodynamic Psychotherapy (10 hours)
Psychoanalysis: Background and basic principles Psychoanalytic theory since Freud
Psychodynamic psychotherapy in contemporary clinical psychology

Module III: Humanistic, Experiential and Family Therapies (12 hours)
Humanistic psychotherapy
Eclectic treatment combinationsFamily therapy
Group therapy

Module IV: Cognitive Behavioural Interventions (15 hours)
Behaviour therapy techniques
Cognitive modification procedures
Cognitive behaviour therapy: specific applications in various psychological disordersDialectic Behaviour therapy

Module V: Relaxation Therapies (15 hours)
Progressive muscular relaxation
Autogenic training
Biofeedback
Eye Movement desensitization and reprocessing

Suggested Readings:
1. Encyclopaedia of Psychotherepy (2002). Academic Press
2. Beck, J.S (1995). Cognitive therapy: Basic and beyond. New York: Guilford Press.
3. Ellis, A. (1970). The essence of rational psychotherapy: A comprehensive approach to treatment. New York: Institutefor Rational Living.
4. Walen, S.R., Digiuseppe, R., & Dryden, W. (1992). A practitioner's guide to rational emotive therapy. Oxford University Press. Inc.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H				
CO 2	M	M	M		
CO 3		H	H	H	H
CO 4			H	H	
CO 5		H	H	H	H
CO 6	H				H

PCNP0038: NEUROPSYCHOLOGY

(3 Credit-45 hours)

Course outcomes (COs)
1. Define the basic concepts of Neuropsychology and naming different biological systems involved in Neurologicaldisorders. (Remembering)
2. Explain the neuropsychological basis of human behaviour. (Understanding)
3. Identify the difference and relation among brain structures, neurological and endocrine systems. (Applying)
4. Classify the sub-systems of the central nervous system of the brain. (Analysing)
5. Compare different neuropsychological systems causing Neuro-pathology. (Evaluating)
6. Discuss the major theoretical perspective, develop the awareness of the neuropsychological basis of behaviour andcan able to formulate rehabilitation. (Creating)

Module-I: Foundation of neuropsychology (15 hours)
Brief history of Neuropsychology, Role of neuropsychology in clinical practice, Early Hypothesis, Localization theory, integrated theory of brain functions,
Major structures and functions of human Brain: Cerebral cortex, Frontal, temporal, parietal and occipital lobes functions and syndromes, Neuro-transmitters.

Module-II: Brain Damage and Neuroplasticity (12 hours)
Causes of Brain damage, Neuropsychological diseases (Stroke, Tumours, Epilepsy, Dementia, Traumatic Brain injury), Animal models of human neuropsychological diseases, Neuro-plastic responses to nervous system damage: Degeneration, Regeneration, Reorganization, and recovery, Neuroplasticity.

Module-III: Neuropsychological Assessments and Diagnosis (12 hours)
General Considerations in Neuropsychological testing, Rationale of the neuropsychological examination, appropriate referrals for neuropsychological evaluation, Psychometric issues in neuropsychological assessment:

Preliminary screening of neuropsychological functioning: Orientation (Arousal), Sensation and Perception, Attention/Concentration, Motor Skills, Verbal Functions/Language, Visuo-spatial Organization, Memory, Judgment/Problem Solving.

Module-IV: Neuro-Psychological Rehabilitation (6 hours)
Basic concepts and models of Neuropsychological rehabilitation (Cognitive, Behavioural, Emotional and Psychosocial),Challenges

ethics and guidelines of Neuro-psychological rehabilitation.

Suggested Readings:

1. Boller, F. &Grafman, J, (1988) Handbook of neuropsychology. New York: Elsevier.
2. Heilman, K.M. & Valenstein, E. (1993). Clinical Neuropsychology. New York: Oxford University Press.
3. Kolb, B., & Whisaw, I.Q. (1990). Fundamentals of human Neuropsychology. New York: Freeman, W.H
4. Pinel, J.P. (2006). Biopsychology. Pearson Education, Inc.
5. Walsh, K. W. (1978). Neuropsychology: A clinical approach. Churchill Livingstone.
6. Rosenzweig, M. R., Breedlove, S. M., & Leiman, A. L. (2002). Biological psychology: An introduction to behavioral,cognitive, and clinical neuroscience. Sinauer Associates.
7. Lezak, M. D., Howieson, D. B., Loring, D. W., & Fischer, J. S. (2004). Neuropsychological assessment. Oxford University Press, USA.
8. Hersen, M. (2004).Comprehensive Handbook of Psychological Assessment: Intellectual and neuropsychologicalassessment (Vol. 1); Personality assessment (Vol. 2); Behavioral assessment (Vol. 3). NY: Wiley

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	H	H	M
CO 2	M	H	H	M
CO 3	H	M	H	H
CO 4	M	H	H	M
CO 5	M	H	M	H
CO 6	H	H		H

PCPG6018 PERSONAL GROWTH I (P/NP)

(2 Credits - Workshop and assignment mode)

Course Outcomes

1. Understand the basic principles of psychology (Remembering)
2. Understand personality traits, values, skills and interests. (Understanding)
3. Gain self-awareness and emotional awareness (Applying)
4. Set specific, achievable short- and long-term goals (Analysing)

Module I: Introduction (15 lectures)

Self esteem, Self awareness, Emotional well being, Self-Motivation

Module II: Introduction (15 lectures)

Critical thinking, Personality development, Communication styles

Suggested Readings

Psychology of Success: Finding Meaning in Work and Life, 5th Edition, Denis Waitley, 2010, McGraw-Hill

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	M			
CO 2		H	M	
CO 3	M	H	H	H
CO 4			H	

PCFA6019: PSYCHOLOGICAL FIRST AID (P/NP)

(2 Credits - Workshop and assignment mode)

Course Outcomes

1. Remember the basic concepts of psychological first aid. (Remembering)
2. Understand the steps of psychological first aid. (Understanding)
3. Gain self-awareness and awareness about emergency care. (Applying)
4. Plan specific, achievable remedial measures (Analysing)

Module I: Introduction (15 lectures)

Definition, Phases, emergency psychological care, mental hygiene.

Module II: Introduction (15 lectures)

Critical thinking, planning emergency psychological intervention.

Suggested Readings

Psychology of Success: Finding Meaning in Work and Life, 5th Edition, Denis Waitley, 2010, McGraw-Hill.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	M			
CO 2		H	M	
CO 3	M	H	H	H
CO 4			H	

PCRP6020 RESEARCH PROJECT PHASE I (4 Credits)

Course outcomes

1. Knowledge of the major theoretical approaches and findings in psychology. (Remembering)
2. Demonstrate knowledge about the research methods used in psychology,. (Understanding)
3. Apply the knowledge for preparing research design, and data analysis. (Applying)
4. Critically analyse information related to the study of behaviour and mental processes, and use the critical assessmentin forming conclusions and arguments. (Analysing)
5. Present and defend opinions by making judgments about information, validity of ideas, or quality of work based on aset of criteria. (Evaluating)
6. Develop the understanding of how to prepare a research proposal. (Creating)

Every student shall undertake a research project work under the supervision and guidance of a faculty member. The student may choose the topic of research and start the preliminary work by the end of the second semester. The students are expected to complete the Literature Review followed by a Literature Review presentation and the Proposal presentation during the Phase I. Students are expected to complete the data collection before the fourth semester.

In Phase II, students are expected to complete the data collection, data analysis and interpretation, and submission of final report. Submission of final copy of the dissertation will be followed by presentation of the research and viva voce examination.

The thesis is to be submitted to the department before the date notified. The mode and components of evaluation of Phase I and Phase II of the research project and the weightages attached to them shall be published by the Department at the beginning of the semester. There shall be a viva voce examination on the research project.

Mapping of COs to Syllabus

Course Outcomes	RESEARCH PROJECT PHASE I
CO 1	H
CO 2	M
CO 3	H
CO 4	H
CO 5	M
CO 6	H

PCSI6021 SUPERVISED INTERNSHIP I

(4 Credits)

Course outcomes
1. Remembering the personal integrity, accountability, professional deportment and concern for the welfare of others. (Remembering)
2. Understanding of Psychological disorders, empathy, reflective practice, and self-care. (Understanding)
3. Applying scientific, theoretical, contextual approach to the discipline (Applying)
4. Analyse the symptom severity and clinical features of disorders. (Analysing)
5. Determine ethical and Legal guidelines of practice (Evaluating)
6. Develop effective work skills, including cognitive and expressive skills, self-directed learning & continuing education. (Creating)

Module I: Introduction
Analysing the situation: Need of counselling, space for counselling, information to clients, documentation, organizing supervision.

Module II: Internship
Taking in clients: first interview, documentation of the case, definition of counselling goals, building the counselling relationship, process of counselling, using skills of counselling, concluding counselling, documentation of the whole counselling process, evaluation; working in a team–role of counselling, resources and challenges, role in the team, case management: discussion, supervision. Evaluation of the internship will be based on the documentation, reports from the organisation, report of the supervisor and the presentation and the viva voce examination of the student at the end of the period of Internship.

Module III: Phases of Supervised Internship
The Supervised Internship is divided into two phases; Phase I and Phase II. Each of these phases consists of 45days (100 hours) of intensive practical learning programs in counselling setting under trained supervisors. The phases of the internship spread across the 3rd and 4th semester of Masters Degree program. The total credit for the supervised internship is divided equally across the final year semesters of the Master's Degree program.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H	M	H
CO 2	H	H	
CO 3	M	H	H
CO 4		H	H
CO 5	H	M	M
CO 6	M	H	H

PCIP6022 SUMMER INTERNSHIP (Pass/Non-Pass)

Students are required to undergo a summer internship of two weeks' during the semester break between the second and third semesters. It is a P/NP course and shall be recorded in the third semester. The Summer Internship gives students an opportunity to apply the theories and principles that they have learnt in class room courses to the "real world" of social service agencies, medical institutions, the criminal justice system, business, and industry. During the internship, students can explore career interests, develop professional skills, learn how community organizations work and expand their clinical and interpersonal skills. The summer internship enriches the students' academic experience while making a valuable contribution to the community and utilizing the vacation optimally.

Course Outcomes
1. Define the clinical features of psychological disorders. (Remembering)
2. Demonstrate fundamental knowledge and comprehension of the major concepts, theoretical perspectives, historical trends, and empirical findings in psychology. (Understanding)
3. Develop Scientific reasoning and critical thinking, including effective research methodology in solving problemsrelated to behavior and mental processes. (Applying)
4. Analyse ethically and socially responsible behaviors for professional and personal settings, including development ofvalues that build diverse communities. (Analysing)
5. Determine their basic area of interest to work further/specialize in clinical setting. (Evaluating)
6. Develop the competence in writing case studies, and interpersonal communication skills. (Creating)

Students are required to undergo a summer internship of two weeks' during the semester break between the second and third semesters. It is a P/NP course and shall be recorded in the third semester. The Summer Internship gives students an opportunity to apply the theories and principles that they have learnt in class room courses to the "real world" of social service agencies, medical institutions, the criminal justice system, business, and industry. During the internship, students can explore

career interests, develop professional skills, learn how community organizations work and expand their clinical and interpersonal skills. The summer internship enriches the students' academic experience while making a valuable contribution to the community and utilizing the vacation optimally.

Mapping of COs to Syllabus

Course Outcomes	SUMMER INTERNSHIP(P/NP)
CO 1	H
CO 2	H
CO 3	M
CO 4	H
CO 5	H
CO 6	M

PCST6023 STUDY TOUR (Pass/Non-Pass)

COURSE OUTCOMES

1. Define mental illnesses and rehabilitation. (Remembering)
2. To understand counselling in real life setting. (Understanding)
3. To apply theoretical principles in order to understand the functioning of various mental health settings (Applying)
4. Distinguish clinical features of different mental illnesses. (Analysing)
5. Explain the importance of different models of mental health and illnesses in assessment. (Evaluating)
6. Develop practical knowledge about different psychological practice and rehabilitation setting. (Creating)

Module I: Introduction

During the programme the students shall undertake a study tour, along with the faculty members, to a place approved by the department. The places are to be so chosen as to be of educational benefit to students. During the tour, the focus shall be to visit and interact with NGOs, hospitals, state/national/ international organisations involved in psychological counselling.

Module II: Documentation and Evaluation

A report of the learning outcomes shall be submitted to the department at the end of the tour. The Study Tour shall be a Pass/No Pass course.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2
CO1	H	H
CO 2	H	
CO 3		H
CO 4	H	
CO 5	H	M
CO 6	H	

PCSI6024: SUPERVISED INTERNSHIP II

(8 Credits)

Course Outcomes

1. Remembering and identifying intervention. (Remembering)
2. Understanding dynamics of history taking and therapeutic approach to psychological counselling. (Understanding)
3. Apply the, theories skills and ethics in counselling. (Applying)
4. Analyse the trial and error essence of a counselling relationship and client needs. (Analysing)
5. Evaluate ethico-legal situations. (Evaluating)
6. Creating facilitative environment for clients in practice. (Creating)

Module I: Introduction

Analysing the situation: Need of counselling, space for counselling, information to clients, documentation, organizing supervision.

Module II: Internship

Taking in clients: first interview, documentation of the case, definition of counselling goals, building the counselling relationship, process of counselling, using skills of counselling, concluding counselling, documentation of the whole counselling process, evaluation; working in a team–role of counselling, resources and challenges, role in the team, case management: discussion, supervision. Evaluation of the internship will be based on the documentation, reports from the organisation, report of the supervisor and the presentation and the viva voce examination of the student at the end of the period of Internship.

Module III: Phases of Supervised Internship

The Supervised Internship is divided into two phases; Phase I and Phase II. Each of these phases consists of 45days (100 hours) of intensive practical learning programs in counselling setting under trained supervisors. The phases of the internship spread across the 3rd and 4th semester of Masters Degree program. The total credit for the supervised internship is divided equally across the final year semesters of the Master's Degree program.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H	M	M
CO 2	M	M	M
CO 3	H	H	M
CO 4	M		H
CO 5	H		H
CO6	M	H	

PCRP6025: RESEARCH PROJECT PHASE II (6 Credits)

Course outcomes

1. Knowledge of the major theoretical approaches and findings in psychology. (Remembering)
2. Demonstrate knowledge about the research methods used in psychology. (Understanding)
3. Apply the knowledge for preparing research design, and data analysis. (Applying)
4. Critically analyse information related to the study of behaviour and mental processes, and use the critical assessment in forming conclusions and arguments. (Analysing)
5. Present and defend opinions by making judgments about information, validity of ideas, or quality of work based on aset of criteria. (Evaluating)
6. Develop the understanding of how to prepare a research proposal. (Creating)

Every student shall undertake a research project work under the supervision and guidance of a faculty member. The student may choose the topic of research and start the preliminary work by the end of the second semester. The students are expected to complete the Literature Review followed by a Literature Review presentation and the Proposal presentation during the Phase I. Students are expected to complete the data collection before the fourth semester.

In Phase II, students are expected to complete the data collection, data analysis and interpretation, and submission of final report. Submission of final copy of the dissertation will be followed by presentation of the research and viva voce examination.

The thesis is to be submitted to the department before the date notified. The mode and components of evaluation of Phase I and Phase II of the research project and the weightages attached to them shall be published by the Department at the beginning of the semester. There shall be a viva voce examination on the research project.

Mapping of COs to Syllabus

Course Outcomes	RESEARCH PROJECT PHASE I
CO 1	H
CO 2	M
CO 3	H
CO 4	H
CO 5	M
CO 6	H

PCPP6026: PSYCHOLOGICAL ASSESSMENT-I (PRACTICUM-I)

(2 credits – 60 hours)

Course/Learning Outcomes

1. Define the important concepts of psychology research, and assessment techniques. (Remembering)
2. Understand the importance and steps associated with planning and conducting an experiment. (Understanding)
3. Apply the basic concepts of research and assessment techniques in measuring important psychological constructs associated with positive psychology. (Applying)
4. Categorize different types of intelligence assessment techniques. (Analyzing)
5. Evaluate the importance of different types of assessment techniques and measurement tools. (Evaluating)
6. Design and conduct an experiment. (Creating)

Module I: Introduction to Practicum (9 hours)
Primary modes of psychological enquiry: Experimental method, Observation, Survey, and InterviewPsychometric Properties: reliability, validity, standardization, sources of error

Module II: Experiment (14 hours)
Memory drum or Maze learning (offline)/serial positioning effect or cluster learning (virtual): Basic concepts, purpose, development, administration, scoring, interpretation

Module III: Positive Psychology - I (12 hours)
General well-being scale or psychological well-being: Basic concepts, purpose, development, psychometric properties, administration, scoring, interpretation

Module IV: Positive Psychology - II (12 hours)
Brief-cope or Coping appraisal or behavior questionnaire: Basic concepts, purpose, development, psychometric properties, administration, scoring, interpretation

Module V: Intelligence tests (13 hours)
Binet-Kamat Test of Intelligence (offline)/Draw-a-person (online): Basic concepts, purpose, development, psychometric properties, administration, scoring, interpretation

Suggested Readings
1. Aiken, L. R (2006). *Psychological Testing and Assessment* (12th ed.). Boston: Allyn and Bacon.
2. Baumgardner, S. R., and Crothers, M. K. (2010). *Positive psychology*. Upper Saddle River, N.J.: Prentice Hall.
3. Kaplan, R. M. & Saccuzzo, D. P. (2007). *Psychological Testing: Principles, Applications, and Issues*. Australia: Thomson Wadsworth.
4. Kothari, C. R. (2004). *Research Methodology: Methods and Techniques* (2nd ed.) New Delhi: New Age International.
5. Morgan, C. T., King, R. A., Weisz, J. R., & Schopler, J. (2017). *Introduction to Psychology (7th ed.,)*. New Delhi: Tata McGraw-Hill.

Mapping of COs to Syllabus

Course Outcomes	Module I	Module II	Module III	Module IV	Module V
CO 1	H	M	M	M	M
CO 2		H			
CO 3			H	H	
CO 4					H
CO 5	H	M	M	M	M
CO 6		H			

PCPP6027: PSYCHOLOGICAL ASSESSMENT-II (PRACTICUM-II)

1. Define the basic terms related to aptitude, personality, projective techniques, positive emotions, posttraumaticgrowth and clinical rating scales.
2. Classify the various types of psychological tests on the basis of their use. (Understanding)
3. Make interpretations and draw conclusions based on the norms given in the manual. (Applying)
4. Examine the details of the rating scale/ test, the aim, applications, procedure of administration and results.(Analysing)
5. Estimate the purpose and importance of each of these tests. (Evaluating)
6. Test the administrator's decision-making process to select a particular test for assessment of a given psychological condition. (Creating)

Module II: Assessment of Personality: Projective Tests (20 Hours) (Offline/Online Classes):
House Tree Person Test (HTP)/ Picture Completion Test (PCT)/Human Figure Test: Basic concepts, psychometric properties of the test, administration, scoring, results and interpretation.

Module III: Assessment of Positive Emotion (10 Hours) (Offline/Online Classes):
Positive and Negative Affect Schedule (PANAS)/Multidimensional Emotional Questionnaire (MEQ): Basic concepts (Definition, Protective Factors of Mental Health & Resilience), psychometric properties of the test, administration, scoring, results and interpretation.

Module IV: Assessment of Posttraumatic Growth (10 Hours) (Offline/Online Classes):
Posttraumatic Growth Inventory: Basic concepts (Definition, Barbara Fredrickson's Broaden-Build Theory), psychometric properties of the test, administration, scoring, results and interpretation.

Module IV: Clinical Assessment Scales (20 Hours) (Offline/Online Classes):

Beck's Depression Inventory/State-Trait Anxiety Inventory: Basic concepts, psychometric properties of the test, administration, scoring, results and interpretation.

Suggested Readings

1. Baron,R.A. Psychology.(1995). 3rd edition. Delhi: Prentice Hall.
2. Morgan, C.T, King, R.A., Weisz,J.R., and Schopler,J. (2004). Introduction to Psychology, 7th edition,24threprint.New Delhi:TataMcGraw-Hill.
3. Gregory, R.J. (2006). Psychological Testing: History, Principles, and Applications (4 th Ed.).New Delhi: PearsonEducation.
4. Baron, Robert A. and Byrne, D. (2001) .Social Psychology 8 th Edition (Reprint).New Delhi : Prentice-Hall of India PvtLtd.
5. Carson,R.C., Butcher,J.N and Mineka,S.(2004). Abnormal psychology. 13th Edition. New Delhi: Pearson Education

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	M	M		
CO 2	M	H	H	H
CO 3	H	H	H	H
CO 4	H	H	H	H
CO 5		M		M
CO 6				H

PCFW6028: FIELD WORK

(2 Credits)

Course Outcomes

1. Define counselling and mental illnesses (Remembering)
2. Understand the value of supervision (Understanding)
3. Apply the theoretical principles to individuals at various setups (Applying)
4. Distinguish clinical features of different mental illnesses. (Analysing)
5. Evaluate the models of mental health and illness. (Evaluate)
6. Create a management plan for patients on the basis of clinical features, diagnosis criteria and therapist competence. (Creating)

Module I: Introduction

The field work practice in the second semester shall focus upon the area of concentration chosen by the students. The students will be placed in the field for a minimum of eight days. The fieldwork setting shall be NGO's, hospitals, clinics and schools. The students are expected to apply all the skills and techniques of counselling whenever applicable depending upon the organization and their service. The students should be involved in the activities of the institution and fulfil the responsibilities as requested by the agency supervisor

Module II: Record and Documentation

Students shall prepare a daily report of the fieldwork activities and submit it to the concerned faculty supervisor. The faculty supervisor shall provide the necessary feedback and guidance to the students.

Module III: Evaluation

At the end of the semester the students shall submit a summary report of the cases taken and activities done during their placement. The students shall also appear for the viva voce examination at the end of the semester.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H		
CO 2	H	H	
CO 3	H	M	
CO 4	H		M
CO 5		M	M
CO 6		H	H

PCPR6029: PRACTICUM-III

(2 credits – 60 hours)

Course/Learning Outcomes

1. Define the basic concepts of disability, intelligence and personality assessment. (Remembering)
2. Extend the theoretical knowledge of disability, personality and intelligence theories and assessment techniques into practice. (Understanding)
3. Make use of the important measurement tools to learn administration and scoring. (Applying)
4. Examining test scores and interpretation of results. (Analyzing)
5. Evaluate the importance of personality, intelligence and disability assessment. (Evaluating)
6. Construct conclusion from the results of psychological assessment. (Creating)

Module 1: Disability Assessment (20 hours)
Indian scale for assessment of autism (ISAA)/WHO Disability Assessment Schedule (WHODAS 2.0): Basic concepts, purpose, development, psychometric properties, administration, scoring, interpretation

Module 2: Intelligence (20 hours)
Bhatia battery of performance test of intelligence (offline) or Vineland Social Maturity scale (online): Basic concepts, purpose, development, psychometric properties, administration, scoring, interpretation

Module 3: Personality assessment (20 hours)
Rorschach Inkblot Test (offline) or Eysenck Personality Inventory (online): Basic concepts, purpose, development, psychometric properties, administration, scoring, interpretation.

(*Note.* Owing to the importance of Rorschach in psychological testing if it is not possible to conduct this practical due to the mode of conduction of classes, the department will try to make sure that students have the knowledge of this test by conducting workshop on this topic.)

Suggested Readings
1. Aiken, L. R (2006). *Psychological Testing and Assessment* (12th ed.). Boston: Allyn and Bacon.
2. Anastasi, A., & Urbina, S. (1997). *Psychological testing (*7th ed.). Prentice Hall/Pearson Education.
3. Gregory, R. J. (2005). *Psychological testing: History, principles and applications*. New Delhi: Pearson Education.
4. Kaplan, R. M. & Saccuzzo, D.P. (2007). *Psychological Testing: Principles, Applications, and Issues*. Australia: Thomson Wadsworth.

Mapping of COs to Syllabus

Course Outcomes	**Module I**	**Module II**	**Module III**
CO 1		H	
CO 2	H		
CO 3			H
CO 4		H	
CO 5			H
CO 6	H		H

PCPR6030: PRACTICUM-IV
(2 Credits, 60 hours)

COURSE/LEARNING OUTCOMES (COs)
At the end of this course students will be able to:
1. Define the basic terms related to cognitive functioning, personality, projective techniques and clinical rating scales & choose a suitable method of psychological test to administer on a subject (Remembering)
2. Classify the various types of psychological and neuropsychological tests on the basis of their use. (Understanding)
3. Make interpretations and draw conclusions based on the norms given in the manual. (Applying)
4. Examine the details of the rating scale/ test, the aim, applications, procedure of administration and subject results. (Analysing)
5. Recommend the use of a suitable psychological assessment for a particular disorder. (Evaluating)
6. Test the administrator’s decision making process to select a particular test for assessment of a givenpsychological disorder. (Creating)

Module I: Neuropsychological screening and test batteries for assessing cognitive functioning and rule out neuropathology (20 hours)
Introduction to Neuropsychological assessments; importance and purpose; various types of Neuropsychological tests; administration, scoring, results and interpretation the tests
The Bender Visual-Motor Gestalt Test (BVGT) (Online/offline)/Rey-Osterrieth complex figure Test (ROCF) (Online/offline
Gesell Drawing test of intelligence (Online/offline)/Mini Mental Status Examination (MMSE)PGI- BBD battery (offline)

Module II: Assessment of personality (22 hours)
Objective and Projective tests for assessing personality and psychopathology. Definition of Personality; Measurement of Personality; Various types of Personality tests, administration, scoring, results and interpretation.
Minnesota Multiphasic Personality Inventory -2 (MMPI-2) (offline)Sacks sentence completion test (SSCT) (online/offline)
Thematic Apperception Test, other techniques (TAT) (online/offline)

Module-III (18 hours)
Rating scales for assessing the severity of Psycho-pathology and Evaluation of Impairment
Introduction to Clinical Rating Scales; Purpose of various rating scales; administration, scoring, results and interpretation;
Hamilton Anxiety Rating Scale (HAM-A) (Online/offline)
Hamilton Depression Rating Scale(HDRS) (Online/offline)Barratt Impulsiveness scale (BIS) (offline/Online)

Suggested Readings
1. Baer, L., & Blais, M. A. (2010). Handbook of clinical rating scales and assessment in psychiatry and mental health (pp.7-35). New York: Humana Press.
2. Bellack, A.S. and Hersen, M. (Ed.s) (1998) Behavioral assessment A Practical Handbook (4th ed.). MA: Allyn and Bacon.
3. Exner, J. E. (2002). The Rorschach, basic foundations and principles of interpretation (Vol. 1). John Wiley & Sons.
4. Goldstein, G. and Hersen, M. (Ed.) (2000) Handbook of Psychological Assessment. (3rded). Oxford: Elsevier science.
5. Hersen, M. (2004).Comprehensive Handbook of Psychological Assessment (Vol. 4). Industrial and Organizational assessment. New York, NY: Wiley.
6. Schutte, N. S., & Malouff, J. M. (1996). Sourcebook of Adult Assessment Strategies. Behaviour Research and Therapy, 10(34), 846-847.

Course Outcomes (COs) mapping

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H	M	M
CO 2	H	H	H
CO 3	H	H	H
CO 4	H	H	H
CO 5	H	H	H
CO 6	M	H	H

VALUE-ADDED COURSES

PCSO6034: SCHOOL PSYCHOLOGY
(2 credits- 30 hours)

Course Outcomes
1. Gain knowledge about the concept of School Psychology. (Remembering)
2. Understanding the process of school counseling. (Understanding)
3. Analyze the needs of school children in the new digital world. (Applying)
4. Apply principles and concepts of counseling in school set up. (Analyzing)
5. Evaluate the gaps in the current scenario. (Evaluating)
6. Create a comfortable environment for children in need of intervention. (Creating)

Module 1: Introduction (5 hrs)
Historical background of school psychology, Definition nature and scope of School Psychology, Role of a School Psychologist as a Professional

Module 2: Guidance and Counseling in School setting (15 hrs)
Definitions, Ethics and Legal aspects, Characteristics of an effective counselor, Basic Counseling Skills- Active listening, reflecting, paraphrasing, questioning, confronting, Counseling process- Building, maintaining and terminations counselor's relationships.

Module 3: Tools and Techniques Practice (10 hrs)
Objective tools: Checklist, rating scales, self report inventories and other standardized tools.
Subjective Tools: Observation, anecdotal records, cumulative Records, Interview and case history
Techniques for group intervention: Group tasks, Group discussion, debriefing and interpretation, summary making.
Techniques for individual intervention: role plays, individual assignments, feedback charts
Importance of Record Keeping

Suggested Readings:

1. Rao, Ramakrishna & Parnajpe, Anand (2008). Handbook of Indian Psychology. New Delhi: Cambridge University Press India Pvt. Ltd.
2. Thomas, Murray R. (1990) Counseling and Life – Span Development. New Delhi: Sage Publications,
3. Herr, Edwin (1974) Vocational Guidance and Human Development (Ed.). Boston: Houghton Mifflin,
4. Wallace & Lewis (1986). Becoming a Professional Counselor. New Delhi: Sage Publications,
5. Shrivastava, K.K. (2004) Principles of Guidance and Counseling. New Delhi: Kanishka Publishers.
6. Anastasi, A. (1977). Psychological Testing. (5th Ed.) New York: MacMillanPublishing Co. Inc.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	H	M	H
CO 2	H	M	H
CO 3	M	M	H
CO 4		H	H
CO 5		H	H
CO 6		H	H

PCCO6035: COMMUNITY MENTAL HEALTH

(2 credits- 30 hours)

Course Outcomes

1. Gain knowledge about the underlying principles of Community Mental Health. (Remembering)
2. Understand current trends of practice and intervention. (Understanding)
3. Apply basic intervention skills in their community projects. (Applying)
4. Analyze gaps in the current functioning of Community Mental Health at regional levels. (Analyzing)
5. Evaluate intervention techniques in multicultural set ups. (Evaluating)
6. Organize awareness programmes for communities. (Creating)

Module 1: Introduction (2 hours)

Basic Principles of Community Mental Health, Counseling Skills, Counseling in Multicultural set up

Module 2: Mental Health Issues (6 hours)

Intellectual disability, Addiction, Developmental disorders, Suicide

Module 3: Identification, Assessment and Intervention (7 hours)

Identification of Mental Health Issues, Assessment of Mental Health Issues, Psycho-education, Evidence Based Practices (Behavior Therapy, Cognitive Behavior Therapy, Rational Emotive Behavior Therapy)

Module 4: Practical (15 hours)

Community Mental Health Projects

Suggested Readings:

1. Community Mental Health; Challenges for the 21st century. (2006). Rosenberg, J. & Rosenberg, S. Rotutledge
2. Ethics in Community Mental Health Care. (2002). Backlar, Patricia & Cutler, David L. (Eds.). Springer US.
3. Community Mental Health and Behavioral-Ecology; A Handbook of Theory, Research, and Practice.(1982). Editors: Jeger, A.M., Slotnick, R.S. (Eds.). Springer US
4. Community Mental Health: Putting Policy Into Practice Globally.(2012).Graham Thornicroft , Atalay Alem, Robert E. Drake, Hiroto Ito, Jair Mari, Peter McGeorge, R. Tara, Maya Semrau (Ed.). Wiley-Blackwell

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	H	M	H
CO 2	H	H	H	H
CO 3		M	H	H
CO 4			H	H
CO 5			H	H
CO 6			H	H

PCLS6036: LIFE SKILLS EDUCATION
(2 credits-30 hours)

Course Outcomes:
1. Choose and gain knowledge about themselves, develop consciousness of self, self-confidence, feelings of mattering, manage personal emotions (Remembering)
2. Able to relate and work with others, practice collaborations, controversy with civility, engage across difference, be committed to ethical action (Understanding)
3. Apply self-knowledge, practice self-worth, congruence, commitment, identify passions and develop common purpose (Applying)
4. Able analyse academic knowledge and integrate into all aspects of living (Analysing)
5. Learn to evaluate and improve upon personal leadership strengths and weaknesses (Evaluating)
6. Create effective change and practice collective efficacy, develop critical thinking/ decision making skills, common purpose and a sense of connectedness within one's communities. (Creating)

Module –I: Introduction (5 hours)
- Definition and Importance of Life Skills
- Livelihood Skills, Survival Skills and Life Skills
- Life Skills Education, Life Skills Approach, Life Skills Based Education
- Life Skills Training - Implementation Models
- Life Skills Education in the Indian Context

Module-II: Social Skills and Negotiation Skills (8 hours)
Introduction
Life Skills: Generic, Problem Specific and Area Specific Skills
- Self-Awareness
  - Definition, Types of Self
  - Self Concept, Body Image, Self Esteem
  - Techniques used for Self Awareness: Johari Window, SWOT Analysis
- Empathy
  - Sympathy, Empathy & Altruism
- Effective Communication
  - Definition, Functions, Models, Barriers
- Interpersonal Relationship
  - Definition, Factors affecting Relationships

Module-III: Coping Skills (5 Hours)
Coping with Emotions
Coping Skills
- Coping & Emotions
  - Definition, Characteristics, Types
  - Classification: Wheel Model, Two-Dimensional Approach
  - Coping Strategies
- Coping with Stress

Definition, Stressors
  - Sources of Stress
  - The General Adaptive Syndrome Model of Stress
  - Coping Strategies

Module-IV: Practical (12 hours)
Life Skills in Specialized Areas
- Peer Education
- Life Skills for Disaster Preparedness
- Life Skills for Corporate Sector
- Life Skills for Special Population
- Life Skills for Geriatric and Palliative Care
- Life Skills in Practice in Educational Settings

Suggested Readings:

1. Dahama O.P., Bhatnagar O.P, (2005). *Education and Communication for Development,* (2nd Edn.), Oxford& IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Debra McGregor, (2007).Developing Thinking; Developing Learning - A guide to thinking skills in education, Open University Press, New York, USA
3. Duffy Grover Karen, Atwater Eastwood, (2008). (8th Edn.), *Psychology for Living- Adjustment, Growth and Behaviour Today*, Pearson Education Inc, New Delhi.
4. Hockenbury (2010). Discovering Psychology, Worth Publishers. New York
5. Nair .V. Rajasenan, (2010). *Life Skills, Personality and Leadership*, Rajiv Gandhi National Institute of Youth Development, Tamil Nadu.
6. Nair. A. Radhakrishnan et al., (2010). *Life Skills Assessment Scale*, Rajiv Gandhi National Institute of Youth Development, Tamil Nadu.
7. Stella Cottrell, (2005). Critical Thinking Skills: Developing Effective Analysis and Argument, Palgrave Macmillan Ltd., New York
8. Nair. A. Radhakrishnan, (2010). *Life Skills Training for Positive Behaviour*, Rajiv Gandhi National Institute of Youth Development, Tamil Nadu. s
9. RGNIYD. (2008). Facilitators *Manual on Enhancing Life Skills. Tamil Nadu*
10. Family Health International, NACO, USAID (2007), *Life Skills Education tool kit for Orphans and vulnerable children in India*

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module
CO 1	H	M	M	M
CO 2	M	H		H
CO 3	M		H	
CO 4	H			H
CO 5			H	
CO 6	M		H	H

DEPARTMENT OF PUBLIC ADMINISTRATION

VISION:
Our unwavering commitment is to emerge as a distinguished centre of excellence in the domain of Public Administration, embodying unparalleled standards in learning, teaching, and research. Through the provision of bespoke experiences, we strive to instill profound human values, ultimately fostering nation-building.

MISSION:
- Strive for academic excellence by delivering high-quality education, research, and practical training in Public Administration, fostering a deep understanding of theoretical frameworks and practical applications.
- Cultivate and nurture visionary leaders with the skills to navigate complex public sector challenges, promoting effective governance and upholding the highest standards of ethical conduct in public service roles.
- Encourage cutting-edge research initiatives that address contemporary societal issues, while fostering strong ties with the community and relevant stakeholders to drive positive societal development.
- Provide a personalized learning environment, catering to individual needs and aspirations, maximizing student potential for growth, success, and lifelong learning in the field.
- Enhance global awareness and prepare students to contribute effectively in an interconnected world, while dedicating efforts to contribute significantly to nation-building through competent and socially responsible public administrators driving positive change and sustainable development.

MA PUBLIC ADMINSTRATION -PROGRAM OUTCOMES (POs)

PO 1: Academic Excellence: Strive for academic excellence by delivering high-quality education, research, and practical training in Public Administration, fostering a deep understanding of theoretical frameworks and practical applications.

PO 2: Leadership Development: Cultivate and nurture visionary leaders who possess the skills and knowledge to navigate complex public sector challenges, promoting effective governance and public service.

PO 3: Research and Innovation: Encourage and support cutting-edge research initiatives that contribute to the advancement of knowledge in Public Administration, generating innovative solutions for contemporary societal issues.

PO 4: Personalized Learning: Provide a personalized and student-centric learning environment, catering to individual needs and aspirations, thereby maximizing the potential for growth and success.

PO 5: Ethical and Responsible Governance: Emphasize the importance of ethical conduct and responsible governance practices, preparing graduates to uphold the highest standards of integrity in their public service roles.

PO 6: Community Engagement: Foster strong ties with the community and relevant stakeholders, encouraging collaboration and knowledge exchange, resulting in a positive impact on societal development.

PO 7: Comprehensive Approach: Foster an interdisciplinary perspective and global awareness, promoting lifelong learning among students and faculty, to produce competent and socially responsible public administrators who can drive positive change, sustainable development, and contribute significantly to nation-building efforts in an interconnected world.

MA PUBLIC ADMINSTRATION -PROGRAMME SPECIFIC OUTCOMES (PSOs)
PSO 1: To foster a comprehensive comprehension of governance structures, processes, and institutions at the local, national, and international levels.
PSO 2: To enable students to gain an in-depth understanding and analytical proficiency in one of the specialized areas, including Human Rights, International Relations, or Public Policy, empowering them to address complex challenges within their chosen field.
PSO 3: To develop and enhance technical skills necessary for comprehensive professional advancement within their respective areas of specialization. This will equip graduates to make well-considered and responsible decisions in their professional endeavours.
PSO 4: To create avenues for sharing the outcomes of academic and disciplinary learning, encouraging students to engage in scholarly research and publish research materials that contribute to the advancement of knowledge in the field.

Mapping of Courses with POs/PSOs:

Courses	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO 4
DC Courses		H		M		H		H	M		M
DC 1	M		H		M		H		H	H	
DC 2		H		H	H		M	M		H	
DC 3	H		H		M			H			H
DC 4	M	H		H		H		H	M		M
DC 5	H		H		M	H		H		H	
DC 6		H		H		H	H		H		H
DC 7	H		H		H		H	H		M	
DC 8		H		M		H		H	M		M
DC 9	M		H		M		H		H	H	
DC 10		H		H	H		M	M		H	
DC 11	H		H		M			H			H
DC 12	M	H		H		H		H	M		M
DC 13	H		H		M	H		H		H	
DC 14		H		H		H	H		H		H
DC 15	H		H		H		H	H		M	
DC 16			H		M			H		H	
DE Courses		H		M		H		H	M		M
DE 1 HR	M		H		M		H		H	H	
DE 1 IR		H		H	H		M	M		H	
DE 2 HR/IR	H		H		M			H			H
DE 2 PP	M	H		H		H		H	M		M
DE 3 HR/IR	H		H		M	H		H		H	
DE 3 PP		H		H		H	H		H		H
DE 4 HR/IR	H		H		H		H	H		M	
DE 4 PP		H			H		H				H
DE 5 HR/IR			H			H			H		
DE 5 PP			H			H			M		H
DE 6 HR/IR	M			H		M		H		M	
DE 6 PP		H			H				H		H
SE 1		H		M		H		H	M		M
Value Add 1	M		H		M		H		H	H	
Value Add 2		H		H	H		M	M		H	
Value Add 3	H		H		M			H			H

DETAILED SYLLABUS

PASE0001: STATE AND ITS ELEMENTS

Credits: 3 (45 lectures) (45 Hours)

COURSE OUTCOMES

At the end of this course students are able to:

1. Trace the evolution and emerging perspectives of the State (Remembering & Understanding)
2. Understand the relationship between State, Society and Public Administration (Understanding)
3. Analyze the origin and changing role of the state (Analyzing)
4. Evaluate the Interface between Citizens and Administration (Applying)

Module – I (15 hours)

Evolution and Perspectives of the State: Origin of the State, the Theory of Divine Origin, Force Theory, Matriarchal and Patriarchal Theory, Social Contract Theory, Evolutionary Theory; Elements and Functions of State; Changing Role of the State; Liberal and Marxist Perspective of the State, Neo-liberal Perspective, and Gandhian Perspective; Autonomy of the indirect economy, and kindness economy.

Module - II (10 hours)

Concepts: Liberty, Equality, Justice, Rights, and Sovereignty, Contemporary Issues, Political Culture & Political Development, Political Socialization. Understanding concepts of Public, Common Good, Welfare, Public Interest, Morality, Empathy, Efficiency and Effectiveness.

Module – III (10 hours)

Governmental structure: Various Forms of Government: Monarchy, Democracy, Oligarchy, Authoritarianism, and totalitarianism; Parliamentary & Presidential, Unitary & Federal.

Module - IV (10 hours)

Relationship between State, Society and Public Administration; People's Struggle for Democracy- Case Studies, Interface between Citizens and Administration; Political Parties, Pressure Groups, Electoral Reforms; Digital economy; Self-reliant theory.

Suggested Readings

1. An Introduction to Political Theory, Gauba · 2009 Publisher: Macmillan Publishers India Limited
2. Political theory ideas and concepts by Sushila Ramaswamy, 2010, Publisher: PHI Learning
3. Institutional Theory in Political Science: 2nd Edition, B. Guy Peters, 2005
4. Political Theory: An Introduction, by Rajeev Bhargava, Ashok Acharya, Pearson Education India
5. Political Man, The Social Bases of Politics (Classic Reprint), 2017
6. Rawls, R.H. - A Theory of Justice
7. Sharma, U., Sharma, S.K. - Principles & Theory of Political Science

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	L
CO 2	L	L	L	H
CO 3	H	L	L	L
CO 4	L	L	L	H

PAIA0002: INTRODUCTION TO THE PUBLIC ADMINISTRATION

Credits: 3 (45 lectures) (45 Hours)

COURSE OUTCOMES

At the end of this course students are able to:

1. Understand the meaning, nature and scope of Public Administration (Remembering & Understanding)
2. Comprehend the changing paradigms of Public Administration (Understanding)
3. Analyse the events that gave shape to the discipline (Analyzing)
4. Evaluate the concept of Good Governance and its implications (Applying)

Module – I (10 hours)

Meaning, nature, scope and significance of Public Administration; Relation with other disciplines of social sciences;

Module – II (10 hours)

Evolution of the discipline and its present status; Ecology, Public and Private Administration.

Module III (15 hours)
New Public Administration; Public Choice Theory; New Public Management; State vs. Market Debate.

Module IV (10 hours)
Recent Developments in Public Administration; Challenges of Liberalization, Privatization and Globalization; Good Governance: concept and application; Good Governance indexes.

Suggested Readings
1. Henry, Nicholas - Public Administration And Public Affairs
2. Nigro, Felix, A. - Modern Public Administration
3. Dixit Manoj (et. al) - Public Administration
4. Awasthi & Maheshwari - Public Administration
5. Sharma & Sharma - Public Administration
6. Bhattacharya, M. - New Horizons of Public Administration
7. Bhambri, C.P. - Public Administration

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	L
CO 2	L	H	M	M
CO 3	M	H	L	L
CO 4	L	M	L	H

PACD0003: COMPARATIVE AND DEVELOPMENT ADMINISTRATION
Credits: 3 (45 lectures) (45 Hours)

COURSE OUTCOMES
At the end of this course students are able to:
1. Understand the Concept, Nature, Scope and Significance of Comparative Public Administration (Remembering & Understanding)
2. Understand the ecological impact on the Public Administration (Understanding)
3. Analyze the problems of Comparative Research and development administration (Analyzing)
4. Evaluate the Changing pattern of Development Administration (Applying)

Module – I (15 hours)
Concept, Nature, Scope and Significance of Comparative Public Administration; Comparative Studies –Influence of Globalization; Public Administration and its Environment. Approaches to the study of Comparative Administration: Institutional, Behavioral, Structural-Functional, Ecological and Systems Approaches

Module – II (10 hours)
Fred Riggs's Typology of Societies and Features; Problems of Comparative Research; Salient Features of the administrative systems of UK, USA, France and Japan

Module – III (15 hours)
Genesis of Development Administration; Development Administration: Meaning, characteristics, Traditional Administration versus Development Administration; Administration of Development and Development of Administration; Politics of Development Administration.

Module – IV (05 hours)
Temporal and Spatial Dimensions of Development Administration; Changing pattern of Development; A critique of Development Administration

Suggested Readings
1. Arora, R.K.- Comparative Public Administration
2. Chaturvedi, T.N.- Comparative Public Administration
3. Chatterjee, S.K. - Development Administration
4. Sapru, R.K.- Development Administration
5. Riggs, F.W.- The Ecology of Public Administration
6. Sharma, S.K. - Development Administration in India
7. Bhattacharya, Mohit – Bureaucracy & Development Administration

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	L
CO 2	L	H	L	L
CO 3	H	H	H	M
CO 4	L	L	L	H

PAPP0004: PUBLIC POLICY

Credits: -3 (45 lectures) (45 Hours)

COURSE OUTCOMES

At the end of this course students are able to:

1. CO1: Understand the public policy process (Remembering & Understanding
2. CO2: Understand the Models and Trends of Public Policy in India (Understanding)
3. CO3: Analyze the issues related to Policy formulation; Implementation and evaluation (Analyzing)
4. CO4: Evaluate the public policies in India (Applying)

Module – I (10 hours)

Public Policy: Articulation, significance and approaches; Public Policy Process

Module – II (10 hours)

Public Policy and Globalization; Public Policy process in India; Models and Trends of Public Policy in India

Module-III (10 hours)

Policy formulation; Implementation; evaluation

Module –IV (15 hours)

Environmental Policy in India; Education Policy in India; Public Health Policy in India; MSME Policy of India.

Suggested Readings

1. Anderson, James E. - Public Policy making, Praeger, New York, 1975
2. Dror, Y. - Public Policy Making Re-examined, Chancellor, Pennsylvania, 1968
3. Sahani, P. - Public Policy Conceptual Dimensions, Kitab Mahal, Allahabad, 1987
4. Saigal, Krishna - Public Policy Making in India: An Approach to Optimisation, Vikas, New Delhi, 1983
5. Madan, K.D. et. al - Public Policy making in Government; Publication Division, Ministry of Information and Broadcasting, New Delhi, 1982
6. Bertcih, Garg, K. Robert P. Clark and David M. Wood - Comparing Political System : Power and Policy in Three Worlds, Macmillan, New York, 1986
7. Sapru, R.K. - Public Policy Formulation, Implementation and Evaluation; Sterling, New Delhi, 2000

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	L	L
CO 2	L	H	L	L
CO 3	M	M	H	L
CO 4	L	L	L	H

PAEP0005: ENGAGED POLICY AND GOVERNANCE

Credits: 3 (45 lectures) (45 Hours)

COURSE OUTCOMES

At the end of this course students are able to:

1. Understand the concept of Participatory Governance (Remembering & Understanding)
2. Understand the Pitfalls in Participatory Governance (Understanding)
3. Analyze the issues related to Community engagement at the Grassroots Level (Analyzing)
4. Evaluate Issues of local Engagement and Participation (Applying)

Module I (10 hours)

Participatory Governance: An Overview; The Rationale of Participation: Concepts and Challenges; New Governance Paradigm: The Emerging Partnerships/Engagement Initiatives

Module II: (10 hours)

Democracy, Social Inclusion and Development: Democracy and Development; Political Regimes, Political Participation and Social Inclusion; Innovations and Pitfalls in Participatory Governance

Module III: (10 hours)
Engaged Governance: Government Transparency in Policy Decisions; Engaging the Community at Grassroots Level; Electronic Platforms for Receiving and Implementing Public Input

Module IV: (15 hours)
Participatory Local Governance: Participatory Governance Toolkits; Measuring Engagement or Participation; Issues in Engagement and Participation; Case Studies a) Kudumbashree in Kerala, India b) Grameen Bank in Bangladesh c) Participatory Budgeting, Brazil d) Watershed Development Programme in Ralegansiddhi, India

Suggested Readings

1. Alexander, Jeffrey C. 2006. The Civil Sphere. New York: Oxford University Press.
2. Baiocchi, G., P. Heller, et al. 2011. Bootstrapping Democracy: Transforming Local Governance and Civil Society in Brazil. Stanford; Stanford University Press.
3. Barber, Benjamin. 1984. Strong Democracy: Participatory Politics for a New Age. Berkeley: University of California Press.
4. Boulding, C. and B. Wampler 2010. "Voice, Votes, and Resources: Evaluating the Effect of Participatory Democracy on Well-being." World Development 38(1): 125-135.
5. Bowler, S. and T. Donovan 2002. "Democracy, Institutions and Attitudes About Citizen Influence on Government." British Journal of Political Science 32(02): 371-390.
6. Diamond, L. J. 1999. Developing Democracy: Toward Consolidation. Baltimore, MD: Johns Hopkins University Press.
7. Fung A., E. Wright, et al. 2003. Deepening Democracy: Institutional Innovations in Empowered Participatory Governance. London: Verso Books.
8. Grindle, Merilee, 2007, Going Local: Decentralization, Participation, and the Promise of Good Governance. Princeton University Press.
9. Heller, P. 2000. "Degrees of Democracy: Some Comparative Lessons from India." World Politics 52(4): 484-519.
10. Isaac, T.M. Thomas and Patrick Heller. 2003. "Democracy and Development: Decentralized Planning in Kerala." In Deepening Democracy: Institutional Innovations in Empowered Participatory Governance. The Real Utopias Project IV. London: Verso.
11. Pateman, Carole. 1970. Participation and Democratic Theory. Cambridge: Cambridge University Press.
12. Sen, Amartya. 1999. Development as Freedom. Oxford: Oxford University Press.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	L
CO 2	L	H	L	L
CO 3	L	L	H	L
CO 4	L	L	L	H

PAAP0007: ADMINISTRATIVE THEORY AND PRINCIPLES (Core Course)
Credits: -3 (45 lectures) (45 Hours)

COURSE OUTCOMES
At the end of this course students are able to:
1. Trace the evolution theories o Public Administration (Remembering & Understanding)
2. Understand the principles of Public Administration (Understanding)
3. Analyze the State of Administrative Theory in 21st Century (Analyzing)
4. Evaluate the theory and practice of public administration (Applying)

Module – I (15 hours)
Classical Perspectives: Woodrow Wilson: The Politics Administration-Dichotomy; Scientific Management: Taylor and the Movement; Classical Theory: Fayol, Urwick, Gulick and others; Bureaucratic Theory: Weber and his critics. Human relations perspectives/post-classical theorists: Elton Mayo and others; Mary Parker Follett; Behavioural approach: Chester Barnard, Chris Argyris, Douglas McGregor, Rensis Likert; Organizational development and system approach.

Module – II (10 hours)
Administrative Behaviour: Decision making – Herbert Simon; Communication; Control; Leadership Theories; Theories of Motivation: Abraham Maslow, Frederick Herzberg. Emerging theories: Geoffrey Vickers-Appreciative System; Warren Bennis-Changing Organizations; New Organisational Culture, Pertinence of Critical Theory, State of Administrative Theory in 21st Century

Module-III (10 hours)
Basic Principles: Organization; Hierarchy; Unity of Command; Span of Control; Authority and Responsibility; Coordination; Centralization and Decentralization.

Module –IV (10 hours)
Delegation; Supervision; Line and Staff; Accountability and Control: Concept; Legislative Control; Executive Control; Judicial Control; Citizen and Administration; Role of Civil Society; People's participation; Right to information

Suggested Readings
1. Henry, Nicholas - Public Administration And Public Affairs
2. Taylor, Frederick W. - The Principles of Scientific Management
3. Etzioni, Amitai - Modern Organizations
4. Bendix R., Max Weber - An Intellectual Portrait
5. Blau, Peter H. - Bureaucracy in Modern Society
6. Nigro, Felix, A. - Modern Public Administration
7. Dixit Manoj (et. al) - Public Administration
8. Sahni, Pardeep (et. al) - Administrative Theory
9. Awasthi & Maheshwari - Public Administration
10. Sharma & Sharma - Public Administration
11. Bhattacharya, M. - New Horizons of Public Administration
12. Bhambri, C.P. - Public Administration

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	L	L
CO 2	L	H	L	L
CO 3	L	H	L	L
CO 4	M	M	M	H

PAIA0008: INDIAN ADMINISTRATION
Credits: -3 (45 lectures) (45 Hours)

COURSE OUTCOMES
At the end of this course students are able to:
1. Trace the evolution of Indian Administration (Remembering & Understanding)
2. Understand the Structure & Functions of Public Administration in India (Understanding)
3. Analyze the role of District Administration in 21st Century (Analyzing)
4. Evaluate the Relationship between Police and Public (Applying)

Module – I (10 hours)
Evolution of Indian Administration: Mauryan, Mughal & British Period and British Legacies to Indian Administration.

Module – II (10 hours)
Central Administration: Structure & Functions of Central Secretariat: Cabinet Secretariat, Cabinet Secretary, Prime Minister's Office (PMO)

Module-III (10 hours)
State Administration: Structure & Functions of State Secretariat, Chief Secretary; State Secretariat Vs Directorate; Divisional Administration & The Divisional Commissioner.

Module –IV (15 hours)
District Administration; District Collector: Powers, Functions & Role, Law and Order in DM-SSP & Commissionery System, Relationship between Police and Public.

Suggested Readings
1. Maheshwari, S.R. - Indian Administration
2. Singh, Hoshiar - Indian Administration
3. Arora, R.K. & Goel. Rajni - Indian Public Administration
4. Johari, J.C. - Indian Govt & Politics
5. Maheshwari, S.R. - State Administration

6. Avasthi, A. & Avasthi, A.P. - Indian Administration
7. Fadia, B.L. & Fadia, Kuldeep - Public Administration in India
8. Singh, Hoshiyar and Singh, Mohinder - Public Administration in India
9. Basu, D.D. Introduction to the Constitution of India
10. Johari, J.C. - The Constitution of India
11. Ramchandran, Padma – Public Administration in India
12. Charabarty, Bidut& Chand, Prakash – Indian Administration

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	L
CO 2	L	H	H	H
CO 3	L	L	L	H
CO 4	L	L	L	H

PAPP0009: PUBLIC PERSONNEL ADMINISTRATION

Credits: -3 (45 lectures) (45 Hours)

COURSE OUTCOMES

At the end of this course students are able to:

1. Trace meaning, nature, scope and significance of Public Personnel Administration (Remembering & Understanding)
2. Understand the recruitment process in civil services (Understanding)
3. Analyze the Role of Civil services in Developing Countries (Analyzing)
4. Evaluate the issues related to Administrative Ethics and Reforms (Applying)

Module – I (05 hours)

Public personnel administration: meaning, nature, scope and significance

Module – II (10 hours)

Civil Services – Structure, Recruitment and training; Promotion; Pay and service conditions; Position Classification; Public Service Commissions; Union and state.

Module-III (20 hours)

Role of Civil services in Developing Countries. Civil Services-Citizenry Interface: Civil Society and Administration; Technology and Changing Nature of Public Services; Ethics and Accountability

Module –IV (10 hours)

Generalist and Specialist; Minister-Civil servant relationship; Administrative Ethics; Administrative Reforms.

Suggested Readings

1. Yoder, Dale - Personnel Management & Industrial Relations
2. Flippo, Edwin B. - Principles of Personnel management
3. Davar, Rustom S. - Personnel Management & Industrial Relations
4. Second Administrative Reforms Commission Report.
5. Monappa, Arun & Mirza, S.Saiyadain - Personnel Management.
6. Stahl, O Glenn - Public Personnel Administration
7. Hays, S.W. & Kearney, R.C. - Public Personnel
8. Goel, S.L. - Public Personnel Administration
9. Sinha, V.M. - Public Personnel Administration
10. P. N. Parashar- History and Problems of Civil Services in India
11. Yogendra Narain- Civil Services: Challenges And Resolutions
12. Abhay Prasad Singh & Krishna Murari - Constitutional Government and Democracy in India
13. S.K. Das - The Civil Services in India
14. Lohit Matani, Vishal - An Introduction to Civil Services
15. S.N. Singh - Politician Civil Servant Relationship and Public Administration in India
16. Sandeep Sharma- Indian Civil Service And Public Administration

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	L
CO 2	L	H	L	L

CO 3	L	L	H	L
CO 4	L	L	L	H

PARM0010: RESEARCH METHODOLOGY

Credits: -3 (45 lectures) (45 Hours)

COURSE OUTCOMES

At the end of this course students are able to:

1. Trace the role of Research in Theory-building (Remembering & Understanding)
2. Understand the Scientific Methods in Social Science Research (Understanding)
3. Analyze the role Sampling and Sampling Techniques (Analyzing)
4. Evaluate trends of Research in Public Policy and Governance; (Applying)

Module – I (15 hours)

Social Science Research: Meaning, Objectives, Scope and Importance of Social Science Research, Normativity and Objectivity in Social Science Research; Distinction between Method and Methodology; Role of Research in Theory-building; Types of Research: Quantitative Research, Qualitative Research, Applied Research, Basic Research, Problem Oriented and Problem Solving.

Module – II (10 hours)

Scientific Methods in Social Science Research; Problem Formulation and Hypothesis; Identification of Variables, Concepts and Operationalization of Concepts; Hypothesis and Procedure of Hypothesis Testing and Estimation; Data: Sources-Primary and Secondary, Methods of Data Collection.

Module-III (15 hours)

Sampling and Sampling Techniques; Scales of Measurement: Measures of Central Tendency and Dispersion, Mean, Mode and Median, Standard Deviation, Correlation; Tools of Data Collection: Observation, Questionnaire, Interview Schedules; Processing and Analysis of Data; Research Design and Research Report Writing; Citation Pattern and Bibliography

Module –IV (05 hours)

Trends of Research in Public Policy and Governance; Ethics of Research in Public Administration; Use of Computers in Social Science Research.

Suggested Readings

1. L. Nagar and R. K. Das, Basic Statistics, New Delhi: Oxford University Press, 2000.
2. C. R. Kothari, Research Methodology: Methods and Techniques, New Delhi: Vishwa Prakashan, 1990.
3. David Dooley, Social Research Methods, (4th ed.), Upper Saddle River, NJ: Prentice Hall, 2001.
4. David E. Gray, Doing Research in the Real World, London: Sage Publications, 2004.
5. E. R. Babbie, The Basic of Social Research, (4th ed.), Australia: Thomson, 2007.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	L
CO 2	L	H	L	L
CO 3	L	L	H	L
CO 4	L	L	L	H

PAOB0012: ORGANIZATIONAL BEHAVIOUR

Credits: 3 (45 lectures) (45 Hours)

COURSE OUTCOMES

At the end of this course students are able to:

1. Understand the concepts and approaches to organizational behaviour (Remembering & Understanding)
2. Understand the concepts of Attitude, Personality and Motivation (Understanding)
3. Analyze the Stress Management and Organizational Change (Analyzing)
4. Evaluate resistance to Change (Applying)

Module I (10 hours)

Concepts and Approaches: Organisational Behaviour (OB) - Meaning and Concept, Traditional and Modern Approaches to OB; Typologies of Organisation, Genesis, Needs and Goals of OB; Challenges of Organisational Behaviour

Module II (15 hours)
Attitude, Personality and Motivation: Attitude- Concept, Factors in Attitude formation, Attitude and Behaviour; Personality: Concept, Theories and determinants, Personality and Behaviour; Motivation: Concept, Theories, Motivation and Behaviour, Motivational system and Incentives, Quality Work Life (QWL), Job Design and Motivation.

Module III (10 hours)
Stress Management and Organizational Change: Power and Politics - Concept, Significance, Concentration and Types of power, Reasons and Management of Organizational Politics.

Module IV (10 hours)
Stress Management: Concept, Causes and Effects of Stress, Coping Strategies; Organizational Change: Nature, Factors and Resistance to Change.

Suggested Readings
1. Kumar, Niraj. Organizational Behavior: A New Look Concept, Theory and Cases. New Delhi: Himalaya 2012.
2. Parikh, Margie and Rajen Gupta. Organisational Behaviour. McGraw Hill Education (India) Pvt Ltd, 2010.
3. Robbins Stephen P. Organizational Behavior 15 Paperback, New Delhi: Pearson 2013.
4. Prasad, L.M. Organizational Behavior. New Delhi: Sultan Chand and Sons, 2019.
5. Pershing, Sandra Parkes and Eric K. Austin. Organization Theory and Governance for the 21st Century. New Delhi: Sage, 2015.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	H
CO 2	L	H	L	L
CO 3	L	L	H	L
CO 4	L	L	L	H

PABF0013: BUDGET AND FINANCIAL ADMINISTRATION IN INDIA
Credits: 3 (45 lectures) (45 Hours)

COURSE OUTCOMES
At the end of this course students are able to:
1. Understand the concept and significance of Budget (Remembering & Understanding)
2. Understand the Budget Policy orientation in India (Understanding)
3. Analyze the Budgetary Process in India (Analyzing)
4. Evaluate Central-State Financial Relations (Applying)

Module – I (10 hours)
Meaning, nature and scope of Financial Administration; Concept of Budget; Definitions of Budget; Significance of Budget; Types of Budget

Module – II (10 hours)
Budget Policy Orientation in India; Major actors in Budgetary Process in India

Module-III (10 hours)
Budget system in India; Budgetary Process in India; Financial Management in India;

Module –IV (15 hours)
Budget system reforms in India; Financial System reforms in India; Finance Commission; Central-State Financial Relations.

Suggested Readings
1. Lall. G.S. - Public Finance & Financial Administration in India
2. Mokherjee, S.S. - Financial Administration in India
3. Chand, Prem - Performance Budgeting
4. Handa, K.L. - Financial Administration
5. Sury, M. M. Government Budgeting in India
6. Geol, S.L. - Public Financial Adminstration
7. Thavaraj, M.J.K. - Financial Administration of India

8. Tyagi, B.P. - Public Finance
9. S.K. Mahajan and A.P. Mahajan: Financial Administration in India

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	L
CO 2	L	H	L	L
CO 3	L	L	H	L
CO 4	L	L	L	H

PASW0014: SOCIAL WELFARE ADMINISTRATION

Credits: -3 (45 lectures) (45 Hours)

COURSE OUTCOMES

At the end of this course students are able to:

1. Understand the concept and significance of social welfare administration in India (Remembering & Understanding)
2. Understand the Social Welfare Administration in New Economic Order (Understanding)
3. Analyze the role of various agencies in social welfare administration (Analyzing)
4. Evaluate the role of International Agencies for Social Welfare (Applying)

Module – I (10 hours)

Social Welfare Administration: Meaning, Scope & Significance, Approaches/Models; Meaning, Social Welfare State- meaning; Social Change and Social Justice; Social Welfare Administration in New Economic Order; Social Welfare in Democratic and Authoritarian States.

Module – II (10 hours)

Social Welfare Administration at Union Level: Composition and Functions of Ministry of Social Justice and Empowerment; Ministry of Tribal Affairs; Ministry of Women and Child Development, Ministry of Minority Affairs; CSWB & SSWAB; Social welfare administration at the state level.

Module-III (15 hours)

Social Welfare Policies and Programmes for SC/ST, OBCs, Women, Child, Disabled and Aged at Central & State level; Composition and Functions of National Commission: for SC/ST, Women, Other Backward Classes and Minorities; Sub Plan strategies for Welfare of Weaker Section.

Module –IV (10 hours)

International Agencies for Social Welfare: Composition and Functions of UNESCO, UNICEF, ILO, WHO (with special reference to India).

Suggested Readings

1. Mukherjee, Radhakamal - Social Welfare Administration
2. Chaudhary, D.P. - A. Hand Book of Social Welfare
3. Sachdeva, D.R. - Social Welfare Administration
4. Prasad, R. - Encyclopedia of Social Welfare Administration
5. Shukla, K.S. - Social Welfare Administration in India
6. Chandra, Sushil - Social Work in Uttar Pradesh
7. Annual Reports of Ministry of Social Justice & Empowerment, Government of India.
8. Goel, S.L. - Social Welfare Administration.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	L
CO 2	H	L	L	L
CO 3	L	H	L	H
CO 4	L	L	L	H

PAEG0015: ENVIRONMENTAL GOVERNANCE

Credits: -3 (45 lectures) (45 hours)

COURSE OUTCOMES
At the end of this course students are able to:
1. Understand the concept of Global Environmental Governance (Remembering & Understanding)
2. Understand the Development and Environmental issues in India (Understanding)
3. Analyze the Impact of urbanization on Environment (Analyzing)
4. Evaluate the Urban Environmental Governance in India (Applying)

Module – I (10 hours)
Development – Environment Discourse; Global Environmental Governance

Module – II (15 hours)
Development and Environmental issues in India; Environmental Policy in India; Role of Judiciary in Environmental governance in India; Civil Society and Environmental protection in India

Module-III (10 hours)
Urban Environmental governance and politics in India; Impact of urbanization on Environment and Public Health.

Module –IV (10 hours)
Urban Environmental Governance: Major initiatives; Environmental politics in Urban India; Environmental Protection and Peoples right.

Suggested Readings
1. Ajith Sankar- Environmental Management
2. Bruckmeier, Karl - Global Environmental Governance: Social-Ecological Perspectives
3. Arild Vatn- Environmental Governance: Institutions, Policies and Actions
4. J.P. Evans - Environmental Governance
5. Jean-Frederic Morin, Amandine Orsini- Essential Concepts of Global Environmental Governance
6. Frank Biermann, Philipp H. Pattberg - Global Environmental Governance Reconsidered
7. Prakash Chand Kandpal- Environmental Governance in India: Issues and Challenges
8. Albert Breton- Environmental Governance and Decentralisation

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	L
CO 2	L	H	L	L
CO 3	L	L	H	L
CO 4	L	L	L	H

PACA0016: CITIZENS AND ADMINISTRATION
Credits: -3 (45 lectures) (45 Hours)

COURSE OUTCOMES
At the end of this course students are able to:
1. Understand the Interaction between Citizens and Administration (Remembering & Understanding)
2. Understand the Preconditions for Citizens-centric Administration (Understanding)
3. Analyze the Mechanism for Redressal of Public Grievances (Analyzing)
4. Evaluate the Changing role of Citizens (Applying)

Module – I (10 hours)
Interaction between Citizens and Administration; Citizens' Perception about Administration

Module – II (10 hours)
Preconditions for Citizens-centric Administration; Peoples participation in India

Module-III (10 hours)
Administrative Accountability; Mechanism for Redressal of Public Grievances

Module –IV (15 hours)
Grievance Redressal Mechanism in India; Governance Discourse and the Changing Role of Citizens.

Suggested Readings
1. S. N. Sadasivan - Citizen and Administration
2. Nita Sanghvi - Administration and the Citizen
3. Citizen, Customer, Partner, Engaging the Public in Public Management, by John Clayton Thomas · 2014
4. Citizens and the New Governance: Beyond New Public Management, by Luc Rouban
5. Avasthi A & Maheshwari, S.R., Public Administration; Lakshmi Narain ' Agarwal: Agra.
6. Barnabas, A.P., Citizens' Grievances and Administration; IIPA, New Delhi.
7. Bhattacharya, Mohit, 1987. Public Administration-Structure, Process and Behaviour
8. Chaturvedi T.N. & Sadasivan S.N. (Eds), 1984. Citizen and Administration; IIPA: New Delhi.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	L
CO 2	L	H	L	L
CO 3	L	L	H	L
CO 4	L	L	L	H

PADL0017: DECENTRALIZATION AND LOCAL GOVERNANCE
Credits: -3 (45 lectures) (45 Hours)

COURSE OUTCOMES
At the end of this course students are able to:
1. Understand various approaches of decentralization (Remembering & Understanding)
2. Understand the concept of democratic decentralization (Understanding)
3. Analyze the implication of the 73^{rd} and 74^{th} Amendment Acts (Analyzing)
4. Evaluate the role of Peoples participation in Rural and Urban Development (Applying)

Module – I (10 hours)
Decentralization: The concept; the significance of decentralization; Approaches to Decentralization

Module – II (10 hours)
Types of Decentralization; Democratic decentralization and local governance in India

Module-III (10 hours)
Rural local government; Urban local government; Implication of 73^{rd} and 74^{th} Amendment Acts; Critical appraisal

Module –IV (15 hours)
Peoples participation in Rural and Urban development; Major Rural and Urban development programmes.

Suggested Readings
1. Pranab Bardhan, Dilip Mookherjee - Decentralization and Local Governance in Developing Countries – A Comparative Perspective
2. T. R. Raghunandan - Decentralisation and Local Governments: The Indian Experience
3. Rémi de Bercegol - Small Towns and Decentralisation in India: Urban Local Bodies in the Making
4. D. Rajasekhar, M Devendra Babu, R Manjula - Decentralisation in Contemporary India: Status, Issues and the Way Forward
5. Chandan Sengupta, Stuart Corbridge - Democracy, Development and Decentralisation in India: Continuing Debates

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	L
CO 2	L	H	L	L
CO 3	L	L	H	L
CO 4	L	L	L	H

PAEG0018: E-GOVERNANCE

Credits: -3 (45 lectures) (45 Hours)

COURSE OUTCOMES

At the end of this course students are able to:

1. Understand Electronic Service Delivery mechanism (Remembering & Understanding)
2. Understand the Models of E-Governance (Understanding)
3. Analyze the Evolution in E-Governance (Analyzing)
4. Evaluate the significance of Technological Infrastructural Preparedness (Applying)

Module – I (10 hours)

Introduction to E-Government and E-Governance: Difference between E-Government and E-Governance; E-Government as Information System; Benefits of E-Government; E-Government Life Cycle; Online Service Delivery and Electronic Service Delivery; Evolution, Scope and Content of E-Governance; Present Global Trends of Growth in E-Governance

Module – II (15 hours)

Models of E-Governance: Introduction; Model of Digital Governance: Broadcasting / Wider Dissemination Model, Critical Flow Model, Comparative Analysis Model, Mobilization and Lobbying Model, Interactive – Service Model / Government-to-Citizen-to-Government Model (G2C2G); Evolution in E-Governance and Maturity Models: Five Maturity Levels; Characteristics of Maturity Levels; Towards Good Governance through E-Governance Models

Module-III (10 hours)

E-Government Infrastructure Development: Network Infrastructure; Computing Infrastructure; Data centres; E-Government Architecture; Interoperability Framework; Cloud Governance; E-readiness; Data System Infrastructure; Legal Infrastructural Preparedness; Institutional Infrastructural Preparedness; Human Infrastructural Preparedness; Technological Infrastructural Preparedness

Module –IV (10 hours)

Case Studies: E-Government Initiatives in USA, UK and India.

Suggested Readings

1. R.P. Sinha- E-governance in India: Initiatives and Issues
2. Prabhu- E-Governance: Concepts and Case Studies
3. Sri Ram Khanna- Digital Drive, E-governance and Internet Services in India: Quality Dimensions
4. Suri, P.K., Sushil - Strategic Planning and Implementation of E-Governance
5. Basandra, S.K - Computers Today Galgotia Publishers Pvt. Ltd
6. Bhatnagar S.S. - E-government: From Vision to Implementation
7. Bhatacharya, J. - E-gov2.0: policies, progress and technologies
8. Brien, J and Marakas G.M - Management Information System: India(TMH)
9. B. Srinivas - E-Governance Technique

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	L
CO 2	L	H	L	L
CO 3	L	L	H	L
CO 4	L	L	L	H

PADP6001: DISSERTATION – Phase I

Credits: -6 (90 Hours)

Every student shall undertake a research project work which has bearing on his/her area under the supervision and guidance of a faculty member. The preliminary work may begin in the third semester. The students are expected to complete the Literature Survey and Synopsis before going for data collection. The thesis is to be submitted to the department before the date notified. The mode and components of evaluation and the weightages attached to them shall be published by the Department/Institute at the beginning of the 3rdsemester. There shall be a viva voce examination on the research project. 6 Credits of this course will be allotted in the 4th semester.

PADP6005: DISSERTATION – Phase II
Credits: -6 (90 Hours)

Every student shall undertake a research project work which has bearing on his/her area under the supervision and guidance of a faculty member. The preliminary work may begin in the third semester. The students are expected to complete the Literature Survey and Synopsis before going for data collection. The thesis is to be submitted to the department before the date notified. The mode and components of evaluation and the weightages attached to them shall be published by the Department/Institute at the beginning of the 3rdsemester. There shall be a viva voce examination on the research project. 6 Credits of this course will be allotted in the 4th semester.

VALUE ADDED COURSES

PAEP0021: ENVIRONMENTAL POLICY AND ADMINISTRATION

Credits: -3 (45 lectures) (45 hours)

COURSE OUTCOMES

At the end of this course students are able to:

1. Understand the Development and Environmental issues in India (Understanding)
2. Understanding the Environmental Policies in India and recent developments (Remembering and understanding)
3. Analyze the Impact of urbanization on Environment (Analyzing)
4. Evaluate the Urban Environmental administration in India (Applying)

Module – I (10 hours)

Development and Environmental issues in India; Environmental Policy in India; Role of Judiciary in Environmental administration in India; Civil Society and Environmental protection in India

Module – II (15 hours)

Development – Environment Discourse; Global Environmental Governance

Module-III (10 hours)

Urban Environmental administration and politics in India; Impact of urbanization on Environment and Public Health.

Module –IV (10 hours)

Urban Environmental administration: Major initiatives; Environmental politics in Urban India; Environmental Protection and People's right and duties; Steps taken by the government for environmental protection in the recent years.

Suggested Readings

1. Ajith Sankar- Environmental Management
2. Bruckmeier, Karl - Global Environmental Governance: Social-Ecological Perspectives
3. Arild Vatn- Environmental Governance: Institutions, Policies and Actions
4. J.P. Evans - Environmental Governance
5. Jean-Frederic Morin, Amandine Orsini- Essential Concepts of Global Environmental Governance
6. Frank Biermann, Philipp H. Pattberg - Global Environmental Governance Reconsidered
7. Prakash Chand Kandpal- Environmental Governance in India: Issues and Challenges
8. Albert Breton- Environmental Governance and Decentralisation

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	L
CO 2	L	H	L	L
CO 3	L	L	H	L
CO 4	L	L	L	H

PAIG0023: INNOVATION IN GOVERNANCE

Credits: 3 (45 lectures) (45 Hours)

COURSE OUTCOMES

At the end of this course students are able to:

1. Understand the Institutional Framework for Promoting Innovations (Remembering & Understanding)
2. Understand the Methodological Approach for studying best Practices (Understanding)
3. Analyze the Innovations in Public Services (Analyzing)
4. Evaluate the role of citizen's participation in governmental innovations (Applying)

Module – I (10 hours)

Innovations in Governance: Meaning of innovation in governance; Perspectives and Challenges; Characteristics and Patterns of Innovations; Institutional Framework for Promoting Innovations; Public Governance and Innovations: Administrative Reform to Innovation Discourse

Module – II (10 hours)
Understanding Innovations: Innovation for Achieving a Quality of Life, Methodological Approach for studying best Practices, Capacities for Innovation and Best Practices

Module – III (10 hours)
Innovations in Public Services: Recent trends; Innovation Capacity in Organizations; Leadership and Innovation; Innovations in different sectors: General Administration, Urban Administration, Health Administration, Private Sector, Agriculture, etc

Module – IV (10 hours)
Transferability of Best Practices and Innovations: The Ombudsman against Corruption, Technology and Changing Nature of Organizations, Best Practices of Knowledge Management Framework, Diffusion of Innovation in a Development Context

Module – V (05 hours)
Issue Areas: Originality and Replication of Innovations; Innovation with or Without Improvement; Citizen Participation in Government Innovations; Research in Innovative Governance

Suggested Readings

1. Anttiroiko et.al. (Eds.) (2011), Innovations in Public Governance, IOS Press.
2. Bevir, Mark, ed. (2010) The Sage Handbook of Governance. Thousand Oaks, CA: Sage Publications.
3. Borins, S. (2001), The Challenge of Innovating in Government (PricewaterhouseCoopers Endowment for the Business of Government,) Governance Innovators Network, http://www.innovations.harvard.edu/
4. Innovations in Governance and Public Administration: Replicating what works, (2006) Department of Economic and Social Affairs, United Nations, New York
5. Jean Hartley (January 2005), Innovation in Governance and Public Services: Past and Present, Public Money & Management, pp.27-36.
6. Newman, J., Raine, J. and Skelcher, C. (2000), Innovation in Local Government: A Good Practice Guide (DETR, London).
7. Peters, B. Guy (1996) The Future of Governance: Four Emerging Models, pp. 1-20.
8. Pollitt, C. and Bouckaert, G. (2000), Public Management Reform: A Comparative Analysis (Oxford University Press, Oxford).
9. Sandford Borins, ed., (2008), Innovations in Government Research, Recognition, and Replication, Brookings Institution Press.
10. Stephen P. Osborne, Ed.,(2001), The New Public Governance? Emerging Perspectives on the Theory and Practice of Public Governance. London: Routledge
11. Walker, R., Jeanes, E. and Rowlands, R. (2002), Measuring innovation: Applying the literature based innovation output indicator to public services. Public Administration, 80, pp. 201–214.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	L	L	L
CO 2	L	H	L	L
CO 3	L	L	H	L
CO 4	L	L	L	H

PASL0200: SERVICE LEARNING

Course Code: Credits: 2 (30 lectures) (60 Hours)

COURSE OUTCOMES
At the end of this course students are able to:
1. Learn the concept of service learning and community engagement. (Remembering)
2. Understand the importance of service learning and community engagement for developing the skills of addressing real life issues in one's own community. (Understanding)
3. Develop an understanding of the importance of communication skills in interacting with community members. (Understanding)
4. Be exposed to and empathize with people who are less fortunate than they are, politically, economically, socially, academically etc. (Applying)

5. Organize awareness programmes, rallies, campaigns, social service etc. (Analysing)
6. Develop the skills of problem solving and reflective thinking. (Analysing)
7. Realize one's potentiality to make a difference in the life of their community members. (Evaluating)
8. Understand and experience various political and administrative issues that exist in the Society. (Evaluating)

Module I: Introduction to Service learning (10 hours)
Nature, Objectives, Historical Overview, Models, Qualities, Role of Higher Education Institutions (HEIs), Benefits, Challenges and Opportunities of Service Learning.

Module II: Social Responsibilities of HEIs (10 hours)
Understanding Social Responsibilities of HEIs, Community-University Engagement, Engaged Teaching, Research and Service, Principles for Community Engagement, Forms of Community Engagement, Community Based Participatory Research.

Module III: Understanding Rural Society (20 hours)
Rural Life Style, Rural Society, Rural Economy and Livelihood, Rural Institutions (Traditional Rural Organisations, Self-Help Groups, Panchayati Raj Institutions), Rural Development Programmes (Sarva Siksha Abhiyan, Beti Bachao Beti Padhao, Swatchh Bharat, Ayushman Bharat, MNREGA etc.).

Module IV: Practices for Service learning and Community (10 hours)
Internship, Community Mobilization, Awareness/Advocacy campaign, community meetings, rural reporting, case studies.

Suggested Readings

1. Berryman, S., and Bailey, T. (1992): The Double &elix of Education and the Economy. New York: The Institute on Education and thd Economy, Teachers College, Columbia University.
2. Blum, R. E. (May 10, 1995): Learning and Teaching: Our Work Together. Draft Concept Paper. Portland, OR: Northwest Regional Educational Laboratory.
3. Carnevale, A.; Gainer, L.; and A. Meltzer. (1990): Workplace Basics: The Essential Skills Employers Want. San Francisco: Jossey-Bass Publishers.
4. Collins, A., Brown, J.S. and S. Newman. "Cognitive Apprenticeship: Teaching the Craft of Reading, Writing and Mathematics", in L.B. Renick (ed.) Knowing Learning and Instruction: Essays in honour of Robert Glaser. Hillsdale, Erlbaum. Druian, G., Owens, J. and S. Owen. "Experiential Education: Search for Common
5. Roots". in R. Kraft and Y. Kielomeier (eds.) Experiential Learning in Schools and Higher EducationJ'. Dubuque, IAI KendalVHunt Publishing Co. (1995), pp. 17-25.
6. Dukehart, L. (1994). Community as Classroom: A Report Based on Presentations at the Work Now and in the Future 11 Conference". 7th Portland, OR Northwest Regional Educational Laboratory.
7. Hamilton, S.F. (1990). Apprenticeship for Adulthoad: Preparing Youth for the Future. New York: Free Press.
8. Zelldin, S. (1995). School to Work and Youth Development: Identifying Common Ground. Boston, M;A. High.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	L	H	L	L
CO 2	L	H	L	L
CO 3	L	L	L	H
CO 4	L	L	H	H
CO 5	L	L	H	H
CO 6	L	L	L	H
CO 7	L	L	L	H
CO 8	H	H	H	H

DE -1: Elective Group I - Choose any one

PAHR0024: INTRODUCTION TO HUMAN RIGHTS (HR)
Credits: 3 (45 Hours)

Course Outcomes:
At the end of this course, students would be able to:
CO 1: Recall the meaning, kinds and nature of human rights, and their evolution and development at domestic and

international levels (Remembering)

CO 2: Explain the nature and importance of UDHR, its universality and worldwide influence(Understanding)

CO 3: Identify the codification, nature and types of rights provided by the ICCPR (applying)

CO 4: Examine the state's obligations for implementing ICESCR (Analysing)

Module - I (15 hours) Understanding Human Rights:
Meaning of Human Rights; Kinds and Nature of Human Rights; Evolution of Rights - Developments at Domestic Level; Important Declarations of Rights; International Efforts to Develop Human Rights Norms.

Module – II (15 hours) Universal Declaration of Human Rights:
Objectives, Nature, and importance of UDHR; Critique of Human Rights; Universality of Human Rights; Worldwide Influence of UDHR; NGOs on Human Rights.

Module -III (15 hours) International Covenant on Civil and Political Rights:
Codification of Rights; Nature of International Covenant on Civil and Political Rights (ICCPR); types of Rights provided by the ICCPR; Limitations on the Exercise of Rights; Mechanism for monitoring the implementation of Rights; The procedure to file complaints.

Module - IV (15 hours) International Covenant on Economic, Social and Cultural Rights:
International Covenant on Economic, Social and Cultural Rights (ICESCR); Implementation Mechanism; The Nature of Obligations under ICESCR; Economic, Social and Cultural Rights under the Indian Constitution.

Suggested ReadingS

1. Baehr, Peter. *Human rights: Universality in practice*. Springer, 2016.
2. O'Byrne, Darren. *Human rights: An introduction*. Routledge, 2014.
3. Assembly, UN General. "Universal declaration of human rights." *UN General Assembly* 302.2 (1948): 14-25.
4. Nickel, James W. *Making sense of human rights: Philosophical reflections on the universal declaration of human rights*. Univ of California Press, 1987.
5. Joseph, Sarah, and Melissa Castan. *The international covenant on civil and political rights: cases, materials, and commentary*. Oxford University Press, 2013.
6. Schabas, William A. *UN International Covenant on Civil and Political Rights: Nowak's CCPR Commentary*. NP Engel Verlag, 2019.
7. Saul, Ben, David Kinley, and Jaqueline Mowbray. *The international covenant on economic, social and cultural rights: commentary, cases, and materials*. OUP Oxford, 2014.
8. Sepúlveda, M. Magdalena, and María Magdalena Sepúlveda Carmona. *The nature of the obligations under the International Covenant on Economic, Social and Cultural Rights*. Vol. 18. Intersentia nv, 2003.

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2		H		
CO 3			H	
CO 4				H

PAIR0025: INTRODUCTION TO INTERNATIONAL RELATIONS (IR)

Credits: 3 (45 Hours)

Course Outcomes:

At the end of this course, students would be able to:

CO 1: Explain the Basic concepts of IR, its development as a discipline, Actors and Processes, Power and Balance of Power, International Economics (Understanding)

CO 2: Identify the theories of International Relations (Applying)

CO 3: Examine the various Issues in Contemporary IR (analyzing)

MODULE I [15 hours]: Introduction and Basic concepts of IR:

a. Introduction: Why study IR – Development of IR as discipline – International System/International Society- Impact of

Globalisation - Global South and IR

b. Actors and processes in IR: States and Non-State Actors (IGO's, NGO's, MNC's and terrorist groups).
c. Power: Definition and Exercising Power – Elements of National Power, Soft Power and Its relevance in the contemporary IR study.
d. Balance of Power – Bi-Polar/Unipolar/Multi-Polar and Non-Polarity- Soft balancing.
e. International Economics

Module II [15 hours]: Theories of International Relations:
Realist, Liberal, Marxist and Critical Theories of IR [Newly added]

MODULE-III [15 hours]: Issues in Contemporary IR:
International Terrorism, Nuclear Proliferation, Human Security, Climate Change and Environmental Security, Energy Security, Natural resource scarcity, Pandemic and Disaster Management, IR in In Covid and Post Covid

Suggested Readings

1. Andrew F. Hart & Bruce D. Jones (2010-2011), How Do Rising Powers Rise**?,** Survival, vol. 52 no.
2. 6, December –January, pp. 63–88.
3. Baylis, John and Steve Smith (2011): *The Globalisation of World Politics,* New York: Oxford University Press .
4. Derek Mcdougal (2012): Responses to 'Rising China' in the East Asian Region: soft balancing with accommodation, Journal of Contemporary China, 21(73), January, 1–17.
5. Joseph Y. S. Cheng (2011): The Shanghai Co-operation Organization: China's Initiative in Regional Institutional Building, Journal of Contemporary Asia, 41:4, 632-656.
6. Mary Martin and Taylor Owen (2010): The Second Generation of Human Security: lessons from the
7. UN and EU Experience, *International Affairs* 86: 1, 211-224.
8. Michael Sheehan (2010): International Security: An Analytical Survey, Viva Books: New Delhi.
9. Oxford University Press: New Delhi.
10. Paul R. Viotti and Mark V. Kauppi (2007): International relations and World Politics: Security,
11. Economy, Identity, Pearson: Delhi.
12. Paul, T.V. (2009): *The Tradition of Non-use of Nuclear Weapons,* Stanford: Stanford University Press.
13. Seethi K.M.(2009): Perils of Nuclear Renaissance, Indian Journal of Politics and International Relations, vol. 1, July-December
14. Tanja A. Börzel and Thomas Risse (2010): Governance without a state: Can it work? *Regulation & Governance,* 4, 113–134.
15. Thomas Wilkins (2010): The new 'Pacific Century' and the rise of China: an international relations perspective, Australian Journal of International Affairs, 64:4, 381-405
16. Vinodan.C. (2010): Energy, Environment and Security in South Asia, *International Journal of South Asian Studies*, vol.3, no.1, pp 1-12

PAIC0026: ISSUES IN CONTEMPORARY INTERNATIONAL RELATIONS (HR/IR)

Course Outcomes:
At the end of this course, students would be able to:

CO 1: Explain the Basic concepts of Globalisation and Challenges to Developing countries (Understanding)
CO 2: Identify Various Environmental Issues addressed at International levels (Applying)
CO 3: Examine the various Regional and Global Security Issues (analyzing)

Module I [Hours 15] : Globalisation and Challenges to Developing Countries
Globalization and (under)development- population explosion- human rights issues- international migration and refugee crisis

Module II [Hours 15] : International Relations of Environmental Issues
Sustainable development- the notion of collective goods- natural resource exploitation and scarcity- global warming and international climate regimes- disputes over resources- nuclear proliferation and international treaties

Module III [Hours 15] : Regional and Global Security Issues
Political instability in third world countries- energy security- cyber security- arms proliferation-Non State actors- terrorism and counter terrorism

Suggested Reading

1. Baylis, John & Smith S (Eds) (2014).*The Globalization of World Politics: An Introduction to International Relations*. OUP.
2. Betts, Alexander & Loescher G (Eds) (2011). *Refugees in International Relations*. Oxford University Press.
3. Brown C & Ainley K (2009). *Understanding International Relations* (4th ed). Palgrave Bull, Hedley (1977). *The Anarchical Society: A Study of Order in World Politics*. Macmillan.
4. Buzan B. & Lawson G. (2015). *The Global Transformation: History, Modernity and the Making of International Relations: CUP*.
5. Castles, Stephen & Davidson A. (2005). *Citizenship and Migration: Globalization and Politics of Belonging*. Routledge
6. Castles, Stephen & Miller M. J. (2003). *The Age of Migration: International Population Movements in the Modern World* (Third Edition). MacMillan.
7. Christian, Reus -Smith & Snidal D (eds.) (2008). *Oxford Handbook of International Relations*.
8. Clark I. (1997). *Globalization and Fragmentation: International Relations in the Twentieth Century*. Oxford University Press.
9. Dinar, Shilom. (2009). Scarcity and Cooperation along International Rivers. *Global Environmental Politics*, *9*(1), 109.
10. Fiddian-Qasmiyeh E. et al. (Eds) (2014). *The Oxford Handbook of Refugee and Forced Migration Studies*. Oxford University Press.
11. Higgins, R. & Flory, M. (2003). *Terrorism and International Law*. Routledge.
12. Robert Art & Robert Jervis (eds) (2012). *International Politics: Enduring Concepts and Contemporary Issues* (11th ed). Pearson.
13. Samson, T. (2000). *Issues in International Relations*. Routledge.
14. Teryima B, Ashaver (2013, Sep. -Oct.). Poverty, Inequality and Underdevelopment in Third World Countries: Bad State Policies or Bad Global Rules?. *IOSR Journal Of Humanities And Social Science (IOSR-JHSS)*, *15*(6), 33-38.
15. Vincent, R. J. (1995). *Human Rights and International Relations*. CUP.
16. Zolberg A. R. Et al (1989). *Escape from Violence: Conflict and the Refugee Crisis in the Developing World*. Oxford University Press.

PAPF0027: POLICY FORMULATION- STRUCTURES AND PROCESSES (PP)

Credits: 3 (45 Hours)

Course Outcomes:

At the end of this course, students would be able to:

CO1- Recall the basic concepts and types of public policy (Understanding).
CO2- Identify the role of different institution in policy formulation (Applying)
CO3- Examine the agencies involved in policy formulation process(Analysing)

Module I (15 Hours) Introduction to Public Policy

Meaning, Nature and Scope of Public Policy; Significance of Public Policy; Types of Policy; Public Policy and Public Administration; Policy Cycle.

Module II (15 hours)Policy Formulation Structures

Inter-Governmental Relations; Role of Legislature; Role of Executive; Role of Judiciary; Role of Bureaucracy; Challenges in Policy Formulation.

Module III (15 Hours) Policy Formulation Processes

Techniques of Policy Formulation; Approaches/ Models of Policy Formulation; Agencies involved in Policy Formulation; Informal Channels of Policy Formulation; Role of International Organizations.

References:

1. R.K Sapru, Public Policy: A Contemporary Perspective, Sage Publications India Pvt Ltd, 2017.
2. Bidyut Chakrabarty and Prakash Chand, Public Policy: Concept, Theory and Practice, Sage Publications India Pvt Ltd, 2016.
3. Maniram sharma, Public Policy in India, Mahaveer Publications, 2023.
4. Haridwar Shukla,Public Policy and Administration in India, Mahaveer Publications, 2021
5. Kuldeep Mathur, Public Policy and Politics in India, Oxford University Press, 2015
6. Ramesh Kumar Tiwari and Aasha Kapur Mehta, Public Policy and Administration, Gyan Publishing House 2012.
7. Christoph Knill and Jale Tosun, Public Policy: A New Introduction, Red Globe Press, London, 2020.

DE 3 : Elective Group II - Choose anyone

PALM0028: LABOUR MIGRATION, CITIZENSHIP AND GOVERNANCE (HR/IR)

Credits: 3 (45 Hours)

Course Outcomes:
At the end of this course, students would be able to:
CO 1: Recall the meaning, nature, reasons, and impact of labour migration. (Remembering/ Understanding)
CO 2: Identify the issue of human rights violations of migrant labourers. (Applying)
CO 3: Explain the Contribution of Labour Migration in India's Development (Understanding)
CO 4: Examine the issues of Labour migration and citizenship rights. (Analysis)

Module - I (15 hours) Understanding Labour Migration
Labour migration-meaning; nature and determinants; reasons and impact; Migrant Labours and human rights; International labour standards on labour migration; the role of ILO.

Module – II (15 hours) Labour Migration in India:
Overview of Labour Migration in India; Contribution of Labour Migration in India's Development; Labour Rights and Labour Standards for Migrant Labour in India.

Module -III (15 hours) Citizenship:
Significance; Nature of Citizenship; Labour migration and citizenship rights.

Module - IV (15 hours) Case studies:
Case Study on Inter-State Labour migration in India; Case Study on International Labour migration; Active citizenship case studies.

Suggested Reading:

1. Amrith, Megha, and Nina Sahraoui, eds. *Gender, work and migration: agency in gendered labour settings*. Routledge, 2018.
2. Panneerselvan, A. S. "Uncertain journeys: labour migration from South Asia".
3. Rajan, S. Irudaya, ed. *India migration report 2010: Governance and labour migration*. Taylor & Francis, 2020.
4. Acharya, Ashok. *Citizenship in a globalizing world*. Pearson Education India, 2011.
5. Mahanta, Nani G. *Citizenship Debate over NRC and CAA: Assam and the Politics of History*. SAGE Publishing India, 2021.

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4
CO 1	H	M		
CO 2	H	M		
CO 3		H		
CO 4			H	M

PASE0029: INDIA IN SOUTH EAST ASIAN POLITICS (HR /IR)
(3 CREDITS)

Course Outcomes:
At the end of this course students are able to:
CO 1: relate important aspects of the history of India and South East Asia (Remembering).
CO 2: explain the policies of India in relation to South East Asian Countries. (Understanding)
CO 3: Identify various Important International institutions and agencies in South East Asia (Applying)
CO 4: Examine the challenges faced by India by South East Asian Politics. (Analysing)

Module I Historical Developments:
Historical, cultural, political, Trade and Social history of India with South East Asia, Indian Influence on South east Asia,

Module II India and its Neighborhood:
Look East Policy, Act East Policy, Kaladan Multi-modal Transit Transport Project,

Module III International Institutions:
ASEAN, RECP, ADB, JICA, World Bank, SCO, BRICS, BIMSTEC

Module IV Indian Challenges:
Golden Triangle, South China Sea and Chinese Claims, String of Pearls, CPEC, OBORI, Malaccan Dilemma, Border Disputes, and Insurgency.

Suggested Readings:

1. Devotta, Neil (2015) An Introduction to South Asian politics. Routledge Publishing: New Delhi.
2. Ahmad, Ahrar (2013) Government and Politics in South Asia. West View Press: Colorado,US.
3. Pandit, Dhulipudi, Santishree and Basu, Rimli (2012) Cultural Diplomacy in South-East-Asia: India's Look East Policy, Buddhism as an instrument of Foreign Policy. LAP Lambart Academic Publishing: London, UK.
4. Ludden, David (2015) India and South Asia: A Short History (Short Histories). Pan Macmillan India: New Delhi.
5. Tat,Urni (2022) India's Development Diplomacy: Understanding Development Cooperation As a Tool For Strategic Engagement In South Asia. KW Publishers: New Delhi.
6. Bhattacharyya, Daipayan (2016) Government as Practice: Democratic Left in a Transforming India (South Asia in the Social Sciences) Cambridge University Press: New Delhi.

PAPP0030: PUBLIC POLICY IN INDIA (PP)
Credits: 3 (45 Hours)

Course Outcomes:
At the end of this course students are able to:
CO 1: Recall the various stages and determinants of public policy(Remembering).
CO 2: Explain the various determinants of Public Policy (Understanding)
CO 3: Identify India's developmental policies(Applying).
CO 4: Examine the policies for weaker and marginalized sections (Analysing).

Module I (15 Hours): Introduction to Public Policy in India
Historical perspectives and developments of Public Policy (Five Year Plans); Socio-economic and political determinants of Public Policy; Technology and Public Policy; Ethics in Public Policy

Module II (15 Hours) India's Developmental Policies
Education Policy; Health Policy; Environmental Policy; IT Policy; Economic Policy.

Module III (15 Hours) Policies for Weaker and Marginalized Sections
Tribal Development; Children Welfare; Women Empowerment; Policies for Senior Citizens; Transgender Inclusion;

References:

1. Rajesh Chakrabarti and Kaushiki Sanyal, Public Policy in India, Oxford University Press, 2016.
2. Bidyut Chakrabarty and Prakash Chand, Public Policy: Concept, Theory and Practice, Sage Publications India Pvt Ltd, 2016.
3. Maniram sharma, Public Policy in India, Mahaveer Publications, 2023.
4. Haridwar Shukla,Public Policy and Administration in India, Mahaveer Publications, 2021
5. Kuldeep Mathur, Public Policy and Politics in India, Oxford University Press, 2015
6. Veerendra Mishra, Transgenders in India: An Introduction, Taylor and Francis Group, Routledge Publications, 2023.
7. John Baldock et. al., Social Policy, London: Oxford University Press, 2011.

PADV0031: DATA MANAGEMENT AND VISUALISATION
Credits: 2 (L.T.P 1-0-1) 15+30 hours

Course Outcomes:
At the end of this course, students would be able to:
CO 1: Exhibit a basic understanding of data management and visualization (Understanding)
CO 2: Apply knowledge of data management and visualization to solve a business problem. (Applying)

Module – I Data Management & Visualisation:
Meaning and significance of data management; Data Management Platforms and software.
Meaning and significance of data visualization; Data Visualization tools and software.

Module -II Data Management & Visualisation – Practical:
SAS - Statistical Analysis System
Visualization software (Tableau, Excel, Power BI)

Suggested Reading:

1. Strengholt, Piethein. Data Management at Scale. N.p., O'Reilly Media, 2020.
2. International, Dama. DAMA-DMBOK: Data Management Body of Knowledge. United States, Technics Publications, 2017.
3. Data Visualization: Trends and Challenges Toward Multidisciplinary Perception. Germany, Springer Nature Singapore, 2020.
4. Grant, Robert. Data Visualization: Charts, Maps, and Interactive Graphics. United States, CRC Press, 2018.

Mapping of COs to Syllabus

	Module 1	Module 2	Module 3	Module 4
CO 1	H	H		
CO 2			H	H

PAIO0032: INTERNATIONAL ORGANISATIONS AND NATIONAL INTEREST (HR/IR)

Credit 3 (Hours 45)

Course Outcomes:

At the end of this course students are able to:
CO 1: Recall key concepts and importance of IOs and national interests (Remembering)
CO 2: Identifying theoretical perspectives of IOs and national interests (Applying)
CO 3: Examine the functioning of the United Nations Organization and other International Organisations (Analysing)

Module 1 (Hours 10): International Organisations (IOs) and National Interest:
Key concepts, necessities of IOs, IOs and national interests, the demand for international regime

Module 2 (Hours 15): Theoretical approaches to international organizations and national interests:
Theories and approaches to IOs and national interest

Module 3 (Hours 20): Functioning of the United Nations Organization and other IOs:
Evolution and Development, role and achievement of the UNO and other IOs, issues and challenges; nation-states' response to the UNO (case study of the permanent member states; non-permanent member states like India)

Suggested Readings:

1. Lenz, T., Hooghe, L., Marks, G. (2019). A Theory of International Organization. United Kingdom: OUP Oxford.
2. Pease, K. S. (2018). International Organizations: Perspectives on Global Governance. United Kingdom: Taylor & Francis.
3. Krasner, S. D. (2020). Defending the National Interest: Raw Materials Investments and U.S. Foreign Policy. United States: Princeton University Press.
4. Burchill, S. (2005). The National Interest in International Relations Theory. United Kingdom: Palgrave Macmillan UK.
5. Weiss, T. G. (2019). The United Nations and Changing World Politics. United States: Taylor & Francis.
6. Coicaud, J. (2007). Beyond the national interest: the future of UN peacekeeping and multilateralism in an era of U.S. primacy. Washington: United States Institute of Peace Press.
7. Roach, S. C., Griffiths, M., O'Callaghan, T. (2014). International Relations: The Key Concepts. United Kingdom: Taylor & Francis.

PAPI0033: POLICY IMPLEMENTATION (PP)

Credits: 3 (45 Hours)

Course Outcome:

At the end of this course students are able to:
CO 1: Explain the policy implementation system, models and approaches (Understanding).
CO 2: Identify policy implementation techniques and challenges(Applying).
CO 3: Examine the impact of public policy through case studies(Analysing).

Module I (15 Hours) Policy Implementation System

Policy Implementation as a Concept; Systems and Issues of Policy Implementation; Approaches/ Models in Policy Implementation;

Module II (15 Hours) Implementation Techniques
Conditions for Successful Implementation of Public Policy;Agencies in Policy Implementation; Challenges in Policy Implementation**.**

Module III (15 Hours) Case Studies in Policy Implementation
Suggested areas- Education, Health, Tribal Development, Weaker Sections. Evaluation and Feedback: Monitoring and Social Audit.

Suggested Readings

1. Bidyut Chakrabarty and Prakash Chand, Public Policy: Concept, Theory and Practice, Sage Publications India Pvt Ltd, 2016.
2. Christoph Knill and Jale Tosun, Public Policy: A New Introduction, Red Globe Press, London, 2020.
3. Paul Cairney,. Understanding Public Policy: Theories and Issues, Red Globe Press, London, 2020
4. Jaideep Singh, Case Studies in Public Administration, Indian Institute of Public Administration, 1983.
5. Maniram sharma, Public Policy in India, Mahaveer Publications, 2023.
6. Haridwar Shukla,Public Policy and Administration in India, Mahaveer Publications, 2021.
7. Kuldeep Mathur, Public Policy and Politics in India, Oxford University Press, 2015

PACG0034: CHINA AND THE GLOBAL SYSTEM (HR/IR)

Credit 3 (Hours 45)

Course Outcome:

At the end of this course students are able to:

CO 1: Explain the policy implementation system, models and approaches (Understanding).
CO 2: Identify policy implementation techniques and challenges (Applying).
CO 3: Examine the impact of public policy through case studies (Analysing).

Module 1 (Hours 15): Rise of China and the debate on Asian Century

1.1 Theoretical Explanations: China as a major power
1.2 China's Foreign policy and World view- Peaceful Rise and State power
1.3 Chinas perspectives on Asian Century
1.4 China and the UNO

Module 2 (Hours 15): China and Global powers

2.1 US- China relations
2.2 Russia- China relations
2.3 EU-China relations
2.4 India- China Relations
2.5 Japan – China

Module 3 (Hours 15): Chinas engagement with the regions

3.1 OBOR (One Belt, One Road)
3.2 Neighbourhood policy – South Asia- East Asia and South East Asia
3.3 Territorial disputes: Maritime disputes: South China Sea Boundary dispute

Suggested Readings:

1. Dahlman, C. (2011). The World Under Pressure: How China and India Are Influencing the Global Economy and Environment. United States: Stanford University Press.
2. Cao, C., Han, X., Parker, R., Appelbaum, R. P., Simon, D. (2018). Innovation in China: Challenging the Global Science and Technology System. United Kingdom: Polity Press.
3. He, A. (2016). The Dragon's Footprints: China in the Global Economic Governance System Under the G20 Framework. Canada: McGill-Queen's University Press.
4. Liu, W. (2014). China in the United Nations. United States: World Century Publishing Corporation.
5. Oertel, J. (2015). China and the United Nations. Germany: Bloomsbury Publishing.
6. Mifune, E., Kondapalli, S. (2010). China and Its Neighbours. India: Pentagon Press.
7. Tai, M. (2019). China and Her Neighbours: Asian Diplomacy from Ancient History to the Present. United Kingdom: Zed Books.

PAPO0035: POLICY ANALYSIS (PP)
Credits: 3 (45 Hours)
Course Outcome:
At the end of this course students are able to:
CO 1: Explain the basic concept and framework of policy analysis (Understanding)
CO 2: Identify methods and techniques of Policy Analysis (Applying).
CO 3: Examine the various issues involved in policy analysis (Analyzing).

Module I (15 Hours) Introduction to Policy Analysis
Meaning of Policy Analysis; Stages in Policy Analysis; Types of Policy Analysis; A Framework of Public Policy Analysis in Indian Context.

Module II(15 Hours)
Policy Analysis Scenario: Policy Sciences: Nature, Scope and Utility; Methods and Techniques of Policy Analysis; Civil Societies and democratization of Policy Analysis;

Module III (15 Hours)
Issues in Policy Analysis: Ethics in Policy Analysis, Key elements of Policy Analysis (Stuart S. Nagel); The major Dimensions of policy analysis; Policy Analysis and Emerging Crisis

References:
1. Jean Dreze, Social Policy, New Delhi: Orient Blackswan Private Limited, 2016.
2. V. K. Agnihotri, Public Policy: Analysis and Design, Concept Publishing Company, 1995.
3. Rachel Meltzer and Alex Schwartz, Policy Analysis as Problem Solving: A Flexible and Evidence-Based Framework, Routledge, 2018.
4. Bidyut Chakrabarty and Prakash Chand, Public Policy: Concept, Theory and Practice, Sage Publications India Pvt Ltd, 2016.
5. Kuldeep Mathur, Public Policy and Politics in India, Oxford University Press, 2015
6. Ramesh Kumar Tiwari and Aasha Kapur Mehta, Public Policy and Administration, Gyan Publishing House 2012.
7. Rajesh Chakrabarti and Kaushiki Sanyal, Public Policy in India, Oxford University Press, 2012.

DEPARTMENT OF SOCIAL WORK
MASTER OF SOCIAL WORK- MSW

VISION
To be a centre of excellence in Social Work teaching, learning, research and practice which promotes commitment to social justice, fosters social consciousness and sensitivity, and upholds the dignity and worth of all.

MISSION
The Social Work Department of Assam Don Bosco University seeks to:
- Promote rights based approaches to development based on the International declaration of human rights
- Achieve excellence in teaching, learning, research, practice, outreach programmes and extension services
- Promote critical thinking and innovative intervention in response to societal and environmental problems
- Mould professionally competent individuals who are sensitive and committed to the values, principles and ethics of social work
- Create and foster an environment of justice and respect for all by promoting social consciousness, courage of conviction, appreciation for diversity and caring for creation.

PROGRAM OUTCOMES – MSW PROGRAMME
PO 1: **Critical Thinking and Professional Judgment:** Apply theoretical knowledge to make a critical analysis, intervene using innovative frameworks and evaluate and follow up.

PO 2: **Effective Communication**: Engage in inter-personnel, behavioral change communication and be proficient in Information Communication Technology.

PO 3: **Gender Sensitization, Social Commitment and Social Interaction**: Work in teams and partnerships at local, national and transnational projects and settings with focus on gender equity and cultural sensitivity

PO 4: **Effective Citizenship**: Engage in service learning and community engagement programmes for contributing towards achieving of local, regional and national goals.

PO 5: **Ethics**: To engage in social work practice as per National Association of Social Worker's ethical framework.

PO 6: **Environment and Sustainability**: Participate and promote World sustainable development goals 2030.

PO 7: **Self-directed and Life-long Learning**: Engage in continuous learning for professional growth and development.

PO 8: **Scientific Temper: -** Gaining aptitude for research for contribution to knowledge enterprise and documentation of social work theory and practice.

PROGRAM SPECIFIC OUTCOMES
PSO 1: **PSO 1: Conceptual clarity:** Students get familiarized and attain conceptual clarity in social work theories, perspectives, models, methods and processes of social work practice.

PSO 2: **PSO2: Attaining procedural skills:** Students attain knowledge of different steps of doing a work/intervention as per local, national and international protocols- norms, legal bindings and regulations.

PSO 3: **PSO3: Strategic intervention skills**: Learn what should be done when, and how it should be done when it comes to social work interventions in the fields of children, women, families, community development, health and mental health, development projects, and other welfare activities.

PSO 4: **PSO4: Attitudinal change:** Working with the personal self for meaningful and enriching social work professional career.

LIST OF COURSES
Sl.NO	Course
1.1	History, Ideologies and fields of Social Work
1.2	Human Growth and Development
1.3	Introduction to Indian Society, Polity and Economics
1.4	Social Work with Communities and Social Action
1.5	Environment and Disaster Management
1.6	Gender Studies
1.7	Concurrent Field Work and Rural Practicum
1.8	Service learning/Rural practicum
2.1	Social Casework Practice with Individuals and families

2.2	Social Work Practice with Groups
2.3	Social Work Research and Statistics
2.4	Social Welfare Administration
2.5	Introduction to Disability Studies
2.6	Concurrent Field Work II
3.1	Social Justice, Human Rights & Para-legal Education
3.2	Emerging Social Work Perspectives and Integrated Approach
3.3	Computer Applications for Social Sciences (Lab)
3.4	Community Development: Rural, Tribal and Urban
3.5	Governance and Community Development
3.6	Family Centered Social Work Practice
3.7	Social Work Practice with Children
3.8	Medical Social Work
3.9	Mental Health and Social Work
3.10	Organisational Structure, Behaviour and Development
3.11	Policies For Development Organisations – Urban, Rural and Tribal Communities
3.12	Introduction to Child Psychology and Development
3.13	Rights of the Child – Legal Framework, National and International Instruments
3.14	Continuous Field Work I
4.1	Social Development and Social Policy
4.2	Project cycle Management and Resource Mobilisation
4.3	Dissertation (Research Phase I and Research Phase II)
4.4	Community Health and Population Management
4.5	Community Development Practice with Disempowered Communities
4.6	Development Concerns and Women Empowerment
4.7	Families With Special Needs
4.8	Psychiatric Social Work
4.9	Community Health and Services
4.1	Human Resource Management: Social Work Perspective
4.11	Corporate Social Responsibilities – Concepts & Ideologies
4.12	Children with Special Needs
4.13	Child Centered Social Work Practice
4.14	Continuous Fieldwork II
4.15	Internship
VALUE ADDED COURSES	
4.16	Results Based Management of Projects and Programmes
4.17	Academic Writing, Research Proposal Development and Dissertation Writing Course
4.18	Working with Diversity

Mapping of Pos and PSOs.

Sl.No	Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
1.1	History, Ideologies and fields of Social Work	H			L	H				H			M
1.2	Human Growth and Development	H	M							H	M		
1.3	Introduction to Indian Society, Polity and Economics	H	M		L		L			H			
1.4	Social Work with Communities and Social Action			H		M	M		M	H	M	M	M
1.5	Environment and Disaster Management	H		H			H		M	H		M	M
1.6	Gender Studies	H		H		M		M	M	H	M		H
1.7	Concurrent Field Work and Rural Practicum	M	M	L	L		M			H	L	L	L

1.8	Service learning/Rural practicum	H	H	H	M	L	M	H	L	M	H	M	L
2.1	Social Casework Practice with Individuals and families	H	M			H			H	H	H	H	H
2.2	Social Work Practice with Groups	H	H			M				H	H	M	H
2.3	Social Work Research and Statistics	H		L		M		M	M	M	L		
2.4	Social Welfare Administration	H	M		M	M				H	M	H	
2.5	Introduction to Disability Studies	H				M				H	M		
2.6	Concurrent Field Work II	H	H	M	M	M		M		H	M	M	M
3.1	Social Justice, Human Rights & Para-legal Education	H		M	H	M				H	M		M
3.2	Emerging Social Work Perspectives and Integrated Approach	H		H		M		M	L	H	H	M	
3.3	Computer Applications for Social Sciences (Lab)	M	H		L			H					M
3.4	Community Development: Rural, Tribal and Urban	H		H	M	M	H		M	H	H	H	H
3.5	Governance and Community Development	M			M		L	H		H		H	H
3.6	Family Centered Social Work Practice	H		H		M				H	H	H	M
3.7	Social Work Practice with Children	H	H	M	M	H				H	H	M	H
3.8	Medical Social Work	H	H			H			M	H	H	H	H
3.9	Mental Health and Social Work	H	H						M	H	H	H	H
3.1	Organisational Structure, Behaviour and Development	H	M			L		M		H		M	
3.11	Policies For Development Organisations - Urban, Rural and Tribal Communities	H		M			M			H	H	H	H
3.12	Introduction to Child Psychology and Development	H				H		M		H	H	H	H
3.13	Rights of the Child – Legal Framework, National and International Instruments	H		H	H	H				H	H	H	
3.14	Continuous Field Work I	H	H	H	H	H	H	H	H	H	H	H	H
4.1	Social Development and Social Policy	H		H	M					H	M	M	
4.2	Project cycle Management and Resource Mobilisation	H				L		H		H	M	H	
4.3	Dissertation ((Research Phase I and Research Phase II))	H	H			M		H	H	H			M
4.4	Community Health and Population Management	H		H	M	M			M	H	H	H	H
4.5	Community Development Practice with Disempowered Communities	H		L	M			M		H	H	H	H
4.6	Development Concerns and Women Empowerment	H	M	H	M	M			M	H	H	M	M
4.7	Families With Special Needs	H	H	H		M				H	H	H	H
4.8	Psychiatric Social Work	H	H			M		M	H	H	H	H	H
4.9	Community Health and	H		H		M			M	H	H	H	H

	Services												
4.1	Human Resource Management: Social Work Perspective	H				M		H		M		H	
4.11	Corporate Social Responsibilities - Concepts & Ideologies	H				M			M	H		M	
4.12	Children with Special Needs	H	M	H		M			M	H	H	H	H
4.13	Child Centered Social Work Practice	H	M	H		M			M	H	H	H	H
4.14	Continuous Fieldwork II	H	H	H	H	H	H	H	H	H	H	H	H
4.15	Internship	H	H	H	H	H	H	H	H	H	H	M	H
4.16	Results Based Management of Projects and Programmes	H	M	H	M	M	H	H	H	M	H	M	H
4.17	Academic Writing, Research Proposal Development and Dissertation Writing Course	M	M	H	M	M	H	H	H	M	M	M	H
4.18	Working with Diversity	M	H	M	H	M	H	M	H	M	M	H	M

DETAILED SYLLABUS

SWHI0035: HISTORY, IDEOLOGIES AND FIELDS OF SOCIAL WORK

(3-0-0) (3 Credits - 45 hours)

Course Outcomes:

- Introduce the basic concepts of social work to the students. (Understanding)
- Introduce to the students the history and philosophy of social work, its methods and fields (Remembering)
- Introduce social work as a profession (Applying)
- Motivate the students to appreciate social work as a profession and to recognize the need and importance of social work education, training and practice. (Creating)

Module I: Introduction to Social Work (11 hours)

Concepts and Definitions: – Social Work, Social Service, Social Welfare, Social Reform, Social Defense, Social Policy, Social Action, Social Legislation and Social Advocacy ; Principles, Objectives, Scope and Goals ; Process of Social Work; Professional values and Code of ethics; Skills of social worker

Module II: History and Ideologies of Social Work (11 hours)

Historical development of Social Work in UK, USA and India: The Elizabethan poor law (1601); Charity Organization Society (1869);The Settlement House Movement, (USA); The Poor Law Commission of 1905; The Beveridge Report (1941); Social Reforms and Social Movements; Gandhian Philosophical Foundation to Social Work in India.

Module III: Social Work Profession (11 hours)

Social Work Theories; Professional organizations; Indian Association of Professional Social Workers; National Association of Social Workers; International/Indian Council of Social Workers; International Association of Schools of Social Work

Module IV: Fields of Social Work Practice (12 hours)

Family, Child and Youth Welfare; Social Work Practice in Industries/ Industrial Social Work; Social Work for weaker sections: Aged, Persons with Disability, Women Welfare; Environment/Ecology; Healthcare: Medical and Psychiatric; School Social Work; Correctional Administration

Suggested Readings

1. Gore. M.S, Social Work and Social Work Education, Asia, Publication house, Mumbai, 1965
2. Jainendra Kumar Jha, Practice of Social work, Anmol Publications, New Delhi, 2002,
3. Joshi.S.C, The Handbook of Social work, Akansha Publishing House, New Delhi, 2004.
4. Paul Chowdhury, Introduction to Social Work, ATMA RAM and SONS, Delhi, 2000.
5. Sanjay Bhattacharya, Social work – An Integrated Approach, Deep and Deep Publications Pvt Ltd, New Delhi, 2003
6. Walsh Joseph, Theories of Direct Social work practice, Thomson Brooks, Cole, 2006
7. Allan, June, Bob Pease and Linda Briskman (ed.). Critical Social Work – An Introduction to Theories and Practices, Rawat Publications, Jaipur, 2003.
8. Bhattacharya, Sanjay, Social Work Interventions and Management, Deep and Deep, New Delhi, 2008
9. Bogo, Marion, Social Work Practice – Concepts, Processes and Interviewing, Rawat Publications, Jaipur, 2007
10. Cox, David and Manohar Pawar, International Social Work – Issues, Strategies and Programs, Vistar Publications, New Delhi, 2006
11. Desai, Murli, Ideologies and Social Work, Rawat Publications, Jaipur, 2002
12. Dominelli, Lena, Social Work: Theory and Practice for a Changing Profession, Polity Press, London, 2004
13. Skidmore AR and Milton G Thackeray, Introduction to Social Work, Prentice Hall, New Jersey
14. Lukose P J, Social analysis: A guide for the Social Workers, Media House Publications, New Delhi-2015.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			M
CO 2		H	M	
CO 3	M	H	H	H
CO 4			H	H

SWGD0036: HUMAN GROWTH AND DEVELOPMENT

(2-0-0) (2 Credits - 30 hours)

Course Outcomes

- Introduce the basic concepts of human growth and development. (Remembering)
- Introduce the Personality theories (Understanding & Applying)
- Introduce the Concept of Mental Health and discuss the role of social worker in promoting it. (Understanding and Creating))
- Introduce the concept of health, causes, symptoms, treatment and prevention of communicable and non-communicable diseases (Understanding, Applying, Analyzing and Evaluating)

Module I: Meaning of Growth and Development (8 hours)

a. Meaning of growth, development and maturity, Principles of human development
b. Approaches to the study of human development: biological, maturational, psychoanalytic, behavioural, cognitive-developmental, ecological, Social
c. Influence of socialization and development - family, social groups, institution, community and culture.

Module II: Developmental Stages and Personality Theories (10 hours

a. Physical, Emotional, Cognitive and Social aspects of the following developmental stages with special reference to Indian conditions – Infancy, Babyhood, childhood, adolescence, adulthood, old age.
b. Personality theories – Freud, Jung, Adler, Erikson, Rogers, Maslow

Module III: Mental health (5 hours)

a. Concept of Normalcy and abnormality - Symptoms, Causes and treatment of neuroses and psychoses, personality disorder and mental retardation.
b. Role of Social Workers in Promoting Mental Health

Module IV: Physical Health (7 hours)

a. Concept of health, hygiene, WHO definition of health; nutrition, malnutrition and its impact on growth
b. Communicable and non-communicable diseases - Symptoms, causes, treatment, prevention and control of some common diseases – communicable: T.B., Leprosy, STD, HIV, Typhoid, Chickenpox, Malaria, Hepatitis; non-communicable: Hypertension, Diabetes, Cancer, Malnutrition and deficiency diseases.
c. Institutions and agencies intervening in human growth and development- family, education, Health care systems

Suggested Readings

1. Berk, Laura E. Development through the Lifespan, 5th edition. Allyn and Bacon. London: 2009
2. Ahuja, Niraj. A Short textbook of Psychiatry, Himalaya Publishing House. New Delhi: 2005
3. Bhattacharya, Sanjay Dr. 2008. Social Work: Psycho-Social and Health Aspects. New Delhi: Deep and Deep Publication, 1992.
4. Clifford T. Morgan, Richard A. King, John R. Weisz, John Schopler, Introduction to Psychology, Tata Mc.Graw Hill Edition.
5. Coleman James. C, Abnormal Psychology and Modern Life, D.B. Taneporevela. Mumbai: 1975
6. Dandapani S., General Psychology, Neelkamal Publications Pvt. Ltd. Hyderabad: 2007
7. Diagnostic and Statistical Manual of Mental Disorders – 4th Edition. DSM – IV-TR. American Psychiatric Association. Washington DC: 2000
8. Hurlock, Elizabeth, Developmental Psychology, Tata Mc Graw Hill. New York: 2001
9. Kaplan Saddock, Synopsis of Psychiatry. 7th Ed. BI Waverly Pvt. Ltd. New Delhi: 1994
10. Park. J.E and Park. K, TextBook of Preventive and Social Medicine, Bansaridas Bhanot. Jabalpur: 2003
11. Robert A. Baron, Psychology, 5th Edition. Pearson. Prentice Hall: 2001
12. Steinberg, Laurence, Adolescence, McGraw Hill Inc. New York: 1993
13. WHO, The ICD – 10 Classification of Mental and Behavioural Disorders, Diagnostic Criteria for Research, AITBS Publishers and Distributors (Regd.). Delhi: 2004
14. Archambeault, John. (2009). Social Work and Mental Health, UK: Learning Matters Pvt Ltd.
15. Paula Nicolson, Rowan Bayne and Jenny Owen. (2006). Applied Psychology for Social Workers, UK: Palgrave Macmillan Ltd. (3rd Edition).

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2	M	H	H	
CO 3		M	H	
CO 4	M			H

SWIS0037: INTRODUCTION TO INDIAN SOCIETY, ECONOMICS AND POLITY

(2-0-0) (2 Credits- 30 hours)

Course Outcomes

- Understand the concept of society& culture, major social institutions, structure, stratification, different approaches to the study of society and to develop an understanding onsocial change and social mobility; (Remembering and Understanding)
- Understand and define basic concepts of economic and political theories ;(Remembering and Understanding)
- Explain how the economic and political institutions are organized, and how they have a bearing on human society ;(Applying)
- Identify and evaluate the political institutions, processes and experiences of India, with special reference to North East India (Evaluating and Creating)

Module I: Basic Sociological Concepts (10 hours)

a. The concept of society – Meaning, definition and characteristics of society;
b. The concept of culture - Meaning, definition, elements & characteristics;
c. Social structure and stratification- Caste, Class, Tribes, Gender & Religion;
d. Approaches to the study of society- Structural Functionalism approach; Conflict/ Dialectical approach; Symbolic Interactionism;
e. Social institutions- Marriage, Family, Education& Religion;
f. Social change and social mobility; Social Work and society

Module II: Basic Concepts in Economics (10 hours)

a. Concept and definition: economy, micro and macroeconomics; market, demand and supply, national income, national income indicators; per-capita income,standard of living, poverty and its measurement in India
b. Economic systems: capitalism, socialism, communism, mixed economy, neoliberalism
c. Global economic institutions: World Bank, IMF, WTO, Asian Development Bank
d. Globalisation and Indian economy: Special Economic Zones and MNCs
e. Growth, development and social justice
f. Social work and economics

Module II: Basic Concepts in Politics (10 hours)

a. The concept of state – Meaning and definition, and elements;Nationalism and Nation State;
b. Perspectives of the state – Liberal, Marxist, Feminist, Gandhi, and Ambedkar
c. Key concepts-Liberty, Equality,Justice, Power, Legitimacy, Authority, Sovereignty;
d. The Constitution of India, and the Federal characteristic of Indian state;
e. Citizenship: rights and duties;
f. North East India: Decentralised governance &political movements

Suggested Readings

1. Abbas, H. Indian government and politics. New Delhi: Dorling Kindersley. (2010).
2. Ananth, V.K. India since independence: making sense of Indian politics. New Delhi: Dorling Kindersley. (2010).
3. Anthony, G. Sociology. Cambridge: Cambridge Polity Press. (2001).
4. Behera, M.C. (Ed.). Globalization and development dilemma: reflection from North East India. New Delhi: Mittal Publications. (2004).
5. Boyes, W., & Michael, M. Textbook of economics: Indian adaptation (6th ed.). New Delhi: Houghton Mifflin Co. (2005).
6. Desai, S. B. et al. Human Development in India: challenges for a society in transition. Hyderabad: OUP. (2010).
7. Dreze, J., &Sen, A. Uncertain glory: India and its contradictions. New Delhi: OUP. (2013).
8. Gupta, D. (Ed.). Social Stratification. New Delhi: Oxford University Press. (1997).
9. Guru, G., &Sarukkai, S. The Cracked Mirror: An Indian Debate on Experience and Theory. New Delhi: OUP (2017).
10. Hayami, Y., &Godo, Y. Development economics: from poverty to the wealth of nations, (3rd ed.). New Delhi: OUP. (2010).
11. Johari, J.C. Contemporary political theory: new dimensions, basic concepts and major trends. New Delhi: Sterling Publishers. (2006).
12. Mankiw, N. G. Principles of economics. Manson OH South West: Cengage Learning. (2008).
13. Menon, N Gender and Politics in India. New Delhi: Oxford University Press. . (1999).
14. Schrems, J. Understanding principles of politics and the state. Maryland: University Press of America. (2007).
15. Sen, A. Development as. New York: OUP. (1999).
16. Sesagiri, N. (Ed.). Survey of rural India: a comprehensive study of gram panchayat and community development block, (Vol. 26). New Delhi: GyanPrakashan. (2013).
17. Xaxa, V. State Society and Tribes. New Delhi: Pearson Education. (2014).

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			M
CO 2	M	H	H	
CO 3		M	H	
CO 4	M			H
CO 5	H		M	H

SWCS0070: SOCIAL WORK WITH COMMUNITIES AND SOCIAL ACTION

(3-0-0) (3 Credits– 45 hours)

COURSE OUTCOMES

- Define and spell community organisation and social action as methods in social work education and practice.(Remembering)
- Explain the concepts related to community organisation and social action as methods of social work education and practice.(Understanding)
- Apply the understanding of the concepts of community organisation and social action in the fields of practice.(Applying)
- Analyze various field situations and apply there levant methods to address social concerns. (Analyzing)
- Assess and choose community organisation or social action strategies to address social issues. (Evaluating)
- Combine effectiveness of community organisation or social action models and strategies and make modification if required for effective intervention in communities. (Creating)

Module I: Concepts of Community (11 hour)

Understanding Community: Definition, Concept, Types(Urban, Rural, Tribal and Open Communities), Structure and Functioning; Community Power Structure and Leadership; Community Dynamics.

Module II: Community Organization (11 hours)

Community Organization: Definition, Scope, Philosophy, Principles; Community Organization and Community Development; Approaches to Community Organization; Role and Skills of Social Worker in the Community; Techniques and Strategies of Community Organization.

Module III: Phases of Community Organization (11 hours)

Process of Community Organization - Study and Survey, Analysis, Assessment, Discussion, Organization, Action, Reflection, Modification and Continuation.

Module IV: Models of Community Organization, Community Development and Social Action (12Hours)

Models of Community Organization; Social Action – Principles and Process of Social Action and its Scope in India; Approaches to Social Action: Radical and Right based; Models of Community Development: Locality Development, Social Planning Model, Social Action Model, Saul Alinsky Model.

Suggested Readings

1. Bhattacharya, Sanjay, Social Work an Integrated Approach, Deep and Deep, New Delhi, 2006
2. Christopher, A.J.,and Thomas William, Community Organization and Social Action, Himalaya Publications, New Delhi, 2006
3. Freire, Paulo, Education for the Oppressed, Seaburg Press, New York, 1970
4. Freire, Paulo, Cultural Action for Freedom, Penguin, Harmonds Worth, 1972
5. Kumar,Somesh,MethodsforCommunityParticipation–aCompleteGuideforPractitioners, Vistaar Publications, New Delhi, 2002
6. Prasad, Ankit, Social Welfare and Social Action.New Delhi: Mittal Publications
7. Ross.M.G.,CommunityOrganisation.Theories,Principles,andPractices,HarperandRow,NewYork, 1955
8. Siddqui, H.Y.., Working with Communities, Hira Publication,New Delhi, 1997
9. Skidmore, A. Rex and Milton. G. Thackeray, Introduction to Social Work, Prentice Hall, New Jersey,1976
10. Shrivasta, S. K (1988) Social Movements for development, Allahabad: Chugh Publications
11. Siddique, H.Y. (1984) Social Work and Social Action,New Delhi: Harnam Publications
12. ZastrowH.Charles–ThePracticeofSocialWork–AComprehensiveWorktext,BROOKS/COLE– Cengage Learning Publications,9th Edition
13. Alinsky Saul (1971) Rules for Radicals: A Practice Primer for Realistic Radicals, Vintage
14. RM Mac Iver and Charles H Page, Society – An Introductory Analysis, Surjeet Publications

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	M	M	M	H
CO 2	H	H	M	M
CO 3			H	
CO 4				H
CO 5		M		M
CO 6	M		H	

SWEM0038: ENVIRONMENT STUDIES AND DISASTER MANAGEMENT(3-0-0)

(3 Credit- 45 hours)

Course Outcome:

- Understand the interrelatedness of human life and environment (Understanding)
- Develop an understanding of problems arising out of environmental degradation and globalization (Analysing)
- Understand the roles of State in disaster management (Evaluating)
- Study the role of social work practice in tracking environmental issues and disaster management (Creating)

Module I: Environment and Sustainable Development (11 hours)

Concepts: Environment and Ecology; the Interrelatedness of living organisms and natural Resources; Global Environmental Crisis and its linkages to the development process. Global warming, Environmental politics and resource development regimes; Sustainable development: Management and Conservation changes

Module II: The State and the Environment (11 hours)

State of India's Environment: Waste Management; Pollution – Air, Water, Soil, Noise; Laws Related to environment; Social Work and Environment: Environment Education, Environment Ethics, Promotion Environment Movements, Environment Management – EIA.

Module III: Concept of Disaster and Models of Disaster Management (11 hours)

Disaster: Definition, Natural and Human made disasters; multiple causes and effects; Stages of disaster; Development and Disaster; Preventive Measures; Models of Disaster: Crunch Model and Release Model

Module IV: Roles of Organizations in Disaster Management (12 hours)

Disaster Management and Phases. Pre-disaster: Prevention, Preparation, Education, Vulnerability and Preparedness. Actual Disaster: Contingency, Short Term and Long Term Plans, Search, Relief, Rescue, Recovery and Restoration. Post Disaster: Rehabilitation and Commemorations; Role of Social Workers and Voluntary Agencies: Role of Social Work Professionals at different levels

Suggested Readings

1. Abbasi S.A., Wetlands of India: Ecology and Threats Vol. 1-3, 1997.
2. Dorr Donal, Social Justice Agenda: Justice, Ecology, Power and the Church, 1990.
3. Goel P.K., Environmental Guidelines and Standards in India, 1996.
4. Madhav Godgil; Ramachandra Guha, Ecology and Equity: The use and abuse of nature in contemporary India, 1995.
5. Neugeboren Bernard, Environmental Practice in the Human Services: Integration of Micro and Macro Roles, Skills and Contexts, 1996
6. Shukla S.K., Srivastava P.R., Human Environment: An analysis, 1992.
7. Shukla S.K., Srivastava P.R., Environmental Pollution and Chronic Diseases.
8. Auf Der Heide. Disaster Response: Principles of Preparation and Coordination. St. Louis: Mosbe, 1989.
9. 9. Canton, Lucien G. Emergency Management: Concepts and Strategies for Effective Programs. Hoboken NJ: Wiley Inter-Science, 2007.
10. Cutter, Susan L. (Ed.). American Hazardscapes: The Regionalization of Hazards & Disasters. Wash DC: Joseph Henry Press, 2001.
11. Godschalk, David R., Timothy Beatley, Philip Berke, David Brower, and Edward Kaiser. Natural Hazard Mitigation: Recasting Disaster Policy & Planning. Island Press. 1999.
12. Haddow, George D. and Jane A. Bullock. Introduction to Emergency Management (2nd Ed.).Burlington, MA: Elsevier Butterworth-Heinemann, 2006.
13. May, Peter J, et al. Environmental Management and Governance: Intergovernmental Approaches to Hazards and Sustainability. London & NY: Routledge, 1996.
14. National Research Council. Facing Hazards and Disasters: Understanding Human Dimensions. Washington, DC: National Academies Press, 2006.

15. Noji, Eric K. (Ed.). The Public Health Consequences of Disasters. New York and Oxford: Oxford University Press, 1997.
16. Platt, Rutherford H. Disasters and Democracy: The Politics of Extreme Natural Events. Washington, DC: Island Press, 1999.
17. Quarantelli, E.L. (ed.) What is a Disaster – Perspectives on the Question. London and New York: Routledge, 1998
18. Tobin, Graham A. and Burrell E. Montz. Natural Hazards: Explanation and Integration. New York and London: The Guilford Press, 1997.
19. Waugh, William L. Living With Hazards/Dealing With Disasters-An Introduction To Emergency Management. Armonk, NY: M.E. Sharpe, Inc., 2000.
20. Wisner, Ben, Piers Blaikie, Terry Cannon, and Ian Davis. At Risk: Natural Hazards, People's Vulnerability and Disasters (2nd Ed.). London and New York: Routledge, 2004.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	H		
CO 2	H		H	
CO 3		H		M
CO 4		M	H	

SWGS0039: GENDER STUDIES (3-0-0)

(3 Credit- 45 hours)

Course Outcomes

- Understand the concept of gender, patriarchy, gender roles and relationships. (Remembering and Understanding)
- Study the feminist theories, women's movements, and women's development(Remembering and Understanding)
- Critically study the intersectionality i.e. how race/ethnicity, sexuality, class, age, citizenship, and other identities crosscut and shape gender identities and roles (Applying and Analysing)
- Critically understand concerns of gender issues, and aim to analyze everyday gendered experiences from Social Work perspectives. (Evaluating and Creating)

Module I: Understanding gender, gender and society, gender studies (11 hours)

Introduction – Gender, Sex, Sexuality, Gender Perspectives of Body, Social Construction of Femininity, Social Construction of Masculinity, Patriarchy, LGBTQ, Gender roles, Gender Lens: Political and Legal Systems, Gender and Education, Inter-sectionality, Social Dynamics of Gender, Women's Studies and Gender Studies

Module II: History, Theory and Women's Movement (11 hours)

Historical Overview of Feminist Movements, Feminist Movement in Europe and the US, Women's Movement in India, Changing profile of women in India- pre and post independent India, History of women's education; Theory- Feminism and types of feminism, Gender Schema theory, Queer theory; Approaches to understanding women and development

Module III: Gender Concerns (11 hours)

Violence against women, conflict, poverty, displacement, migration, disaster –impact on women, women working in organized and unorganized sector, reproductive health, social, cultural and political determinants of health

Module IV: Constitutional Rights of Women, Policies and Programmes (12 hours)

CEDAW, Dowry Prohibition Act 1961, Equal Remuneration Act 1976, Maternity Benefit Act 1961, Plantation Labour Act 1951, Medical Termination of Pregnancy Act 1971, Pre-natal Diagnostic Techniques (Regulation and Prevention of Misuse Act 2002, Protection of Women from Domestics Violence Act 2005, The Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act 2013, Functions of National Commission for Women and State Commission for Women

Suggested Readings

1. Bhasin, K. Understanding Gender. Kali for Women Publication. (2000).
2. Bhasin, K. What is Patriarchy? Kali for Women Publication. (2000).
3. Ckhakravati, U. Gendering Caste: Through a Feminist Lens (Theorizing Feminism). Stree; UK ed. edition (January) (2003).
4. Cook, R. Human Rights of Women: National and International Perspectives. Philadelphia, University of Pennsylvania Press (1994).
5. Harding, Sandra G(ed.). The Feminist Standpoint Theory Reader. New York: Routledge. (2004).
6. Gordon, L. P. Violence against Women. New York: Nova Publishers. (2002).
7. Kumar, Girish (ed.). Health Sector Reforms in India. New Delhi: Manohar (2009).
8. Lalkima, C. Lalneihzovi. Changing Status of women in north-eastern states. New Delhi: Mittal Publications. (2009).
9. Pandya, Rameshwari. Patel, Sarika. Women in the Unorganised Sector of India. New Delhi: New Century Publications. (2010).
10. Joshir, T.S. Women and Development. New Delhi, Mittal Publications. (1999).

11. Mies, M.,Shiva, V. Eco-feminism. London: Zed Books.. (1993).
12. Agnes, Flavia. Law and Gender Inequality: The Politics of Women's Rights in India. Delhi: Oxford University Press. (2004).
13. Arya, Sadhna. Roy, Anupama. Poverty, Gender and Migration. New Delhi: Sage Publications. (2006).
14. Ramazanouglu, Caroline. Holland, Jannet. (ed). Feminist Methodology: Challenges and Choices. London: Sage Publications Inc. (2002).
15. Ganesamurthy, V,S. Empowerment of Women in India: Social, Economic and Political. New Delhi: New Century Publications. (2008).
16. Datar, Chaya. Integrating activism and academics. In Jain, Devika and Rajput, Pam (Eds.), Narratives from the Women's Studies Family: Recreating Knowledge (pp. 136-149). New Delhi: Sage Publication. (2003).

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H		M	
CO 2	M	H	H	
CO 3		M	H	
CO 4	M		M	H

SWPF0040: SOCIAL WORK PRACTICE WITH INDIVIDUALS AND FAMILIES(3-0-0)

(3 Credits – 45 hours)

Course Outcomes:

- Introduce the concept of social casework as a method of social work practice and the tools used in Casework. (Remembering, Understanding & Applying)
- Introduce the approaches to Case work. (Remembering, Understanding & Applying)
- Introduce Casework process and the techniques used. (Understanding, Applying, Analyzing & Evaluating)
- Discuss the application of social casework in different settings. (Understanding, Analyzing, Evaluating & Creating)

Module I: Introduction to Nature and Development of Social Casework (11 hours)

Social Casework: Meaning, Nature, Assumptions, Principles, Ethics and Process of Social Casework; Tools – Observation, Listening, Relationship, Interview, Home Visit, Collateral Visit, Family group conferencing; Casework and Counseling, Casework and Psychotherapy

Module II: Approaches to Casework Practice (11 hours)

Diagnostic and Functional approach; Psycho-social approach; Problem solving approach; Task centered approach; Client centered approach; Pearlman approach

Module III: Process and technique of social casework (11 hours)

Phases of casework intervention: Intake, Problem identification, Diagnosis of the problem, Treatment, Assessment, Monitoring and Evaluation, Termination/ Follow up; Techniques of Casework Intervention -Supportive Techniques, Enhancing Resources Techniques; Casework recording: Types and Principles of recording

Module IV: Social Casework Practice (12 hours)

Application of Social Case Work in different settings and Clientele groups- Casework with Children, Correctional Settings, Clinical Settings, Geriatric Care, the Terminally Ill people, and Crisis Situations; Discussion of Case Records in different Agency Settings, Relations of Casework with other methods of social work.

Suggested Readings

1. Biestek Felix, The Casework Relationship, Unwin University Books, London, 1968
2. Government of India, Encyclopedia in Social Work, Publication Division (Social Welfare Ministry), New Delhi, 1987
3. Hamilton, Gordon, The New York School of Social Work: Theory and Practice of Social Case Work, Columbia University Press, New York and London, 1970
4. Holis, Florence and Woods, Mary E., Casework – A Psychosoical Therapy, Fantom House, New York, 1981
5. Kadushin, Alfred, The Social Work Interview, Colulmbia University Press, New York, 1990
6. Keats, Daphne, Interviewing – A Practical Guide for Students and Professionals, Viva Books Pvt. Ltd., New Delhi, 2002.
7. Mathew Grace, An Introduction to Social Case Work, Tata Institute of Social Sciences, Bombay, 1992
8. Nelson Jones, Richard, Practical Counseling and Helping Skills, Harper and Row, London, 1984
9. Nursten, Jean, Process of Case Work, Pitman Publishing Corporation, 1974
10. O'Hagan, Kieran, Kingsley, Jessica, Competence in Social Work Practice – A Practical Guide for Professionals, London, 2003
11. Perlman, Helen Harris, Social Case Work – A Problem Solving Process, University of Chicago Press, London, 1964
12. Rameshwari Devi, Ravi Prakash, Social Work Methods, Practices and Perspectives (Models of Casework Practice), Vol. II, Ch.3, Mangal Deep Publication, Jaipur, 2004

13. Richmond, Mary, Social Diagnosis, Free Press, New York, 1970
14. Thompson, Neil, People Skills, 2nd Ed., Palgrave Macmillan, New York, 2006
15. Aptekar Herbert, The Dynamics of Casework and Counseling, Houghton Mifflin Co., New York, 1955.
16. Babara, J. G., Beyond Case Work, London, 1991
17. Fisher Joe, Effective Case Work Practice – An Elective Approach, McGraw Hill, New York, 1978
18. Garrett, Annett, Interviewing – Its Principles and Methods, Family Service Association of America, New York, 1972
19. Lishman, Joyce, Communication in Social Work, Palgrave MacMillan, New York, 1994
20. Sena, Fine and Glass, Paul H., The First Helping Interview Engaging the Client and Building Trust, Sage Publications, New York, 1966
21. Sheafor, Bradford, Horejsi, Charles, Horejsi, Gloria, Techniques and Guidelines for Social Work Practice, Allyn and Bacon, London, 1997
22. Timms, Noel, Social Case Work, Routledge and Kegan Paul, London, 1966

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H		M	M
CO 2		H		H
CO 3			H	H
CO 4		H		H

SWPG0041: SOCIAL WORK PRACTICE WITH GROUPS (3-0-0)

(3 Credits- 45 hours)

Course Outcomes

- Understand the concept of groups and its importance and influence on individuals (Remembering and Understanding)
- Understand social group work as a method of social work (Remembering and Understanding)
- Develop skills to apply group work methods in various settings (Creating and Evaluating)
- Identify and acquire the skills needed to work with groups effectively (Applying and Analysing)

Module I: The Concepts (11 hours)

Concept of group: definition, characteristics, Classification of different social Groups, Functions of Groups and Group as a medium of Social change.

Module II: Methods of Social Group Work (11 hours)

Social group work as a method of social work: definition, values, principles, assumptions, ethics, and functions of social group work; Techniques and skills used in Social Group work practice, Roles of Social group workers.

Module III: Process and Phases of Social Group Work (11 hours)

Group work process; Identification of the needs and interest; Program Planning and Program Development; Criteria of effective process and programme in SGW; Phases of Group Work: Pre-group, initial, treatment, and critical phase, evaluation and termination; Stages of Group Development (Forming, Norming, Storming, Performing and Adjourning) and Group Dynamics

Module IV: Social Group Work Practice in Agency Settings (12 hours)

Social Group Work in Different Settings: Self Help Groups, Groups in community setting, Groups in institutional settings (Hospitals, Rehabilitation Centers, Children's Home, Old Age Homes and Educational Settings); Discussion of Group records.

Suggested Readings

1. Cooper, Cary L, Theories of Group Processes, London: John Wiley and Sons, 1976
2. Douglas, Tom, Group Work Practice, London: Tavistock Publications, 1976
3. Douglas, Tom, Basic Group Work, London: Tavistock Publications, 1978
4. Ely, P.J. and M.K.McCullough, Social Work with Groups, London: Routtedge and Kegan Paul, 1975
5. Kanopka G, Social Group Work – A Helping Process, Engelwood Cliff: Prentice Hall (later version), 1963
6. Siddiqui, H.Y, Group Work: theories and practice; India, Pakistan, Bangladesh and Sri Lanka, Jaipur: Rawat Publications, 2007
7. Toseland, W. and Rivas, R.S. An Introduction to Groups Work Practice, Boston: Allyn and Bacon, 2000
8. Trecker, H.B., Social Group, New York: Association Press, 1975.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	M	H		M
CO 2	H	M	H	
CO 3	H	M	H	
CO 4	M			H

SWRS0042: SOCIAL WORK RESEARCH AND STATISTICS(3-0-0)

(3 Credits- 45 hours)

COURSE OUTCOMES

- Define and show social science research and social work research and the application of statistics in social work practice. (Remembering)
- Explain and discuss social work research as a method of social work and it application in addressing social issues. (Understanding)
- Apply the knowledge, skills for interpretation, documentation and presentation of results of social work research and statistics in carrying out applied research in addressing social issues. (Applying)
- Analyze various social issues and use research methods, strategies and data to suggest solutions.(Analyzing)
- Assess relevant research methods and techniques in carrying out social work research. (Evaluating)
- Create critical methods to carry out research in social work practice and suggest solutions to social issues. (Creating)

Module I: Introduction to Social Work Research (7 hours)

a. Research and Social Work Practice- Philosophical Foundations of Research.
b. Natural and social science research - characteristics and scientific attitude.
c. Social work research as a social research - relevance, ethics and values. Scope of social work research - basic and applied research.

Module II: Research designs, approaches and types (7 hours)

a. Research designs: Descriptive, Exploratory and Experimental: meaning, scope, characteristics, application in social work setting.
b. Research Approaches: Qualitative and Quantitative Research: meanings, scope, methods, steps, sampling, data collection, analysis, interpretation and reporting. Strengths and weaknesses.
c. Evaluative research: Programme and projects evaluation: concept, types, steps, reports.
d. Participatory research and action research: concepts, scope, application and steps.

Module III: Steps in Research Process (12 hours)

a. Problem Formulation: Identifying research issue, formulating research topic and problem, review of literature (library work), theoretical framework, formulating objectives, clarifying concepts, variables - conceptual and operational, formulating hypothesis.
b. Population and Sampling: Inclusion and exclusion criteria of population, the logic of sampling size and techniques: probability and non-probability sampling.
c. Tools for data collection: Levels, Types of measurements, reliability and validity of tools. Constructing tools for data collection: questionnaire, interview schedule, scales. Quantification of qualitative data.
d. Sources, Collection and Analysis of Data: Secondary and primary sources. Data collection data editing, coding, master sheet, analysis, report writing. Using a computer for data analysis: coding, analysis- graphs and results.

Module IV: Introduction to Statistics (12 hours)

a. Statistics: Definitions, Uses and Limitations. Classification and tabulation of data, univariate and bivariate, diagrammatic and graphical presentations. Measures of central tendency, Mean, Median and Mode and their uses; Measures of variability - range, variance and standard deviation.
b. Correlation: Meaning and computation of coefficient of correlation as product moment, Spearman's Rank Correlations, interpretation of correlations.
c. Test of Hypotheses: Basics, Probability distribution, normal distribution. t-test, Chi-Square Test

Module V: Application of Statistics and Reporting Research (7 hours)

a. Application of Statistics in Social Work Research.
b. Ethical guidelines in social work research.
c. Professional writing.
d. Introduction to software packages for statistical analysis.

Suggested Readings

1. Ahuja, Ram, Research Methods, Rawat, Jaipur, 2001
2. Alston, M. Bocoles, W., Research in Social Workers- An Introduction to the Methods, Rawat, Jaipur, Indian Edition 2003
3. Baker, T.L., Doing Social Research, McGraw Hill, Singapore, 1994
4. Dooley, D., Social Research Methods, Prentice Hall of India Pvt. Ltd., New Delhi, 1997
5. Goode, W.J. and Hatt, P.K., Methods in Social Research, McGraw Hill Singapore, 1981
6. Grinell, R. M., (Jr.), Social Work Research and Evaluation, F.E. Peacock Pub. Inc., Illinois, 1988
7. Gupta, C.B., Introduction to Statistical Methods, Vikas Publishing House, 1995
8. Gupta, S.C., Fundamentals of Statistics, Himalaya Publishing House, Delhi, 1997
9. Gupta, S.P., Statistical Methods, Sultan Chand and Sons, New Delhi 1997
10. Jacob, K.K., Methods and Fields of Social Work in India, Asia Publishing, Bombay, 1996
11. Kothari, C.R., Research Methodology: Methods and Techniques, 2nd edition reprint, New Age International New Delhi, 2004
12. Krishnaswamy, O.R., Methodology for Research in Social Science, Himalaya, Bombay, 1993
13. Laldas, D.K., Practice of Social Research, Rawat, Jaipur, 2000
14. Mikkelsen, B., Methods for Development Work and Research-A New Guide for practitioners, Sage, New Delhi, 2005
15. Ramchandran, P., Social Work Research and Statistics, Allied Publishers, Bombay, 1968
16. Rubin, A. and Babbie, E., Research Methods for Social Work, 4th edition, Wadsworth, West, Brooks/Cole and Schirmer, 2001
17. Sarantakos, S., Social Research, Palgrave Macmillan, New York, 2005
18. Sharma, B.A.V., Prasad, R.D. and Satyanarayana, C., Research Methods in Social Sciences, Sterling, New Delhi, 2002
19. Sharma, K.R., Research Methodology, National Publishing House, Jaipur, 2002
20. Wilkinson, T.S. and Bhandarkar, P.L., Methodology and Techniques of Social Research, Himalaya, Bombay, 1984
21. Young, p., Scientific Social Surveys and Research, Asian Students edition, Asia Publishing House, Japan, 1960

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4	Module 5
CO 1	H				M
CO 2	M				H
CO 3			H	H	
CO 4		H	M	M	H
CO 5		H		M	
CO 6	M				H

SWWA0043: SOCIAL WELFARE ADMINISTRATION (3-0-0)

(3 Credits- 45 hours)

Course Outcome:

- Develop an understanding of social welfare administration as a method of social work (Remembering)
- Understand the various components of social welfare administration (Understanding)
- Understand the concept and theories of Development (Analysing)
- Familiarize the students with the concepts of Management of Organisations and its principles (Evaluating)

Module I: Social Welfare Administration (11 hours)

Social Welfare Administration: Definition, Characteristics, Principles and Functions of Social Welfare Administration; Types of Social Welfare Administration: Social Welfare Administration and Public Administration; Establishment, Objectives and Importance of Central Social Welfare Board, State Social Welfare Board and International Organizations

Module II: Management of an Organization (11 hours)

Management: Principle and Significance of Management for Social Work; Components of Programme Management, Finance Management, Human Resource Management and Office Management

Module III: Strategies and Mechanisms of Administration (11 hours)

Processes related to Registration of Societies, Trust and Non-Profit Organization: Societies Registration Act 1860, Trusts and Non-Profit Organizations under Indian Companies Act: Foreign Contribution Regulation Act 1976 and Income Tax Rules applicable to Development / Charitable Organisations under Income Tax Act 1961; Role of Social Workers in Decision Making Process, Communication and Networking, and Sustainability of Programme

Module IV: Social Welfare Programmes (12 hours)

Social Welfare Programmes and Policies: Children, Youth, Women, Widows, Elderly and Differently- able and marginalized

Groups; Recent trends and Changes in Social Welfare Administration

Suggested Readings

1. Chowdry, Paul, Social Welfare Administration, Atma RRam and Sons, Delhi, 1992
2. Sankaran and Rodrigues, Handbook for the Management of Voluntary Organisations, Alpha Publications Chennai, 1983
3. Kulkarni, P.D., Social Policy and Social Development in India Association of schools of social work in India
4. Fred, Luthans, Organization Behaviour, III and IV edition
5. Rao, Subba, GCV. Family Law in Law, S. Gogia and Company, Hyderabad, 1999
6. Sulivan, Michael, Sociology and Social Welfare, Allen and Unwin, Winchester, USA, 1987
7. Reider, Dale, Evaluating Development Programmes and Projects, Second edition, Sage Publications, 2004
8. Gupta, N.S. Organization Theory and Behaviour. Delhi, 2009
9. Chaturvedi, A.N, Rights of the Accused under Indian Constitution.: Deep and Deep Delhi. 1984
10. Donnisson, D &Chapman, Social Policy and Administration. London. 1989
11. P.J. Lukose, Inclusive Development : A Human Rights Approach, Media House, New Delhi, 2014

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2	H	H		
CO 3				
CO 4		M	H	

SWDS0044: INTRODUCTION TO DISABILITY STUDIES(3-0-0)

(3 Credits- 45 hours)

Course Outcomes:

- Introduce the concept and different types of disabilities.(Remembering, Understanding & Applying)
- Introduce the Legislations for Persons with disabilities. (Remembering, Understanding & Applying)
- Introduce the concept of Inclusive Education in India. (Understanding, Applying, Analyzing, Evaluating and Creating)
- Discuss the Preventive Measures and government programs for Persons with Disabilities. (Understanding, Applying, Analyzing, Evaluating & Creating).

Module I: Understanding Disability (11 hours)

Disability: Definition, Causes, Types of Disabilities; Magnitude of various disabilities and their impact on persons with disability and their families; Needs and problems of persons with disability and their families across the life span; Social attitudes towards persons with disability.

Module II: Legislation, Programme and Schemes for PWD (11 hours)

Legal instruments related to PWDs: Persons with Disability Act-1995; Rehabilitation Council of India Act – 1992; National Trust Act-1999; Mental health Act; Rights of the Person with Disability Act 2016,

Module III: Inclusive Education (11 hours)

Concept and Meaning, Needs and importance; issues and challenges in implementing Inclusive education in India; Planning and managing an inclusive curriculum in schools; Measures for implementing Inclusive Education.

Module IV: Management of Disability and Policies (12 hours)

Prevention and Management of Disabilities at Primary, Secondary and Tertiary levels; Models -Social, Medical, Educational and Institutional ; National Policy on Persons with Disabilities, UN Conventions and Declarations on Persons with Disabilities; Different Government Schemes and programmes for Persons with Disabilities.

Suggested Readings

1. Albrecht G.L, Katherine D Seelman. & Michael Bury. Handbook of Disability (2001).
2. Bacquer, A. and Sharma, A. Disability: Challenges vs Responses, Delhi: CAN Publications (2007).
3. Hans, A. and Patri, A. Women and Disability, Delhi: Sage. (2003).
4. Hegarty Seamus & Mithu Alur. Education and Children with special needs, London: Sage. (2002).
5. Karanth, Pratibha & Joe Rozario. Learning disability in India, London: Sage (2003).
6. Grant. Learning disability: A lifecycle approach to valuing people, London: Open University Press (2005).
7. Moore. Researching disability issues, London: Open University Press. (2005).
8. Rothman, J.C. Social Work Practice Across Disability. Boston: Allyn & Bacon. (2003).
9. Oliver, M. & Sapey, B. (ed.) Social Work with Disabled People. London: Palgrave Macmillan. (1998).

10. Banerjee, G. Legal Rights of a Person with Disability. New Delhi: Gyan Publishing House. (2001).
11. WHO. Community-based rehabilitation: CBR guidelines. Geneva: WHO Press. (2010).
12. Karna, G.N. Disability Studies in India: Retrospect and Prospects, New Delhi: Gyan Publishing House. (2001).
13. NCF National Curriculum Framework. New Delhi: NCERT. (2005).
14. B huimali, A Rights of disabled Women and Children In India. New Delhi: Serials Publications (2010).
15. Burke, Peter Disability and Impairment: Working with children and families. Jessica Kingsley Publications. (2008).

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M		M
CO 2	M	H		
CO 3		M	H	
CO 4	M	M		H

SWSJ0045: SOCIAL JUSTICE, HUMAN RIGHTS AND PARALEGAL EDUCATION(3-0-0)
(3 Credits–45 hours)

Course Outcomes
- Provide an understanding on social legislation and social action with relevance to social work practice (Remembering and Understanding)
- Develop an understanding about various social welfare legislationswith specific reference to different groups of people; 9 Evaluating and Creating)
- Understand the provisions of the legal system and the mechanisms available in the country for addressing issues of social change. (Understanding, Applying and Analysing)

Module I: Social Justice and Human Rights (7 hours)
a. Meaning of Justice, Forms of Justice, Theories of Justice,
b. Law and Social Justice, Human Rights and Social Justice, Issues in Social Justice.

Module II: Social Legislation and Social Work (7 hours)
a. Understanding concepts of law, social justice and social legislation, Legislation as an instrument of social justice and control.
b. The Constitution of India: preamble and fundamental rights; Directive Principles of State Policy
c. Classification of law: civil and criminal law. Relevance of law and legal systems to social work practice, partnership and interface between social workers and legal systems.

Module III: Reformatory Law and Laws related to Protection of Human Rights (7 hours)
a. Major provisions of the law for the protection of human rights, Structure, functions and powers of National and State Human Rights Commissions.
b. Major provisions in Indian Penal Code (IPC) related to family violence, murder, suicide, rape.
c. Meaning of cognizable and non-cognizable offences and conditions and procedures for bail; Importance and Procedures for filing a First Information Report (FIR)

Module IV: Social legislations: Major Provisions (20 hours)
a. Laws Related to Children: Juvenile Justice Act, Laws relating to Adoption and Guardianship, Child Marriage Restraint Act, Prohibition and Regulation of Child Labour Act. Protection of Children from Sexual Offences (POCSO) Act Laws Related to Family: Personal laws and the Civil law related to Marriage, Divorce, Maintenance and Succession; Law against Domestic Violence; Law of Family Court. Laws Related to Women: Immoral Trafficking Prevention Act (ITPA), The Sexual harassment of Women at Workplace (Prevention, Prohibition, Redressal) Act, 2013. Medical termination of pregnancy, Prohibition against Prenatal diagnostic tests (for sex determination). Laws Related to Scheduled Castes and Scheduled Tribes: Protection of Civil Rights; Law against Atrocities. Laws Related to Disabled: Mental Health Act, Persons with Disabilities Act, National Trusts Act. Laws Related to Workers: Minimum wages, Workmen’s compensation. Laws Related to Consumers and Citizens: Consumer protection, Food adulteration, Right to information, Project affected persons.
b. Protection of Children from Sexual Offences Act (POCSO) and Sexual harassment of women in workplace act.

Module V: Justice System and Legal Aid provisions (4 hours)
a. Agencies of the justice system: police, judiciary, correctional systems, their structure and functions
b. Structure and jurisdiction of courts: district and sessions courts, high court, Supreme Court. Distinction between civil and criminal courts; Consumer courts Special courts/tribunals– accident, corruption
c. Concept of legal aid, Lok Adalat; Public Interest Litigation (PIL)

Suggested Readings

1. Samaddar Ranabir (Ed), State of justice in India-issues of social justice, sage publication, 2009.
2. Acharya, Basu Durga Das: Introduction to the Constitution of India, New Delhi: Prentice Hall of India Pvt.Ltd. (7th. Edition)
3. Ahuja, Ram: Criminology, Jaipur: Rawat Publications
4. Biju, M. R, Human Rights in a Developing Society, New Delhi: Mittal Prakashan, 2005
5. Diwan, Paras and Diwan, Peeyush, Child and Legal Protection, New Delhi : Deep and Deep Publications, 1994
6. Flavia, Give us this Day, Our Daily Bread, Procedures and Case Law on Maintenance, 1997
7. Gaikwad, P. E, Law Basic Concepts, Pune: YASHADA, 2004
8. Galanter, Marc, Law and Society in Modern India, Delhi: Oxford University Press, 1992
9. Gangrade, K.D, Social Legislation in India (Vol-1 and Vol.2), Delhi: Concept Publishing Company.
10. Gaur K. D, A Textbook on the Indian Penal Code, Delhi: Universal Law Publication Co. Ltd., 2004
11. Kant, Anjani, Women and the Law, New Delhi: APH Publication Corporation. 1997
12. Matthew, P. D, Constitution of India Simplified, New Delhi: Indian Social Institute, 1993
13. Pradhan, V. P, The Indian Constitution, New Delhi: Ombudsman Publishing House, (1st Edition).
14. Prakash, Ravi, Constitution of Fundamental Rights and Judicial Activism in India, Jaipur: Mangal Deep Publications
15. Purohit, B. R. and Joshi, Sandeep (Ed)) Social Justice in India, Jaipur: Rawat Publication, 2003
16. Qureshi, M. A, Muslim Laws of Marriage, Divorce and Maintenance, New Delhi: Deep and Deep Publications, 1992
17. Sastry, T. S. N, India and Human Rights, Delhi: Concept Publishing Company, 2005
18. Saxena, D. R, Law Justice and Social Change, New Delhi: Deep and Deep Publications, 1996
19. Shah, Ghanshyam,Social Justice- A Dialogue, Jaipur: Rawat Publication, 1998
20. Sharma, S. S, Legal Aid to the Poor, New Delhi: Deep and Deep Publications, 1993
21. Siddiqi, Fatima E. and Ranganathan Sarala: Handbook on Women and Human Rights – A Guide for Social Activists (Part 1 and Part 2), New Delhi: Kanishka Publication.
22. Singh, Alka, Women in Muslim Personal Law, New Delhi: Rawat Publications, 1992
23. Singh, Shiv Sahai, Unification of Divorce Laws in India.1992
24. South Asia Human Rights Documentation Centre. Handbook of Human Rights and Criminal Justice in India, New Delhi: Oxford University Press, 2006
25. P J. Lukose, Inclusive Development: A Human Rights Approach, New Delhi: Media Publications, 2014

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M		M
CO 2	M	H		
CO 3		M	H	

SWES0046: EMERGING TRENDS AND PERSPECTIVES IN INTEGRATED SOCIAL WORK PRACTICE(3-0-0)

(3 credits- 45 hours)

Course Outcomes

- Define, identify and explain the meaning and concept of a social work perspectives (Remembering and Understanding)
- List, define and classify the perspectives that have prominently informed social work practice ;(Applying and Analysing)
- Locate and critically evaluate the relevance of perspectives in social work fields of practice ;(Evaluating and Creating)
- Apply social work perspectives in practice settings (Applying)

Module I: Perspectives on Social Problems (11 hours)

Meaning and concept of Social Work Perspective: its importance and implications for practice; Social problems, human systems and social work response- structural-functionalist perspective, Conflict perspective, symbolic interactionist perspective

Module II: International Social Work Perspectives (11 hours)

Integrated Social Work Practice Model; Systems Theory and Ecosystems Perspective- Conceptual Systems in Social Work Practice; Strengths Perspective- Philosophy, Concept and Principles, Preparation for Strengths Approach to Practice; Assessing Clients' Strengths; Human Rights Perspective: Human Rights Based Approach

Module III Radical Social Work Perspectives (11 hours)

Marxist approaches- Critical and Structural Social Work; Freirian and Liberation theological perspectives-Conscientization and adult education; Feminist approach; Anti-discriminatory and anti- oppressive perspectives

Module IV Indian Social Work Perspectives (12 hours)

Gandhian Social Work Principles; Ambedkarite Social Work practice: Anti-caste intervention framework in India; Tribal/Indigenous Social Work Perspective; Social Work Practice in North East India

Suggested Readings:

1. Freire, P. Cultural Action for Freedom New York: Penguin Books. (1972)
2. Goldstein, H. Social work practice: a unitary approach. Columbia: University of South Carolina Press. (1973)
3. Gray, M., Coates, J., & Bird, M.Y. Indigenous social work around the world: towards culturally relevant education and practice. Burlington: Ashgate. (2008)
4. Mapp, Susan C.. Human rights and social justice in a global perspective: an introduction to international social work. New York: OUP. (2008)
5. Mooney, L. A., Knox, D., & Schacht, C. Understanding Social Problem, (2nd Edition). USA: Wadsworth/Thomson Learning. (2000).
6. Miley, K. K., O'melia, M., & Dubois, B. L. Generalist Social Work Practice: An Empowering Approach. Boston: Allyn and Bacon. (1995).
7. Mullaly, R. Structural social work: ideology, theory and practice. Toronto: McClelland & Stewart Inc. The Canadian Publishers. (1993).
8. Nash, M., Munford, R., & O'Donoghue, K. (Eds). Social Work Theories in Action. London: Jessica Kingsley. (2005).
9. Pardeck, J.T. Social work practice: an ecological approach. Westport, CT: Greenwood Publishing Group. (1996)
10. Payne, M... Modern Social Work Theory, (2nd Ed). Chicago: Lyceum Books. (1997)
11. Pincus, A., & Minahan, A. . Social work practice: model and method. Illinois: F.E. Peacock Publishers. (1993)
12. Powell, F. The politics of social work. New Delhi: Sage. (2001).
13. Saleeby, D. (Ed.). The strengths perspective in social work practice, (3rd Ed). Boston: Allyn and Bacon. (2002)
14. Saulnier, C. F. Feminist theories and social work: approaches and applications. NY: Haworth Press. (1996).

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M		M
CO 2	M	H		
CO 3		M	H	
CO4	H			M

SWRT0048: COMMUNITY DEVELOPMENT: RURAL, TRIBAL AND URBAN(3-0-0)

(3 credits- 45hours)

Course Outcomes

- Define the concepts, approaches, policies and strategies of community development (rural, tribal and urban) (Remembering)
- Discuss and explain the development issues of communities – tribal, rural and urban (Comprehension)
- Apply the knowledge and skills acquired in social work education to address issues of marginilisation, exclusion and oppression. (Application)
- Able to analyse various developmental issues and address them by applying relevant empowerment and development models and approaches in social work practice (Analyse)
- Able to assess development concerns, and adopt and apply models and approaches of development for alleviation and reduction of community inequities (Evaluating)
- Able to design development practice for effective community development experiences (Creating).

Module I: Community and Community Development (11 hours)

Understanding Communities – Urban, Rural and Tribal; Concept, Definition and Objectives of Community Development; Aspects of Community Development – Social, Cultural, Economic, Political and Environment; Approaches of Rural, Tribal and Urban Development.

Module II: Rural and Tribal Community Development (11 hours)

Rural Demography, Sociology and Economy; Tribal Identity and Ethnicity; Rural and Tribal Development Policies; Rights and Positive Discrimination; Governance Structures and Functions of Rural and Tribal Communities; Rural Reconstruction Experiments – Pioneering Period Sriniketan, Marthandam, Gurgaon; Probation period: Firka, Nilokheri and Etawh Projects.

Module III: Urban Community Development (11 hours)

Urban, Urbanization, Urbanism, Industrialization and Development; Urban Development Authority; Urban Governance; Urban Ecology and Growth of Cities; Concepts of Metropolis, Megapolis, Satellite Towns, Commuter Town / Bedroom Community, Suburbs, Metropolitan; Leisure Time Theories and Leisure Time in Cities.

Module IV: Issues of Rural, Tribal and Urban Development and Social Work Intervention (12 hours)

Rural and Tribal Development Concerns – Poverty, Migration, Education, Unemployment, Development Induced Displacement, Health and Livelihoods; Urban Development Concerns – Poverty, Migration, Slums, Homelessness, Eviction, Traffic Congestion and Accidents, Health, Human Trafficking and Crimes; Role of Social Worker in Rural, Tribal and Urban Development.

Suggested Readings

1. Desai, A. R., Rural Sociology in India, Bombay: Popular Prakashan, 1961
2. Narang, A., Indian Rural Problems, Murari Lal and Sons, New Delhi, 2006
3. Shah, Dilip., Rural Sociology, ABD Publisher, India, 2005
4. Butter W Edgar, Urban Sociology- A Systematic Approach, Harper and Row Publishers, New York, 1976
5. Loornis and Beegle, Rural Sociology (The Strategies of change), Englewook, Cliffs, New Jersey : Prentice Hall, Inc, 1957
6. Sharma, K Rajendra, Rural Sociology, Atlantic Publishers and Distributors, New Delhi, 2004
7. Sharma Ramnath, Indian Rural Sociology, Munshiram Manoharlal Publishers Pvt. Ltd. New Delhi, 1979
8. Doshi S L, Rural Sociology, Rawat Publications, Jaipur, 2002
9. Singh S, Rural Sociology, Prakashan Kendra, Lucknow, 1980
10. Bhanti, Raj, Social Development (Analysis of some social work and field), Himanshu Publication, New Delhi, 2001
11. Dasgupta, Bilap, Village Society and Labour Use, Oxford University Press, New Delhi
12. Doshi, S.L. and Jain, P.C., Social Anthropology, Rawat Publications, New Delhi 2001
13. Dubey, S.C., Indian Society, National Book Trust in India, New Delhi.
14. Jain, Netra Pal, Rural Reconstruction in India and China (A comparative study), Writers and Publishers Corporation, 1970
15. Khadria, B., The Migration of Knowledge workers, New Delhi, London: Sage Publications, 1999
16. Khan, Mumtaz Ali, Scheduled Caste and their status in India, Uppal, Publishing House, New Delhi, 1980
17. Mishra, Anil Kant, Rural Tension in India, Discovery Publishing House, New Delhi, 1998
18. Mishra, Omprakash (Ed.), Forced Migration, Manak Publication, Delhi, 2004

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	H	M
CO 2	M			H
CO 3			M	M
CO 4		H	M	M
CO 5	M	H		
CO 6				H

SWGC0049: GOVERNANCE AND COMMUNITY DEVELOPMENT (3-0-0)

(3 Credits- 45 hours)

Course Outcomes

- Understand the context, meaning and relevance of decentralised governance for urban, rural and tribal areas. (Remembering and Understanding)
- Develop knowledge about the structure and functioning of governing bodies at various levels. (Creating and Evaluating)
- Develop an understanding to the various constitutional amendments for better governance and development (Creating and Evaluating)
- Understand contemporary issues and challenges in accessing governance bodies for people's development. (Applying and Analysing)

Module I: Rural Governance (11 hours)

Democratic Decentralization: Meaning, objectives and Importance, Governance: Meaning and Structures; Concept and Evolution of Panchayati Raj: Historical Development of the Concept, National level Committees in the evolution of Panchayati Raj (Balwantrai Mehta, Ashok Mehta, Singhvi committees)

Module II: The Functions of Panchayati Raj Institutions/Traditional Institutions (11 hours)

Panchayati Raj/Traditional Institutions: Structure, Functions and Powers at each level; Revenue Sources at each level; its role and Importance, Community Participation in Governance.

Module III: Urban Governance: Urban Local Self-Government in India (11hours)

Types of Urban Local Self-Government in India, Municipal Corporation, Municipalities, Municipal Council/Nagar Palika; Structures, Functions and Powers at each level; Sources of Revenue at each level; System of Elections to Urban Local Self-Government; Relation of Urban Local Self-Government with bodies of Governance at the State level issues; Challenges in Developing Partnerships between Elected Bodies, Bureaucracy and Civil Society.

Module IV: Constitutional Amendments (12 hours)
The 73rd Constitutional Amendment; PESA (Panchayat Extension in Scheduled Areas): Context of its Emergence and its Significance; Issues and Challenges in its implementation; 74th Constitutional Amendment

Suggested Readings
1. Chahar, S.S. (Ed.), Governance of Grassroots Level in India, Kanishka Publishers, New Delhi, 2005
2. Devas, N. et. al., Urban Governance, Voice and Poverty in Developing World, Earthscan, London, 2006
3. Hooja, Prakash and Hooja, Meenakshi, Democratic Decentralization and Planning, Rawat Publications, Jaipur, 2007
4. Mishra, S.N., Mishra Sweta and Pal, C., Decentralized Planning and Panchayati Raj Institutions, Mittal Publications, New Delhi, 2000
5. Singh, Amita (Ed.), Administrative Reforms (towards sustainable practice), Sage Publications, New Delhi, 2005
6. Baluchamy, S. Panchayat Raj Institutions, Mittal Publication, New Delhi, 2004
7. Bevir, Mark (Ed.), Encyclopedia of Governance in United Kingdom, Sage Publication, 2007
8. Bevir, M., Governance: A Short Introduction. United Kingdom, Oxford University Press, 2011
9. Chhotray, Vasudha and Stoker, G., Governance Theory and Practices: A Cross-Disciplinary Approach, UK: Palgrave Macmillan, 2009
10. Goel, S.L., Good Governance: An Integral Approach. New Delhi: Deep & Deep Publication Ltd., 2007
11. Grindle, Merilee S., Going Local: Decentralization, Democratization, and the Promise of Good Governance, New Jersey: Princeton University Press, 2007
12. Anwar Shah (ed.), Local Governing in Developing Countries (Public Sector Governance and Accountability Series). Washington: World Bank
13. Sivaramakrishnan, K C., Revisiting the 74th Constitutional Amendment for better Metropolitan Governance, Economic and Political Weekly Vol. 48 (13), 2013
14. Srivastava, OM Prie., Municipal Government and Administration in India, Allahabad: Chuch Publications, Contribution to Indian Sociology 45 (2), Pp. 157- 187, 1980
15. Stoker, Gerry., Governance as Theory: Five Preposition, International Social Science Journal Vol 50 (155), Pp 17-28, 2008

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	H	M
CO 2	M	H		H
CO 3	M		M	M
CO 4		H	M	M

SWCS0050: FAMILY CENTERED SOCIAL WORK PRACTICE (3-0-0)
(3 credits- 45 hours)

Course Outcomes:
- Define family and marriage, and theories associated with these concepts in the context of prevalent customary, legal instruments and social processes and explain how the differential structure of families affect its dynamics and processes (Remembering and Understanding)
- Assess and present the gender relations in society in the context of patriarchal social structure (Evaluating and Creating)
- Apply social work theoretical models for conceptualizing intervention plans that are best-suited for addressing problems located in different family structures (Applying and Analysing)
- Identify and evaluate the different plans and schemes of the government of India pertaining to family development and welfare (Evaluating)

Module I: Concept and Forms of Family and Marriage (11 hours)
Concept of family- Origin, Traditional Forms Family; Concept of marriage- Types of Marriage; Alternative Forms of Family and Marriage Patterns and Structures- Dual earner/Career Families; Single Parent families, Reconstituted/Step families; Childless Families; Same-sex Families, Adoptive family & Foster Family.

Module II: Theories and Dynamics of Family (11 hours)
Family theories – Developmental theory, Systems theory, Social Exchange theory, Structural Functionalist theory, Feminist theory, Ecological theory; Family Dynamics – Power, Myths, Role, Relationships; Gender and Patriarchy; Implications of Patriarchal Social Structure in Families-Global, National and Local.

Module III: Social Processes and Changes in Family Structure (11 hours)
Social Processes and Factors for Change- Industrialisation, Urbanisation, Modernisation, and Globalisation; Technology and Media; Migration; Displacement and Disaster (War, Conflict, riots and Natural Calamities)& Pandemics; Changes in the Family

Structure - Family Demography&Determinants of Change in Family Structure- Fertility change, Change in at marriage & age at first birth, Change in size and structure of the households, Change in Marital Unions, Marital Dissolution, Widowed, Remarriages, Non-Marital Unions & Sexual Behaviours, and Alternative family formation behaviours

Module IV: Social Work with Families- Interventions, Techniques and Skills (12 hours)
Family Social Work, Assumptions & Principle of Family Social Work; Practical Aspects of Family Social Work- Family Assessment-Qualitative-Genogram, Quantitative-Self-Anchored and Self-Monitoring Instruments; Problem Solving Approach; Developmental Approach- Family life-cycle & life enrichment programmes; Strengths& Resilience Perspective;Efforts of Government and Non-Government Agencies in strengthening families – Policy, Legislations and Programmes

Suggested Readings

1. Barnett, O.W., Miller-Perrin, C.L., & Perrin, R.D., Family violence across the lifespan: an introduction, New Delhi: Sage, 2011
2. Carter, B., &McGoldrick, M., The changing family life cycle: a framework for family therapy, (2nd Ed.), London: Pearson, 1989
3. Coontz, S., Marriage, a history: how love conquered marriage, New York: Penguin, 2005
4. Devine, E. T., The family and social work, New York: Andesite Press, 2017
5. Peoples, J., & Bailey, G., Humanity: an introduction to cultural anthropology, 7th ed., Belmont, CA: Thomson Wadsworth, 2006
6. Strong, B., DeVault, C., & Cohen, T.F., The marriage and family experience: intimate relationships in a changing society, Australia: Cengage, 2011
7. Yuen, F.K.O, Skibinski, G.J., &Pardeck, J.T., Family health social work practice: a knowledge and skills casebook, New York: Routledge, 2002
8. Collins, D., Jordan, C., & Coleman, H., An Introduction to Family Social Work, CA: Brooks/Cole, Cengage Learning, 2010
9. Hepworth, D., Rooney, R., Rooney, G., Strom-Gottfried, K., Direct Social Work Practice, 10th ed. Belmont, CA: Brooks/Cole, 2013 • Chapter 10: Assessing family functioning in diverse family and cultural contexts
10. White, J.M., Klein, D.M., Martin, T.F., Family Theories. An Introduction. New Delhi: Sage, 2015
11. Uberoi, P., Family, Kinship and Marriage in India, New Delhi: Oxford University Press, 1993
12. Parekh, S., Banerjee, G., &Kashyap, L., Family Life Education and Enrichment Programmes, The Indian Journal of Social Work, 70(2): 227-303, 2009
13. Chakravorty, S., Goli, S., & James, K.S., Family Demography in India: Emerging Patterns and Challenges, Sage Open: 1-18, 2021, https://doi.org/10.1177/21582440211008178

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	H	M
CO 2	M	H		H
CO 3	M		M	M
CO 4		H	M	M

SWPC0051: SOCIAL WORK PRACTICE WITH CHILDREN (3-0-0)
(3 Credits- 45 hours)

Course Outcomes:
- Understand the process of socialization of a child (Remembering and Understanding)
- Understand health and children's' health i.e. Both mental and physical well-being. (Remembering and Understanding)
- Analyze the difficult situations faced by children in the present context. (Analysing)
- Know the national and international efforts for child welfare and the child related laws. (Remembering and Understanding)
- Understand and acquire the skills for working with children. (Applying and Analysing)

Module I: Understanding Child and Childhood (11 hours)
Understanding Child- Childhood Development, Scope of Child Development, Meaning and Importance of different stages of Growth and Development - Heredity and Environment – Salient features of different stages in life - Factors influencing Growth and Development - Principles of Child Development;Child Rearing Practices, Socialization of Children with special needs- Special Schools/ Inclusive Schools; Theories: Cognitive Development Theory, Psycho-Social Theory, Personality Theory, Learning Theory

Module II: Concerns and Issues faced by Children (11 hours)
General Health of Children: Common Diseases, Malnutrition, Infant mortality and morbidity, health of Adolescent Girls; Concept of Mental Health, Child mental health and Psycho-Social Development. Mental health needs and mental health problems and

disorders in Children of various age groups, Learning Disabilities, Pervasive Developmental Disorder; Children in need of care and Protection- Street Child, Destitute, Abandoned, Orphaned, Child abuse, Child labour, Child trafficking, Natural calamity affected children, Children in Conflict situation, HIV-AIDS affected and infected children, Special problems of Girl child and Children in conflict with law.

Module III: Child Rights, Policies and Programmes (11 hours)
Working with Children – From charity to rights holders, Declaration of rights of the child 1924, UN Conventions and declarations - UNCRC, National Charter for Children, National Action Plan for Children, History of child development programs in India.; Constitutional Provisions, National Policy for Children, Commissions for Protection of Child Rights, Juvenile Justice (Care and Protection of Children) Act, 2015, Protection of children from sexual offences Act, 2012, Central Adoption Regulatory Agency (CARA guidelines), Child Labour (Prohibition and Regulation) Act 1986. Current initiatives- ICDS, ICPS, SSA and RTE, NRHM

Module IV: Fields of SWP and Skills for working with Children (12 hours)
Family, Child Welfare Organizations, School Settings, Children's Home, Adoption Agency; Communication Skill, Interpersonal Skills, Imagination and creativity- Art and Craft, and relationship building Skills, Counseling, and Discipline and Behavior Management; Good Practices by Organizations- CRY, Action Aid, Aide-Et-Action, UNICEF, RED CROSS and SOS Children's Village.

Suggested readings
1. Anandaraj, H., Children at Risk, Hyderabad: Neelkamal Publications, 2007
2. Banerjee, B. G., Child Development and Socialisation, New Delhi: Deep and Deep Publication, 1987
3. Baroocha, P. P., Handbook on Child, New Delhi: Concept Publishing Com, 1999
4. Berk, Laura E., Child Development (8th edition), New Delhi: Pearson Prentice Hall, 2009
5. Bhalla, M. M., Studies in Child Care, Delhi: Published by NIPCCD, 1985
6. Bossare, James H. S., The Sociology of Child Development, New York: Harper and Brothers, 1954
7. Chandra Kulshreshtha Jinesh, Child Labour in India, New Delhi: Ashish Publishing House, 1978
8. Chaturvedi, T. N., Administration for Child Welfare, New Delhi: Indian Institute of Pub., 1979
9. Choudhari, D. Paul., Child Welfare / Development, Delhi: Atma Ram and Sons, 1980
10. Ghathia, Joseph, Child Prostitution in India. New Delhi: Concept Publishing Company, 1999
11. Gokhale, Sharad D. and Sohoni, Neera K., Child in India, Mumbai: Somaiya Pub., 1979
12. Gopalakrishnan B., Rights of Child, Jaipur: Aavishkar Publishers, 2004
13. Hugh, Jolly, Diseases of Children, Oxford: The English Language book society and Blackwell Scientific Publications, 1981
14. Hurlock, Elizabeth B., Child Development, New Delhi : Tata McGraw Hill Pub; Com; Ltd., 1968
15. Kumar, Arvind, Fundamentals of Child Rights: Concepts, Issues and Challenges, Lucknow: Laxmi Shikshan Sansthan, 2002
16. Nanda, V. K., Nutrition and Health for child Development, New Delhi: Anmol Publication Pvt. Ltd., 1998
17. Pandya, K. C., Element of Child Development. New Delhi: Kalyani Pub., 1988
18. Pimpley, P. N., Singh K. P., A. Mahajan, Social Development Process and Consequences, Jaipur: Rawat Publication, 1989

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Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	H	M
CO 2	M	H		H
CO 3	M		M	M
CO 4		H	M	M
CO5	H	M		H

SWMS0052: MEDICAL SOCIAL WORK (3-0-0)
(3 credits-45 hours)

Course Outcome:
- Introduce the historical development of medical social work in western countries and in India. (Remembering)
- Students will develop an insight on the impact of disease on the individual and his/her social system.
- (Understanding)
- Students would learn to implement social work intervention strategies in medical and psychiatric settings. (Applying)
- Students will develop competencies in the roles and functions of medical social workers in various settings. (Applying)

Module I: Historical overview (11 hours)
Medical Social Work:- Historical development of Medical Social Work in Western Countries and in India; Social Workers in General Health Care System in India; Challenges in the field of Medical Social Work in India.

Module II: Disease, Illness and Sickness and Concept of Care (11 hours)

Illness as a social problem and its effect on the individual, family and community, the concept of Patient as a Person; Social and Emotional factors involved in disease; Social Work with terminally ill, Social Work with dying and bereaved, Palliative Care, Hospitalization and its implications on patient and the family members; Rights of Patients; Modern trends in treatment of illness; Care in different Medical Settings – Hospitals, Outpatient Departments, Emergency, Crisis care, Hospice, Special Clinics.

Module III: Skills (11 hours)
Skills and Qualities of Medical Social Worker; Teamwork and multidisciplinary approach in the treatment of illness; Role and functions of a Medical Social Worker, Organization and Administration of Medical Social Work Department in Hospitals; Assessment and Diagnosis- Interviews, Reporting and Record maintenance; Medical Social Worker and Public Relations.

Module IV: Medical Social Work in different Departments in Hospitals (12 hours)
Medical Social Work in different Departments in Hospitals: Oncology, Nephrology; Reproductive Health, Family Welfare and Family Planning; Sexual Health (STD, HIV/AIDS); Geriatrics, Diabetology, Cardiology, Accident, Disability and Burns Department.

Suggested Readings

1. Anderson R. and Bury M. (Eds.), Living with Chronic Illness – the Experience of Patients and their Families, Unwin Hymman: London, 1988
2. Bajpai P.K., Social Work Perspectives in health, Rawat Publications: New Delhi, 1997
3. Barlett H.M., Social Work Practice in the Health Field, New York: National Association of Social Workers, 1961
4. Dimatteo, M. Robin and Leslie R. Martin, Health Psychology, Dorling Kindersley (India) Pvt. Ltd.: New Delhi, 2007
5. Field M., Patients are People – A Medical – Social Approach to Prolonged Illness, Columbia University Press: New York, 1963
6. Narasimhan, M. C. and Mukherjee, A.K., Disability – A Continuing Challenge, Wiley Eastern Ltd. New Delhi, 1987
7. Pathak S. H., Medical Social Work in India, New Delhi: DSSW, 1961
8. Pokarno K.L., Social Beliefs, Cultural Practices in Health and Diseases, Rawat Publications, New Delhi, 1996
9. Park, J.E., Textbook of Social and Preventive Medicine, 17th edition, Jabalpur: Banarsidas Bhanot, 2006
10. World Health Organization, World Health Report, Geneva, 2001

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H		M	
CO 2		H		M
CO 3	M	M	H	M
CO 4		M	M	H

SWHS0053: MENTAL HEALTH AND SOCIAL WORK (3-0-0)
(3 credits-45 hours)

Course Outcome:
- Introduce the concept of mental health, normal and abnormal behaviour, meaning of psychiatry and its history. (Remembering)
- Students will develop the skills of assessment of mental illness. (Applying)
- Students will learn about various mental illnesses affecting people. (Applying)
- Introduce the concept of Community Psychiatry and significance of community mental health. (Analyzing)

Module I: Understanding mental health and mental illness (10 hours)
Mental health: A Conceptual Framework: Historical background of the concept. Definitions of mental health components. Mental health in the changing society. Concept of normal and abnormal behaviour. Psychiatry – definition, history and growth of psychiatry. Traditional and modern attitude towards psychiatric illness. Symptomatology – Disorders of perception, thought, speech, memory, emotion.

Module II: Psychiatric assessment (10 hours)
Assessment in psychiatry. Psychiatric interviewing, case history recording and mental status examination (MSE). Classification in psychiatry- need, types - ICD and DSM.

Module III: Major Psychiatric disorders (15 hours)
Prevalence, etiology, clinical manifestation, course and outcome and different treatment modalities of the following disorders:

a. Neurotic and somatoform disorders – Phobia, anxiety disorders, Obsessive compulsive disorders, dissociative (conversion) disorders, somatoform disorders
b. Mood (affective) disorders
c. Organic mental disorders – dementia, (Alzheimers), Amnesic syndrome, delirium

d. Schizophrenia and Delusional disorders
e. Disorders of adult personality and behaviour _ paranoid, schizoid and histrionic personality disorders. Gender identity disorders, disorders of sexual preference
f. Disorders of psychological development – developmental disorders of speech and language and scholastic skills; learning disability, mental retardation, pervasive developmental disorders – autism, Rett's and Asperger's syndrome
g. Behavioural and emotional disorders in childhood and adolescence – Hyperkinetic and conduct disorders, anxiety, phobia and depression
h. Disorders due to substance use

Module IV: Community mental health (10 hours)
Community psychiatry – concept and meaning, evolution of community psychiatry; Community mental health in India, Social – cultural factors in psychiatric disorders with special reference to India, culture bound syndrome.

Suggested Readings

1. American Psychiatric Association, Diagnostic and Statistical Manual of Mental Disorders, 4thEdition. DSM –IV-TR, APA, Washington DC, 2000
2. Carlson R. Neil, Foundations of Physiological Psychology, 6th Ed, Pearson Education, India, 2007
3. Chaube S.P., Abnormal Psychology, Educational Publishers
4. Clifford T. Morgan, Richard A. King, John R. Weisz, John Schopler, Introduction to Psychology, Tata Mc. Graw Hill Edition
5. Colman. M. Andrew, Oxford Dictionary of Psychology, Oxford University Press, New York, 2009
6. Correy Gerald, Theory and Practice of Counseling and Psychotherapy, Student Manual, 8th Ed, Brooks Cole Cengage Learning, USA, 2005
7. Fernald/Fernald, Munn's Introduction to Psychology, 5th Edition, AITBS Publishers, India
8. James D. Page, Abnormal Psychology, Tata McGraw Hill Edition,
9. Kring M. Ann, Johnson L. Sheri, Davison C. Gerald, Neale M. John, Abnormal Psychology, 11th Ed, Wiley India Pvt. Ltd, New Delhi, 2010
10. Kumar Updesh, Mandal, Manas (Editors), Suicidal Behaviour, Assessment of People-at-Risk, Sage Publications India Pvt. Ltd, New Delhi, 2010
11. Maxmen S. Jerrold, Ward G. Nicholas, Essential Psychopathology and its Treatment, 2nd Ed. Revised for DSM IV, W.W. Norton and Company, New York, 1995
12. Mishra. A.K., Psychology of Aging, Sublime Publications, Jaipur, 2007
13. Patel Vikram, Thara R. (Editors), Meeting the Mental Health Needs of Developing Countries, NGO Innovations in India, Sage Publications, New Delhi, 2003
14. Ranjana, Cognitive Psychology, RBSA Publishers, Jaipur, 2010
15. Robert A. Baron, Psychiatry, 5th Edition, Pearson Education
16. Robert C. Carson, James N. Kutcher, Susan Minela, Jill M. Hooley, Abnormal Psychology, 13th edition, Pearson Education
17. Santrock W. John, Educational Psychology 2nd Ed, Tata McGraw- Hill Edition, New Delhi, 2006
18. Scileppi A. John, Teed L. Elizabeth and Torres D. Robin, Community Psychology: A common sense approach to mental health, Prentice Hall, USA, 2000
19. Shepherd, Michael et al., Childhood Behaviour and Mental Health, University Press. London, 1971
20. World Health Organization, the ICD 10 Classification of Mental and Behavioural Disorders, Clinical Description and Diagnostic Guidelines, Oxford University Press, Geneva, 1992

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Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			
CO 2		H	H	
CO 3		H	H	
CO 4	M			H

SWOD0054: ORGANISATIONAL STRUCTURE, BEHAVIOUR AND DEVELOPMENT (3-0-0)
(3 credit: 45 hours)

Course Outcome
- Understanding the structure and functioning of an organization (Remembering and Understanding)
- To develop the skills for Organisation Development Process (Evaluating and Creating)
- To establish and manage any development organisation. (Evaluating and Creating)
- To introduce the students to organisational structure and management (Remembering and Understanding)
- To familiarize the students with the skills and legal base for managing the workforce of an organisation. (Applying and Analysing)

Module I: Organizational Structure (10 hours)
Organizational Structure: Definition, Concept and Nature Formation of Organizational Structure; Types of organizational Structure

Module II: Basic concepts in Organisational Behaviour (10 hours)
Organizational Behaviour: concept and theories; Models of Organizational Behavior: Development and Types; Organisation Climate, Culture and Team building; Employee counseling, Work life balance, managing occupational stress

Module III: Basic skills for Organisational Development (10 hours)
Leadership - traits, typology and theories; Motivation: need, significance, theories, methods and practices; Communication - concept, significance, modes, channels, impact

Module IV: Legal Base for Practice (15 hours)
Legislations for industrial relations-Factories Act, 1948, Industrial Dispute Act,1947, Industrial Employment Standing Orders Act, 1946; Legislations related to Wages – Minimum Wages Act,1948, Payment of Wages Act, 1936, Equal Remuneration Act, 1976, The Payment of Bonus Act, 1965, Payment of Gratuity Act , 1972; Equal Opportunities, Protection of Rights & Full Participation) Act,1995; Provisions related to employees behaviour : discharge, misconduct, domestic enquiry and disciplinary action; sexual harassment at workplace; Legislations related to employment- Inter-state Migrant Worker's Act,1979, Contract Labour Act, 1970

Suggested Readings

1. Daft, R.L., Organization: Theory and Design, Mason: OH, South Western Publishing, 2004
2. Jacoby, S.M. (Ed.). The Workers of Nations: Industrial Relations in Globalized Economy, New York: Oxford University Press, 1994
3. Mallick, P.L., Industrial Law, Lucknow : Eastern Book Company, 2002
4. Mathis, R. L., & Jackson, J.H., Human Resource Management, U.K: Prentice Hall International, 1997
5. Pareek. U., & Rao, T.V., Designing and Managing HR Systems, New Delhi: Oxford & IBH Publishing, 1992
6. Ramnarayan, S., Rao, T.V., & Singh, K., Organization Development: Interventions and Strategies, New Delhi: Sage Publications, 1998
7. Robbins, S.P., Organizational Behaviour (10thEd.), New Delhi: Prentice Hall of India, 2002
8. Silvera, D.M., Human Resource Management: The Indian Experience, New Delhi: New India Publications, 1990
9. Sivananthiran, .A. & Venkatratnam, C.S., Best Practices in Social Dialogue, New Delhi: ILO, 2003
10. Veena, A.K., Kochan R.D., & Lansbury, R.D., Employment Relations in the Growing Asian Economics, London: Routledge, 1995
11. Ramnarayan, S., Rao, T.V., & Singh, K., Organization Development: Interventions and Strategies, New Delhi: Sage Publications, 1998
12. Robbins, S.P., Organizational Behaviour (10thed.), New Delhi: Prentice Hall of India, 2002

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			M
CO 2		H	H	
CO 3		H	H	
CO 4	M		M	H
CO5	H	M		H

SWDO0055: POLICIES FOR DEVELOPMENT ORGANISATIONS - URBAN, RURAL AND TRIBAL COMMUNITIES (3-0-0)
(3 credits- 45 hours)

Course Outcomes
- Develop an understanding about the social policies and decision making process of the government in planning for development in India. (Evaluating and Creating)
- Understand the Governmental efforts for development of Rural, Tribal and Urban communities (Remembering and Understanding)
- Understand and analyze Governance issues at local, regional, state and national levels (Applying and Analysing)

Module I: Introduction to Social Policies (8 hours)
Meaning and Definition of Policy and social policy; History and process of Social Policy development in India; Evolution of planning – Planning commission, NITIAayog.

Module II: Policies and Schemes in Urban Areas (8 hours)

Challenges for urban development; urban poverty management; urban governance systems; Government schemes and policies

Module III: Policies and Schemes in Rural Areas (8 hours)
Challenges for rural development; rural poverty management; rural governance systems - decentralization processes; Government schemes and policies

Module IV: Policies and Schemes in Tribal Areas (8 hours)
Challenges for tribal development; Poverty management; Governance systems; Government schemes and policies

Module V: Issues of Governance and Planning (13 hours)
Issues of Development and Displacement; Diversity and Citizenship Issues

Suggested Readings

1. Akhup, A., Identities and their struggles in Northeast India (TAS 2), Kolkata: Adivaani, 2015
2. Bodhi, S.R., Social Work in India: Tribal and Adivasi Studies- Perspectives from Within, Kolkata: Adivaani, 2016
3. Dreze, J., & Sen, A., An uncertain glory: India and its contradictions, London: Princeton University Press, 2013
4. Fernandes, W., Bharali, G., Uprooted for whose benefit? Development-induced displacement in Assam, Guwahati: NESRC Press, 2011
5. Jacob, K.K., Social Policy in India, Udaipur: Himalaya Publications, 1989
6. Shivaramkrishnan, K.C., Kundu, A. & Singh, B.N., Handbook of Urbanization in India, New Delhi: Oxford University Press, 2007
7. Mishra, R., Globalisation and the welfare state, London: Edward Elgae, 1999
8. Singh, K. (2009). Rural Development: Principles, Policies and Management, 3rd Ed. New Delhi: Sage.

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Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H		M	
CO 2		H	H	M
CO 3	M	H	H	

SWCP0056: INTRODUCTION TO CHILD PSYCHOLOGY AND DEVELOPMENT (3-0-0)
(3 Credits- 45 hours)

Course Outcomes
- Introduce and help students understand the psychological, legal and cultural definitions of child and childhood (Remembering and Understanding)
- Introduce students to the major personality theories of psychology thus enabling them to understand human behaviour. (Applying and Analysing)
- Help students discover the different factors that influence development and behavior of children (Evaluating and Creating)
- Understand the principles, values and code of ethics for working with children (Remembering and Understanding)

Module I: Introduction to Child and Childhood (11 hours)
Understanding Child and Childhood- Definitions and Notions of Childhood across varying Cultural, Political, Social, Historical, Biological and Philosophical Contexts; Legal and Constitutional Definitions: Different Age based definition in the Juvenile Justice (Care and Protection of Children) Act, 2000; Child Labour (Prohibition and Regulation) Act 1986; The Right of Children to Free and Compulsory Education Act, 2009; United Nations Convention on the Rights of the Child (UNCRC); Development Stages of Childhood- Human Life Cycle Approach: Development Stages, Socialization and Agents of Socialization, Child Rearing Practices; Common Illness and ailments

Module II: Theories on Child Development (11 hours)
Theories of Child Behavior; Emotional Theories; Learning Theories; Intellectual Theories; Psycho-Social Theories; Personality Theories; Moral Theories; Implications of Theories.

Module III: Situational Child Psychology (11 hours)
Factors Determining Well-Being and Development of Children – Adult Child Relationships- Age, Gender, Caste, Class, Education, Social and Cultural Practices, Ethnicity, Religion, Region, Language, Influence of Technology on Family Relationships; Family dynamics, Peer relationships, Sibling relationships and birth order; Effects of separation, divorce, bereavements; Power Dynamics- Protection, Care and Support; Punishments and Threats; General Adult Attitudes; Effect of Cultural Practices; Laws and Institutional Practices; Representation in Literature and Media; Factors enabling Healthy Adult Child Relationships

Module IV: Values and Principles of Working with Children (12 hours)
Code of ethics- Responsibility for Self, Responsibility to Children, Young People and their Families, Responsibility to Colleagues,

Responsibility to Employers, Responsibility to the Profession, Responsibility to Society; Principles and Values- Seven International Ethical Principles for People Working with Children and Young People; Psychiatric rehabilitation principles and values by Psychiatric Rehabilitation Association (PRA)

Suggested Readings:

1. Ahuja, N., A Short textbook of Psychiatry, Himalaya Publishing House, New Delhi, 2005
2. Banerjee, B. G., Child Development and Socialisation, New Delhi, Deep and Deep Publication, 1987
3. Archambeault, J., Social Work and Mental Health, UK: Learning Matters Pvt Ltd, 2009
4. Baroocha, P.P., Handbook on Child, New Delhi: Concept Publishing Com, 1999
5. Berk, Laura E., Child Development (8th edition), New Delhi: Pearson Prentice Hall, 2009
6. Bhalla, M. M., Studies in Child Care, Delhi: NIPCCD, 1985
7. Bossare, James H. S., The Sociology of Child Development, New York: Harper and Brothers, 1954
8. Berk, Laura E., Development through the Lifespan, 5th edition, Allyn and Bacon, London, 2009
9. Bhattacharya, S., Social Work: Psycho-Social and Health Aspects, New Delhi: Deep and Deep, 2008
10. Clifford T. Morgan, Richard A. King, John R. Weisz, John Schopler, Introduction to Psychology, Tata Mc.Graw Hill Edition.
11. Coleman James. C, Abnormal Psychology and Modern Life, D.B. Taneporevela, Mumbai, 1975
12. Feist Jess, Feist J. Gregory, Theories of Personality, 7th Edition, McGraw Hill, Primis, 2008
13. Fernald/Fernald, Munn's Introduction to Psychology, 5th Edition, AITBS Publishers, India
14. Feshback Seymour, Weiner Bernard, Bohart Arthur, Personality, 4th Edition, D.C. Health and Company, Lexington, 1996
15. Hurlock, Elizabeth, Developmental Psychology, Tata Mc Graw Hill, New York, 2001
16. Giddens, Anthony, Social Theory and Modern Sociology, Stanford University Press, 1987
17. Steinberg, Laurence, Adolescence, McGraw Hill Inc, New York, 1993
18. WHO, the ICD – 10 Classification of Mental and Behavioural Disorders, Diagnostic Criteria for Research, AITBS Publishers and Distributors (Regd.), Delhi, 2004
19. Theories of Personality, Hall and Goindzey

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	H	M
CO 2	M	H		H
CO 3	H		H	M
CO 4		H	M	M

SWRC0057: RIGHTS OF THE CHILD – LEGAL FRAMEWORK, NATIONAL AND INTERNATIONAL INSTRUMENTS(3-0-0)

(3 Credits- 45 hours)

Course Outcomes:

- Make the students well abreast of the International. National and other relevant instruments on Child Rights and get to know the legal sanctions and safeguards regarding children's rights(Remembering and Understanding)
- Get to know the provisions enshrined in the Indian constitution which safeguard the rights of children and ensures a life of dignity for them (Remembering and Understanding)
- Make the students understand the role, functions and powers of the UN agencies and their mandate in working towards the cause of children(Analysing)
- Familiarize the students with the working of the statutory bodies and their role in providing justice to children. (Evaluating and Creating)

Module I: Introduction to Human Rights and Children's Rights (11 hours)

Theoretical Foundation of Human Rights, Historical Evolution of Human Rights; Child Rights as Human Rights of Children; Evolution of Child Rights, Children as objects of Charity to rights holders; Specialized instruments on the Rights of the Child & Foundational Principles- Declaration of the Rights of the Child 1924, Declaration of the Rights of the child 1959, Beijing Rules, 1985; UN Convention on the Rights of the Child 1989 (Survival Rights, Development Rights, Protection Rights and Participation Rights), United Nations Convention on the Rights of Persons with Disabilities.

Module II: Legislations relating to Children in India (11 hours)

Introduction to the Indian Constitution, Fundamental Rights and Directive Principles of State Policy;; National Policy for Children, 1974 and 2013, Child Labour (Prohibition and Regulation Act, 1989), The Plantations Act, The Prohibition of Child Marriage Prevention Act, Immoral Trafficking (Prevention) Act, Pre-natal Diagnostic Techniques Act, 1994, Right to Education Act, POCSO Act;, Juvenile Justice (Care and Protection) Act 2016; Central Adoption Resource Agency, Rights of Children with Disabilities.

Module III: Child Protection (11 Hours)
The Legal Foundation of Child Protection, Defining Child Protection; Concept and definition of vulnerability, Settings or Habitats of Children and its Effect on Vulnerability: (Family, Streets or Public Places, Institutions); Magnitude of Abuse, Neglect, Violence and Exploitation Cases Child in need of care and protection or vulnerable groups- Child Labour, street Children, abused Children, Children With disability, Trafficked Children, Children in Institutions and Children in "Families At Risk". Child Poverty: Multi-dimensional Deprivation; Children and the Law- Children in Conflict with the Law, A System's Approach to Child Protection- Components of a Child Protection System, Identifying Problems in Child Protection System, Global and Local Action to Strengthen Child Protection Systems

Module IV: Child Rights, Protection and its Applications (12 hours)
Role of duty bearers in ensuring child rights and protection- Role in Protection, Prevention, Intervention and Rehabilitation by Family, Community, Civil Society, Media, and State; Structure, Functions and Role of UN and its specialized agencies for the protection of child rights, UNICEF, WHO, Red Cross; National and State Commissions for Protection of Child Rights - Their role and Functions; Government Schemes: Integrated Child Protection Scheme, Integrated Child Development Scheme; Programs and interventions for Child Protection- Family strengthening, Institutional Services and Non-Institutional services, Alternative Care

Suggested Readings

1. Acharya, B., & Das, D., Introduction to the Constitution of India, (7th. Edition), New Delhi: Prentice Hall of India Pvt.Ltd, 2008
2. Ahuja, R., Criminology, Jaipur, Rawat Publications
3. Biju, M. R., Human Rights in a Developing Society, New Delhi: Mittal Prakashan, 2005
4. Diwan, Paras and Diwan, Peeyush, Child and Legal Protection, New Delhi: Deep and Deep Publications, 1994
5. Nirmal C. J., Human Rights in India: Historical, Social and Political Perspectives (Oxford University Press, India)
6. Bajpai Asha, Child Rights in India: Law, Policy and Practice, Oxford University Press, USA, 2005
7. Leister Erich and Nanda Sujata, Human Rights of Children, Kalinga, New Delhi, 2009
8. KumariVed , The Juvenile Justice System in India: From welfare to Rights, Oxford University Press, New Delhi, 2004
9. Brien Damick, ed, Child Labour in India: Realities and Issue, London, OUP, 2010
10. Sinha Santa, Child Labour and Education Policy in India, Administrator Vol XII, July-September, 1996
11. Arun Kumar, Child as a Human Resource, Sarup& Sons, 2002
12. Myron Weiner, NeeraBurra, AshaBajpai, Born Unfree, OUP, 2006
13. JyotsnaTiwari, Child Abuse and Human Rights, Isha Books, 2011
14. Samaddar Ranabir (Ed), State of justice in India-issues of social justice, sage publication, 2009.
15. Sastry, T. S. N, India and Human Rights, Delhi, Concept Publishing Company, 2005

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	H	M
CO 2	M	H		H
CO 3	H		M	H
CO 4		H	M	M

SWSP0058: SOCIAL DEVELOPMENT AND SOCIAL POLICY (3-0-0)
(3 Credits- 45 hours)

Course Outcomes
- Understand the key concepts and issues related to Social Development (remembering and Understanding)
- Promote alternative paths of Social Development that promotes the wellbeing of Individuals, families and communities (Creating and Evaluating).
- Develop an understanding of social policy in the perspective of the national goals as stated in the constitution. (Creating and Evaluating)
- Develop the capacity to recognize the linkage between the developmental issues and social policy, plans and programmes related to social work practice. (Applying and Analysing)

Module I: Social Development (11 hours)
Definition, meaning and concepts; Approaches to Social Development; Developmental Indicators; Measurement of Development; Models of Development; Economic growth and Social Development; Human Development; Relationship between Social Development and Sustainable Development .

Module III: Theories of Social Development (11 hours)
Baran's Theory; World System Theory; Dependency Theory; Theory of Unequal Exchange; Theory of Economic Growth; Theory of Positivistic Development; Theory of Realistic Development.

Module III: Social Policy (11 hours)
Concept and Objectives; Values underlying Social Policy based on Constitutional provisions (i.e. Directive Principles of State Policy, Fundamental Rights and Fundamental Duties); Instruments of Social Policy; Approaches to Social Policy – Residual Welfare, Unified, Integrated, Sectoral; Models: Industrial achievement and Institutional Redistributive Model and their applicability to the Indian situation.

Module IV: Evolution of Social Policy (12 hours)
Process of Social Policy formulation; Methods of evaluation of Social Policy; Critical review of Policies concerning Education, Health, Youth, Welfare of Backward Classes, Tribal development and Poverty alleviation

Suggested Readings

1. Blakemore, Kenneth, Social Policy: An Introduction, Mc Graw- Giriggs, E, Hill Education, New York, 2007
2. Bogo Marion, Social worker Practice: concept, processes and interviewing, New Delhi, Rawat, 2007
3. Bose, A.B., Social Welfare Planning in India, New Delhi: ECAEF
4. Gilbert, N and Specht, H Planning for Social Welfare: Issues, Models and Tasks, Prentice Hall Inc. Englewood cliffs, New Jersey
5. Goel, S.L. and Jain, P.K., Social Welfare Administration, Vol. 1 and 2, New Delhi: Deep & Deep Publication, 1988
6. Huttman, E.D., Introduction to Social Policy, New YorkMcGraw Hill, 1981
7. Hills J., Making Social Policy Works, Rawat Publications, New Delhi, 2007
8. Hudson J., Understanding the Policy Process, Rawat Publications, ND, 2007
9. Jones, Kathleen and others, Issues in Social Policy, Routledge and Paul, Kopan London, 1983
10. Kulkarni, P.D., Social Policy in India, Tata Institute of Social Sciences, Bombay, 1965
11. Kulkarni, P.D., Social Policy and Social Development in India: Madras, Association of Schools of Social Work in India, 1979
12. Lavalette Michael, Alam, Social Policy-Theories, Concepts and Issues, Sage, New Delhi.
13. Livingstane, A., Social Policy in Developing Countries, London: Routledge and Kogan Paul, 1969
14. Modison, Bernice and George, Meaning of Social Policy: A Comparative Dimension in Social Welfare, London, 1980
15. Mishra, R., Society and Social Policy, Macmillian Ltd., London, Allen and Unwin, 1977
16. Mullard, M, Social Policy in Changing Society London: Routledge, Spicker, 1998.
17. Simpson, G., Social Policy for Social Welfare Professionals, 2011

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			M
CO 2		H	H	
CO 3		H	H	
CO 4	M			H

SWPM0059: PROJECT CYCLE MANAGEMENT AND RESOURCE MOBILISATION(3-0-0)
(3 Credits- 45 hours)

Course Outcomes
- Understand the importance and process of planning, methodology for planning and formulating projects using the Logical Framework Analysis (Remembering and Understanding)
- Develop an understanding of the problems and issues faced by the poor and the marginalized (Creating)
- Develop an insight into the different strategies and approaches commonly adopted by Development Organisations for Project Management (Applying and Analysing)
- Learn Skills to develop project proposals, implement, monitor and evaluate project, enhance process documentation and reporting skills (Evaluating and Creating)

Module I: Overview (7 hours)
Concept of Results Based Management; Planning and its importance for PCM; Overview of Project Cycle Management: Identification, Design, Implementation, Monitoring, Evaluation, Identification of the best practices.

Module II: Project Identification (8 hours)
Needs assessment: Situational analysis; Capacity assessment: Human, Social, Natural, Physical, Economic and Cultural; Stakeholders analysis, types: Primary and Secondary Stakeholders and mapping of Stakeholders; Importance of Stakeholder participation and different levels of participation

Module III: Project Design (10 hours)
Problem Tree analysis; Objective Tree analysis and formulation of objectives; Hierarchical results: Impact, outcome, Outputs, Inputs; Assumptions, Indicators, Means of Verification; Activities and scheduling; Budget preparation

Module IV: Monitoring and Evaluation (10 hours)
Concept and definition of monitoring and evaluation; Difference in Monitoring and Evaluation; Learning the lessons; documentation and reporting; PERT and Critical Path Method (CPM) of Monitoring

Module V: Resource Mobilization (10 hours)
Internal and External Resources; Fundraising – principles, sources, ethics, methods and their implications. International sources for Funding – Concept note; application, procedure and FCRA, record keeping, documentation and legal compliance

Suggested Readings
1. Lukose P J, A to Z in Projects Cycle Management: A Results Based Approach, Media House, Publications, New Delhi, 2015
2. Capezio, P., Powerful Planning Skills. Mumbai: Jaico Publishing House, 2000
3. Smith, S., Plan to Win. New Delhi: Kogan Page India, 2002
4. Dale, R., Evaluation Frameworks for Development Programmes and Projects. New Delhi: Sage Publications, 2001
5. Loehle, C., Thinking Strategically, New Delhi: Foundation Books, 2000
6. Padaki, V., Development Intervention and Programme Evaluation, New Delhi: Sage Publications, 1995
7. Dadrawala, N.H., The Art of Successful Fundraising, New Delhi: CAP

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H		H	M
CO 2		H	H	
CO 3		H	H	
CO 4	M			H

SWHP0060: COMMUNITY HEALTH AND POPULATION MANAGEMENT (3-0-0)
(3 credit- 45 hours)

Course Outcomes
- Define health, disease, epidemiology, health policies, health education and related terms of community health and population studies (Remembering)
- Explain the concepts of health, health indicators and relevance of social work in health (Understanding)
- Apply and knowledge and understanding of the concepts of community health in social work practice for development (Application)
- Able to analyse various health issues in communities, and suggest and apply solutions to community health concerns (Analyse)
- Able to assess and choose health intervention plans and policies for community needs (Evaluate)
- Able to combine effectiveness of health interventions, approaches, policies and programmes for effective intervention for healthy communities (Creating).

Module I: Health, Disease and Epidemiology (11 hours)
Meaning and Scope of Health and Epidemiology; Concepts and Models of Health and Disease; Factors associated with health and diseases; Concepts of sickness, illness and diseases; Environmental Health, Nutritional Health, Occupational Health, Mental Health and Reproductive Health, Tribal Health.

Module II: Health Indicators, Health Statistics and Management System (11 hours)
Health Statistics and Health Indicators – Morbidity and Mortality: MMR, IMR, TFR; Communicable and Non-communicable diseases; HMIS – Computer systems, Data sources, Collection, Analysis and uses; Primary, Public and Community Health Care Services: Structure, Organization, and Community Participation; Physical and psychological aspects of Community Health; Preventive and Promotive Health care in Indian context. Community Health Concerns: Drugs and Alcoholism.

Module III: Health and Population Policies (11 hours)
Health and Population Policies: Health Policy; Alma Ata Declaration, National Health Policy; Mental Health Act; NRHM, Assam Public Health Act; Population Policy; Population Dynamics- National and the North East Context.

Module IV: Health Education and Role of Social Worker in Health Service (12 hours)
Health Education, Consumer Health and Health Products; Meaning, importance, principles and components of health education; IEC for health: mass media, audio-visual; Agencies for Health Education Programmes-Voluntary and Government; Analysis of Health Education in India. Formal and Informal health care provider; Modern and traditional practices, safe and risk

health behavior and practices. Quackery, Consumer Law on health, consumer agencies; Role of Social Work in Preventive, Promotive and Rehabilitative Programmes in Communicable and Non-Communicable Diseases.

Suggested Readings

1. Abelin, T., Brzenski Z.J., and Carstairs, V.D., Measurement in Health Promotion and Protection, WHO, Copenhagen, 1987
2. AIDS Prevention through Health promotion by WHO, end of pub.
3. Alderson, M., An Introduction to Epidemiology, 2nd edition, Mac-Millan, London, 1983
4. Anssi. Perakyla, AIDS Counseling – Institutional Interaction and Clinical Practice, Cambridge, University Press, 1995
5. Bhore, J., Report of the Health Survey and Development Committee. Vol. 2. Government of India., New Delhi, 1946
6. Dutta, I. and Bawari, S., Health and Healthcare in Assam: A Status Report, CHEAT and OKD, Mumbai, 2007
7. Francis, C.M., Promotion of Mental Health with community participation- The center for Health Care Research and Education, Kerala,1991.
8. Government of India (GOI). Operational Guidelines for Programme Managers and Service Providers for Strengthening STI/RTI Services, GOI, Ministry of Health and Family Welfare, New Delhi, 2011
9. Green L.W and Anderson, C.L., Community Health 5th edition, Times Mirror Mosby, St. Louis 1986
10. Park, K., Park's Textbook of Preventive and Social Medicine, 20th edition, Bhanot, 2009
11. Thomas, G., AIDS and Family Education – Gracious Thomas, Rawat, Jaipur, 1995
12. Thomas, G., Sinha, N.P. and Thomas, K.J. AIDS'S Social Work and Rawat, Jaipur, 1997

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	M	M
CO 2	M	M	M	M
CO 3	M			H
CO 4	M	H		
CO 5			H	M
CO 6				H

SWDC0061: COMMUNITY DEVELOPMENT PRACTICE WITH THE DISEMPOWERED COMMUNITIES (3-0-0)

(3 credits- 45 hours)

Course Outcomes:

- Understand the issues of marginalization, oppression and disempowerment of vulnerable communities such as the dalits, tribes and the indigenous peoples and women ;(Remembering and Understanding)
- Build capacity among the students for critical reflection and analysis of community development issues pertaining to the disempowered ;(Applying and Analysing)
- Build upon the existing understanding of community dynamics, structures and experiences ;(Evaluating and Creating)
- Strengthen skills and capacity of the students for intervention at different levels taking an "empowerment" and anti-oppressive stance. (Applying)

Module I: Power, Privilege and Oppression (11 hours)

Conceptual Frameworks and Theoretical Perspectives; Systems Theory; Critical Theories; Understanding oppression, privilege and oppression in Indian context.

Module II: Political Economy of the Dalit Development (11 hours)

Social stratification; Caste; Casteism; Colonialism and State; Ambedkar and the Annihilation of Caste

Module III: Political Sociology of the Tribes and Tribal Development (11 hours)

Perspectives on Tribes; History of Tribes/Adivasis in India; Evolution of Tribal Policy; Administration and Local Governance; Politics of Tribal Welfare and Development; Critical Social Work; Anti-oppressive Approach; Structural Social Work

Module IV: Specific Identity Constructs and Populations at Risk (12 hours)

Gender and Sexism; Gender, Culture, and Society; Race, Sexuality, and Culture (Intersections); Gendered Relations; Health, Sex, and Gender.

Suggested Readings

1. Chacko, P.M. (Ed.), Tribal Communities and Social Change
2. Freire, A. M. A., and Macedo, D. (Eds.), The Paulo Freire reader. New York: Continuum, 1995
3. Freire, P., Pedagogy of the oppressed, (M. B. Ramos, Trans.) New York: Continuum, 1990
4. Freire, P., Education for critical consciousness. New York: Continuum, 1969/1998
5. Freire, P., Pedagogy of freedom: Ethics, democracy, and civic courage. (P. Clarke, Trans.) Lanham, MD: Rowman and

Littlefield Publishers, Inc., 1998
6. Freire, P., and Macedo, D. P., A dialogue: Culture, language, and race. Harvard Educational Review, 65(3), 1995
7. Fultner, B. (ed.), JurgenHabermas: Key Concepts. Rawat Publications. Jaipur, 2012
8. Taylor, D. (ed.), Michael Foucault: Key Concepts. Rawat Publications. Jaipur, 2011
9. Elwin, V., The Philosophy of NEFA
10. Bartlett and Kennedy eds., Feminist Legal Theory , 1991
11. Wing ed., Critical Race Feminism: A Reader, 1997
12. Ortner, S., Is Female to Male as Nature is to Culture? in M.Rosaldo and L. Lamphere (eds.), Women, Culture and Society, Stanford University Press, pp. 67-88., 1974
13. Moore, H.L., Feminism and Anthropology, Ch.2, Cambridge: Polity Press, pp. 12-41, 1988
14. Kimmel M., the Gendered Society. Introduction and Chapters 1, 2 and 4, 2000
15. Hollway, W., 'Gender difference and the production of subjectivity', in Helen Crowley and Susan Himmelweit (eds.) Knowing Women, p240 - 275, Oxford: Polity, 1984

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	H	M
CO 2	M	H		H
CO 3	M		M	M
CO 4		H	M	M

SWWE0062: DEVELOPMENT CONCERNS AND WOMEN EMPOWERMENT (3-0-0)

(3 Credits- 45 hours)

Course Outcomes:

- Develop an understanding of the feminist perspective of women empowerment (Remembering and Understanding)
- Understand the status of women in the present social, political and economic context (Remembering and Understanding)
- Develop an understanding of the women's problems and issues (Analyse)
- Know the national and international efforts for the welfare of women and gender parity(Evaluating and Creating)

Module I: Understanding Gender, Patriarchy, and Society (11 hours)

Gender, Sex and Patriarchy- Meaning; Social Construction of Femininity, Social Construction of Masculinity, Patriarchy, Intersectionality and Gender roles; Feminism – Meaning, Feminist Theories- Liberal, Radical, Marxist, Socialist and Eco-Feminism, Feminist Research Methodology; Feminist Economics and Introduction to Women's Studies

Module II: Women's Movement and Women's Development (11 hours)

Women's Movement in the USA, UK and India- Seneca Fall Declaration, the Suffragettes; Women in Indian Society - Women in early India, pre-colonial period and modern India, Women's Movement in India and its impact, The history of women's education; Theories of Development (Empowerment, Alternative Approaches: Women in Development, Women and Development and Gender and Development)

Module III: Concerns, Issues and Laws (11 hours)

Concerns relating to Women – Social, Economic and Political determinants of women's health; Women's right and Legal Advocacy; Violence against Women; Women in Conflict Areas; Migration, Displacement, Disaster – Impact on women; Women and Climate change; Working women in organized and Unorganized Sector; Sexual Harassment at Work place, Women and Globalization, PRIs and Women in India; Constitutional Rights of Women, Policies and programmes for empowerment of women, CEDAW, Dowry Prohibition Act 1961, Equal Remuneration Act 1976, Maternity Benefit Act 1961, , Medical Termination of Pregnancy Act 1971, Protection of Women from Domestics Violence Act 2005, The Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act 2013, National Commission for Women and State Commission for Women.

Module IV: Social Work Practice with Women (12 hours)

Social Action- Saul Alinsky's Theory, Advocacy, Examples of Social Action by women's groups, Recent Trends; Good Practices by INGOs and NGOs- UN Women, SEWA, NEN, The Ant, ABWJF, MGSN, Meira Paibis, Assam Mahila Samitti, Naga Mothers Association, Mizo Hmichhe Insuihkhawm Pawl, Impulse, Achik Mothers Association.

Suggested Readings

1. Agnes, Flavia., Law and Gender Inequality: The Politics of Women's Rights in India. Delhi: Oxford University Press, 2004
2. Arya, Sadhna. Roy, Anupama, Poverty, Gender and Migration. New Delhi: Sage Publications, 2006
3. Addlakha, Renu., Deconstructing Mental Illness: An Ethnography of Psychiatry, Women, and the Family. New Delhi: Zubaan, 2008

4. Datar, Chaya., Integrating activism and academics. In Jain, Devika and Rajput, Pam (Eds.), Narratives from the Women's Studies Family: Recreating Knowledge (pp. 136-149). New Delhi: Sage Publication, 2003
5. Ferber, A, Marriane. Nelson, A, Juie., Feminist Economics Today: Beyond Economic Man. London: The United Chicago Press Inc., 2003
6. Ganesamurthy, V, S., Empowerment of Women in India: Social, Economic and Political. New Delhi: New Century Publications, 2008
7. Gordon, L. P., Violence against Women. New York: Nova Publishers, 2002
8. Harding, Sandra G (Ed.). the Feminist Standpoint Theory Reader. New York: Routledge, 2004
9. Iralu, E., A Terrible Matriarchy. Zubaan Publications. New Delhi, 2007
10. Lalkima, C. Lalneihzovi., Changing Status of women in north-eastern states. New Delhi: Mittal Publications, 2009
11. Kols, A., Women, Peace and Security in Northeast India. Zubam Publication, New Delhi, 2018
12. Kumar, Radha., The History of Doing. New Delhi: Zubaan, 1993
13. .Kumar, Girish (Ed.)., Health Sector Reforms in India. New Delhi: Manohar, 2009
14. Mies, M., Shiva, V., Ecofeminism. London: Zed Books, 1993
15. Pandya, Rameshwari. Patel, Sarika., Women in the Unorganised Sector of India. New Delhi: New Century Publications, 2010
16. Ramazanouglu, Caroline.Holland, Jannet. (ed)., Feminist Methodology: Challenges and Choices. London: Sage Publications Inc., 2002

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	H	M
CO 2	M	H		H
CO 3	H		M	M
CO 4		H	M	M

SWSN0063: FAMILIES WITH SPECIAL NEEDS (3-0-0)

(3 credits- 45 hours)

Course Outcomes:

- Understand the context, responses and practice framework for special-care-needs families (Remembering and Understanding)
- Imbibe and become familiar with practice principles, values and ethics while dealing with families with special needs (Remembering and Understanding)
- Develop skills required for meaningful intervention (Applying and Analysing)
- Promote care-planning for families with special needs (Evaluating and Creating)

Module I: Understanding the Context (11 hours)

Understanding Early Childhood Development: Disabilities, Diseases, Gender; Issues Of Care Planning For Children, Youths, Women, Men With Special Care Needs; Special Needs of families in Northeast India: Families in Conflict, Disasters, Displacement, Superstition, Homelessness and Poverty; Emerging Concerns Of Seniors and Elderly: Global, National And Regional Contexts.

Module II: Understanding the Responses (11 hours)

Understanding the theoretical foundations for Social Work Support, Counseling, Resource Coordination and Advocacy Services for Families With Special Care Needs; Overview of service systems for special need groups; Issues, challenges and practice approaches with children and parents in Adoptions and Foster care; Clients and care-providers in Institutional Care; Adoption System: pregnant women, Adoptive Parents And Adopted Children; Disability, Pregnancy, LGTBs, geriatric care, Long-term care needs of terminally ill; Social Work Practice Principles and values in these settings.

Module III: Advanced Practice Skills (11 hours)

Case/Care Management of families with special needs: Terminally ill person, Mental Health Care, Addictions, Long-Term Care, Aging, HIV/AIDS, Disabilities, Occupational services, Child Welfare, and Immigrant/Refugee Families; Assessment; Care planning, and Resource linkages: programmes, schemes and services; Family Therapy: Communication-pattern Approach; Family subsystem Approach; Cognitive Behavioral Approach: cognitive restructuring, contingency contracting, skills.

Module IV: Working with Parents in families with Special Needs (12 hours)

Child Development Knowledge and Care; Positive Interactions with Child, Responsiveness, Sensitivity; Nurturing, Emotional Communication, Disciplinary Communication, Discipline and Behavior Management; Promoting Children's Social Skills or Pro-social Behavior; Promoting Children's Cognitive or Academic Skills.**Suggested Readings**

1. Bhuimali, A., Rights of disabled women and children in India. New Delhi: Serials Publications, 2009
2. Bindra, A., HIV/AIDS health care and human rights. Delhi: Mangalam Publishers, 2010
3. Boyd-Franklin, N., Steiner, G.L., and Boland, M.G., Children, Families, and HIV/AIDS: Psychosocial and Therapeutic Issues. The Guilford Press, 1995
4. Burke, Peter, Disability and Impairment: Working with Children and Families. Jessica Kingsley Publishers, 2008
5. Cambridge, P., and Carnaby, S. eds., Person centered planning and care management with people with learning disabilities. Philadelphia: Jessica Kingsley Publishers, 2005
6. Cosis-Brown, H., and Cocker, C., Social Work with Lesbians and Gay Men. New Delhi: Sage, 2011
7. Dasgupta, S., and Lal, M. (eds.), The Indian family in transition: reading literary and cultural texts. New Delhi: Sage, 2007
8. Emmatty, L.A., An insight into dementia care in India. New Delhi: SAGE, 2009
9. Gorman, J.C., Working with challenging parents of students with special needs. New Delhi: Sage, 2004
10. Grobman, L.M., and Bourassa, D.B., Days in the Lives of Gerontological Social Workers: 44 Professionals Tell Stories from "Real-Life" Social Work Practice with Older Adults. White Hat Communications, 2007
11. Humphrey, G.M., and Zimpfer, D.G. (eds.), Counselling for grief and bereavement, 2ndEd. New Delhi: Sage, 2012
12. Lobo, A., and Vasudevan, J., The penguin guide to adoption in India. Delhi: Penguin Books, 2002
13. McInnis-Dittrich, K., Social Work with Older Adults (3rd Edition). Pearson, 2008
14. McKenzie, R.B., Rethinking orphanages for the 21st century. New Delhi: Sage, 1998
15. Nayar, U.S. (Ed.). Child and adolescent mental health. New Delhi: Sage, 2012
16. Riddick-Grisham, S., and Deming, L., Pediatric life care planning and case management, second edition. Taylor and Francis Group, 2011
17. Satia, J., Misra, M., Arora, R., and Neogi, S., Innovations in maternal health: case studies from India. New Delhi: Sage, 2013

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	H	M
CO 2	H	H		H
CO 3	M		M	H
CO 4		H	M	M

SWPW0064: PSYCHIATRIC SOCIAL WORK (3-0-0)
(3 credits- 45 hours)

Course Outcomes:

- Introduce the field of psychiatric social work and comprehend the roles and responsibilities of psychiatric social workers (Remembering and Understanding)
- Introduce the concept of rehabilitation and the application of different therapeutic interventions (Understanding and Applying)
- Introduce different non-pharmacological therapeutic approaches used in psychiatry (Understanding, Analyzing and Applying).
- Introduce National Policies and Programs related to Mental Health and discuss (Understanding, Analyzing, Evaluating & Creating)

Module I: Psychiatric Social Work and its Application in the Field (11 hours)
Psychiatric Social Work - Definition and Historical development in UK, USA and India; Present status and challenges in the field; Multi-disciplinary team approach in the treatment of Psychiatric Illness; Role and Functions of Psychiatric Social Worker in the team; Psychiatric social worker in the Field Of Community Mental Health; Skills and Techniques used in Psychiatric Social Work Practice.

Module II: Rehabilitation and Practice of Psychiatric Social Work in various Clinical settings (11 hours)
Psychiatric rehabilitation - definition, psychosocial rehabilitation, principles and strategies; The concept of social diagnosis and social work interventions in psychiatric settings.- psychiatric departments /hospitals/clinics, halfway homes, day care centers, child guidance clinics and de- addiction centers.

Module III: Therapeutic Approach to Mental Illness (11 hours)
Treatment and after care of mentally ill patients, application of social work methods in the treatment of mental disorders; Various therapeutic methods: Psychotherapy, Electroconvulsive Therapy, Occupational Therapy, Group Therapy, Client Centered Therapy, Gestalt Therapy, Reality Therapy, Behaviour Therapy, Play Therapy, Rational Emotive Therapy, Therapeutic Community, Motivational Enhancement Therapy, Psycho education and Family Therapy.

Module IV: Policies and Programmes in the Field of Mental Health (12 hours)

Mental health policies and legislation in India; National Mental Health Programmes; Designing and implementing programmes on mental health in communities, monitoring and evaluation of programmes; Research – qualitative and action research on mental health issues.

Suggested Readings:

1. Bhattacharya, Sanjay Dr., Social Work: Psycho-Social and Health Aspects. Deep and Deep New Delhi: 2008
2. Carson C. Robert, Kutcher N. James, Minela Susan, Hooley M. Jill, Abnormal Psychology. 13th Edition. Pearson Education. 2010
3. Francis, C. M., Promotion of Mental Health with Community Participation. The Center for Health Care Research and Education. Kerala: 1991
4. Hudson Barber, Social Work with Psychiatric Patients. Macmillan Publishers. New Delhi: 1960
5. Maxmen S. Jerrold, Ward G. Nicholas, Essential Psychopathology and its Treatment, 2nd Edition. W.W. Norton and Company. USA: 1994
6. Patel Chhaya, Social Work Practice – Religio – Philosophical Foundations. Essays in Honour of Professor Indira Patel. Rawat Publications. Jaipur: 2009
7. Patel Vikram, Thara R.., Meeting the Mental Health Needs of Developing Countries – NGO Innovations in India. SAGE Publications. New Delhi: 2003
8. Pritchard Colin, Mental Health Social Work, Routledge. USA: 2006
9. Rukadhikar A., Rukadhikar P., Mental disorders and You, Psychiatric Centre. Miraj: 2007
10. Scileppi A. John, Teed L. Elizabeth, Torres D. Robin, Community Psychology, A Common Sense Approach to Mental Health, Prentice Hall. New Jersey: 2000
11. Segal, E. A., Gerdes, K.E. and Steiner, S., Professional Social Work... Rawat Publications. New Delhi: 2010
12. Stroup H. Herbert, An Introduction to the Field. 2nd Edition, Surjeet Publications. New Delhi: 2008
13. Verma, Ratna, Psychiatric Social Work in India. Sage Publications. New Delhi: 1991

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M		
CO 2		H	M	
CO 3		M	H	
CO 4	M			H

SWCH0065: COMMUNITY HEALTH AND SERVICES (3-0-0)

(3 credits: 45 hours)

Course Outcomes

- Define the concept of health, community health and health care services. (Remembering)
- Explain the administration of basic health infrastructure and services in the country; and illustrate the important national health policy, health programmes, their implementation, advocacy and lobbying. (Understanding)
- Make use of the knowledge on health education and health promotion in the field of work. (Applying)
- Analyze the important strategies and approaches of social work in community health. (Analyzing)
- Assess the health problems and health services with specific focus on marginalized and vulnerable groups and determine the role and specific skills required for social work practice in community health. (Evaluating)
- Build the skills of communication, community mobilization, organization, counselling and referrals; and formulate approaches for prevention and promotion of health, curative and rehabilitative services in Indian context. (Creating)

Module I: Understanding the concept of Health and Community Health (11 Hours)

Understanding Health and epidemiology. Components of Health: Physical, psychological, Emotional, Social and Spiritual. Determinants of Health and Indicators of Health; Socio political, Economic and Cultural factors influencing health. Community Health: Aspects of community Health, Models of Intervention and the role of Professional Social Worker. Rural and Urban health in India: Health Status, Health Problems and Health Services with specific focus on marginalized and vulnerable groups.

Module II: Health education and health promotion (11 hours)

Meaning, importance, principles and components of health education. Agencies for Health education programme – voluntary and Governmental Organizations, Health Network, Educational and Religious Institutions. Approaches for prevention and promotion of health, curative and rehabilitative services in Indian context. Prevention levels and modes of intervention.

Module III: National Health Programmes (11 hours)

Health Policies and Committees – National Health policy, National Health Mission, Health programs; their implementation, advocacy and lobbying. Health administration and Planning: Structure and Functions at National and State and District levels-

Primary Health Centers - Corporation and Municipal health services. Hospital Administration and Management.

Module IV: Strategies and approaches of social work in Community health (12 hours)
Understanding health from the Human Rights perspective – Environment issues and health – Media and health. Health Movements and Campaigns. Role and Specific skills required for Social Work Practice. Health education and communication, counseling and referral, Community mobilization and organization, Health system restructuring and reform, Capacity building and training, Resource mobilization and application

Suggested Readings

1. Park, J. E., Textbook of Preventive and Social Medicine, 17th edition. Jabalpur: Banarsidas Bhanot, 2006
2. Ministry of Health and Family Welfare, National Health Policy, New Delhi, 1983
3. Department of Health Ministry of Health and Family Welfare, National Health Policy, New Delhi, 2002
4. Breslow, L., Encyclopedia of Public Health. New York: Macmillan Reference USA, 2002
5. Duggal R. and Gangolli L., Review of Healthcare in India. Mumbai: CEHAT, 2005
6. Gibson Robert, Counselling and Guidance, Merrill, 595,199 New Jersey, Fleet-2, 2003
7. Schneider, Mary- Jane, Introduction to Public Health. London: Jones and Bartlett, 2006
8. Abelin, T., Brzenski Z.J., and Carstairs, V.D., Measurement in Health promotion and protection, WHO, Copenhagen, 1887
9. Alderson, M., An introduction to Epidemiology, 2nd Edition, Mac-Millan, London, 1983
10. Green L.W and Anderson, C.L, Community Health 5th edition, Times Mirror Mosby, St. Louis, 1986
11. Government of India (GOI), Operational Guidelines for Programme Managers and Service Providers for Strengthening STI/RTI Services, GOI, Ministry of Health and Family Welfare, New Delhi, 201

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M		
CO 2	M		H	
CO 3			M	M
CO 4		M		H
CO 5	M			M
CO 6		M	M	H

SWHR0066: HUMAN RESOURCE MANAGEMENT: SOCIAL WORK PERSPECTIVE (3-0-0)
(3 Credits- 45 hours)

Course Outcomes
- Understand HRM as a profession. (Remembering and Understanding)
- Understand the role of HRM in business. (Remembering and Understanding)
- Equip learners with knowledge, skills, attitude, professional competencies and social sensitivities essential for a successful career in HRM. (Applying and Analyzing)
- Integrate the knowledge obtained from theory with the practice. (Evaluating and Creating)

Module I: Introduction to Human Resource Management (11 hours)
Concept, scope and applicability of Human Resource Management- HR as a profession (Strategic Role – Basics); Structure, functions, mechanisms of HRM; Functional area of Human Resource Management; Role, characteristics and skill essentials of Human Resource Managers; International HRM; HRM in a dynamic environment – Basic concepts and trends.

Module II: Basics of Human Resource Management Practice (11 hours)
Procurement of Personnel – Human Resource Planning, Recruitment, selection; Talent Management – Acquiring, nurturing and retaining talent in knowledge based economy- issues, challenges and approaches; Mobility of people – concept of promotion, transfer, separation – Management and issues; Wage determination and Administration – Payroll management, and deductions – issues and challenges. Fringe benefits, profit bonus, pay for performance and competency based pay; Social Compliance Audit and HR Audit; Competency Development and Management.

Module III: Contemporary Human Resource Management (11 hours)
Process, benefits and relevance of strategic HR; Human Resource - The Strategic Business Partner; Mergers and acquisitions – Concept, meaning, process and issues; Human Factors in mergers and acquisitions; Employee engagement and Climate /Engagement Surveys – Meaning, concept and best practices; Benchmarking – Meaning, concept and purpose.

Module 1V: Career Development (12 hours)
Career development and succession planning - Concept and changing aspects; Mentoring and employee development – Concept and issues; Performance Management System – Meaning, Methods, Merits and limitations; Quality Management

System and its significance – ISO Standards; Employee Counseling – Relevance and Practice.

Suggested Readings

1. K.B Akhilesh, Enabling execution excellence - Himalaya Pub House, 2006
2. Abraham, E, Alternative approaches and strategies of Human Resource Development, Jaipur: Rawat Publications, 1988
3. Agarwal, Naik Banerjee, Personnel Management & Industrial Relations, Meerat: Pragathi Publications, 2003
4. Aquinas, P.G., Personnel Management, Mangalore: Sita Publishing House, 2005
5. Aswathappa K, Human Resource & Personnel Management, Tokyo: Tata McGraw Hill, 2002
6. Alan Barkar, How to hold better meetings – Magan Page Ltd, 1997
7. Alan Barkar, Creativity for Managers Excel books. Magan Page Ltd, 2005
8. Armstrong Angela, Strategic HRM - Barn Jaico Pub house, 2007
9. Armstrong and Murlis, Reward Management – Kagan Page, 2007
10. K Ashwathappa, Human Resource and Personnel Management Tata – McGraw Publication 3rd Edition, 2002
11. Britt and Boyd, Marketing and Administrative Action 3rd Edition – Mac Glaw, 1999
12. Bhaskar Chatterjee, Human Resource Management Sterling Publishers, 2004
13. Bhargava P.P, Issues in Personnel Management, Print well Publishers, 1990
14. Beardwell Ian Len Holden, Human Resource Management, De Montfort University, 1995
15. Bhagoliwal T.N., Personnel Management & Industrial Relations, Agra: SahithyaBhavan Publications, 1996
16. BhaskarChattergi, Human Resource Management, New Delhi: Sterling Publications Pvt. Ltd, 2004
17. Cole, G.A. Personnel Management, Theory & Practice, London: D.P. Publications
18. Cushway& lodge, Organizational Behaviour and Design, New Delhi: Inst Publishing house, 2001
19. Cushway, Human Resource Management, New Delhi: Crest Publishing house, 2001
20. Cascio F Waynes, Managing Human Resources, New Delhi: Tata McGraw Hil, 2004
21. Chaudhri K.K, Personnel Management for Executives, New Delhi: Himalaya Publishing House, 1998
22. Cynthia D. Fisher, Human Resource Management, Chennai: All India Publishers and Distributors, 1998
23. Davis, Keith, Human Behaviour at work, New Delhi: Tata McGraw Hill, 1983
24. Rao, V.S.P, Human Resource Management Text and Cases, Excel Book, New Delhi, 2006
25. Sharma K.K. Organization Behaviour, New Delhi: Deep & Deep Publications
26. SubrotoBagchi, Go kiss the world. Penguin India, 2008
27. SubrotoBagchi, The Professional. Penguin India, 2009
28. SubrotoBagchi, The High Performance Entrepreneur. Penguin India, 2006

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M		H
CO 2	M		H	
CO 3	H		M	M
CO 4		M		H

SWCI0067: CORPORATE SOCIAL RESPONSIBILITIES - CONCEPTS & IDEOLOGIES (3-0-0)

(3 Credits- 45 hours)

Course Outcome

- Introduce students into CSR concepts (Understanding)
- Develop competencies for effective field interventions, research and management of CSR interventions (Applying)
- Develop an insight into present CSR strategies and model business organization (analysing)
- Enable students with conceptual clarity on need, purpose and relevance of research applicability in CSR practice (Creating)

Module I: Concepts (11 hours)

CSR: Definition, Concept and scope; Evolution of CSR,; CSR and Social Legitimacy; The evolving role of stakeholders; Moral and Economic arguments for CSR; History of CSR in India; Dimensions & importance of CSR; Understanding CSR: Responsibility, Accountability & Sustainability.

Module II: CSR Policy and Governance (11 hours)

Stakeholder engagement; Environmental assessments; Theories & Models of CSR; CSR in emerging market; Limitation of CSR; Strategic Context of CSR.

Module III: Community Investment and Evaluation (11 hours)

CSR and Human Resource Management; Reporting and communication; Implementing CSR programmes; Monitoring and measuring the impact of CSR programs; Company Act: 2013; CSR: Global Perspective; Roles of institutions in CSR: Government, NGOs, Education institutions & role of Media.

Module IV: - Introducing a Systems-Based Approach to Developing CSR (12 hours)
Assessing the current state of a company's CSR activities; Linking CSR to brands and reputation; Stakeholder engagement; Current and future Trends & Practices in CSR; Indian CSR: Selected Case Studies.

Suggested Readings

1. Bali. C. and Prasad. A., Corporate Social Responsibility, Concept & Cases: The Indian Experience, Excel Books, New Delhi, 2013
2. Modi. P. K., Corporate Social Capital Liability, Arise Publishers & Distributors, Delhi, 2009
3. Prasenjit M., Corporate Social Responsibility - Vol. – I & II, Sharda Publishing House, Jodhpur (India), 2010
4. Reddy S., Corporate Social Responsibility, The Environmental Aspects, The ICFAI University, ICFAI Books, Hyderabad, 2010
5. Raj S., Corporate Social Responsibility Cases, The ICFAI University, ICFAI Books, Hyderabad, 2012
6. Sharda M., Corporate Social Responsibilities. - Vol. – I & II, Publishing House, Jodhpur (India), 2010
7. Vara V., Case study on Corporate Social Responsibility. – Vol. – I [ICFAI Business School Case Development Centre.] ICFAI Books, Hyderabad, 2011
8. Werther. B.W. & Chandler D., Strategic Corporate Social Responsibility, Stake holders in a global Environment, Sage Publication, 2009

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H			M
CO 2	H	M		M
CO 3		H	H	
CO 4	H		H	H

SWSP0068: CHILDREN WITH SPECIAL NEEDS (3-0-0)
(3 Credits – 45 hours)

Course Outcomes
- Understand the children with special needs and develop skills in social work intervention (Remembering and Understanding)
- Understand the context, responses and practice framework for inclusive programs and special-care-needs families (Remembering and Understanding)
- Imbibe and become familiar with practice principles, values and ethics while dealing with families with special needs (Applying and Analyzing)
- Apply a number of assessment procedures that identify internal and external risk protective and promotive factors that may affect children and adolescents. (Applying and Creating)

Module I: Understanding Children with Special Needs (11 hours)
Developmental Disabilities- Causes, Classifications and Labeling of children with special needs; Sensory Impairments- Vision, Hearing, And Speech; Physical disabilities and health problems; Learning, Behaviour and Emotional disorders; Understanding the Environment- Bronfenbrenner's ecosystem perspectives.

Module II: Best Practices in Inclusion (11 hours)
Definition and History of Inclusion; Benefits and challenges of Inclusion for Children with and without Disabilities; Elements of Good quality, inclusive programs for Infants, Toddlers, And Preschoolers; Six key aspects of best practices for Working with Children with Special Needs; Public Policy and Advocacy for inclusive practices; History and Impact of legislations affecting Children with Special Needs; Landmark court cases on Services for Children with Special Needs.

Module III: Documenting and Assessing to Support Families with Special Needs (11 hours)
Knowing about and using Observation, Documentation, and other appropriate Assessment Tools Understanding and practicing responsible Assessment, Knowing about Assessment Partnerships with Families and other Professionals; Documenting Case History; Family Assessment- Understanding the Goals, Benefits, and uses of Assessment; Problems-Strengths Identification.

Module IV: Partnerships with families and caregivers (11 hours)
Knowing about and understanding Family, Family in transition, and Community characteristics; Impact of Disabilities on Families- Understanding Families, Family Crises; Supporting and Empowering Families and Communities through Respectful, Reciprocal relationships; Involving Families and Communities in their Children's Development and Learning- Transitions and Adapting Materials and use of Adapting Technologies; Individualized Education Programs (IEPs); Individualized Transition Plans (ITPs) and; Individualized Family Service Plans (IFSPs); Community Resources and Cultural Sensitivity; Services by Government

and Non-government agencies in India.

Suggested Readings

1. K. Eileen Allen, Glynnis E. Cowdery, The exceptional child: inclusion in early childhood education, 6th edition. United States: Delmar Thompson Learning, 2009
2. Bhuimali, A., Rights of disabled women and children in India. New Delhi: Serials Publications, 2009
3. Boyd-Franklin, N., Steiner, G.L., and Boland, M.G., Children, Families, and HIV/AIDS: Psychosocial and Therapeutic Issues. The Guilford Press, 1995
4. Burke, Peter, Disability and Impairment: Working with Children and Families. Jessica Kingsley Publishers, 2008
5. Berk, Laura E. Development through the Lifespan, 5th edition. Allyn and Bacon. London: 2009
6. Cambridge, P., and Carnaby, S. eds., Person centered planning and care management with people with learning disabilities. Philadelphia: Jessica Kingsley Publishers, 2005
7. Dasgupta, S., and Lal, M. (eds.), The Indian family in transition: reading literary and cultural texts. New Delhi: Sage, 2007
8. Hurlock, Elizabeth, Developmental Psychology, Tata Mc Graw Hill. New York: 2001
9. Gorman, J.C., Working with challenging parents of students with special needs. New Delhi: Sage, 2004
10. Nayar, U.S. (Ed.)., Child and adolescent mental health. New Delhi: Sage, 2012
11. Riddick-Grisham, S., and Deming, L., Pediatric life care planning and case management, second edition. Taylor and Francis Group, 2012
12. Venkatesan, S., Children with developmental disabilities: a training guide for parents, teachers and caregivers. New Delhi: Sage, 2005
13. Webb, Nancy Boyd., Social work practice with children (2nd Ed.). New York: Guilford, 2003
14. Yuen, Francis K.O., Social Work Practice with Children and Families: A Family Health Approach (Haworth Health and Social Policy). Routledge, 2005
15. WHO, The ICD – 10 Classification of Mental and Behavioural Disorders, Diagnostic Criteria for Research, AITBS Publishers and Distributors (Regd.). Delhi: 2004

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	H	M
CO 2	M	H		H
CO 3	H		M	M
CO 4		H	M	H

SWRP0070: CHILD RIGHTS AND CHILD PROTECTION (3-0-0)

(3 Credits – 45 hours)

Course Outcomes

- Understand different social work perspectives on working with children. (Remembering and Understanding)
- Recognize the role of families and other stakeholders in child protection and demonstrate methods of strengthening families for child protection. (Applying and Analysing)
- Develop advanced intervention skills in working with children, adolescents and their families. (Evaluating and Creating)
- Help students practice effective communication, networking and collaboration skills with different stakeholders related to child protection. (Applying and Analyzing)

Module I: Social Work Perspectives on Working with Children (11 hours)

Ecological Model; Strengths based Perspectives; Child-centered Approach; Children's Perspective to Life; Family Centered Social Work, Problem Solving Approach; Developmental approach.

Module II: Governance and Child Rights (11 hours)

Understanding Governance, Child Rights Governance from Global Perspective; Governance in North East; Child Poverty and Good governance; Public finance and Child Budgeting, Child Rights Programming; Planning and Advocacy for Child Rights, Activism and Networking with Allied systems.

Module III: Working with Families and other Stakeholders (11 hours)

Working with Families- Families in the Indian Context (Diverse Functions, Structure and Size of Families) , Family Dynamics , Family Work and Parenting Skills, Strengthening Family's ability to Protect Children (Assessment, Identifying Needs and Life Stage of Each Member, Impact of Family Conditions on the Child, Linkages with Schemes for Family Strengthening); Working with Other Stakeholders (Child Protection Committees, Panchayats, Police, Government Departments, Schools, Residential Care Institutions, Community Groups, Self-Help Groups, Youth Groups), NGOs, Statutory Committee)

Module IV: Skills in Working with Children (12 hours)
Counseling and guidance - Counseling Techniques – Client-centered, Counselor Centered and Eclectic Counseling; Types of Counseling and Tools Required – Individual and Group counseling, Family Group Counseling, Individual Counseling Tools–Interview, Case study, Tests and Clinical; Assessment; Group Counseling–Informal Discussion; Group Reports, Lectures, Dramatics, Case conference; Communication Skills - Individual and Group, Use of Creative Activities like Storytelling, Play, Art, Music and Dance Movement; Skills in Behavior Modification techniques, Advocacy and Campaigning for Children, Relationship Building; Skills in working with different Vulnerable Groups; Facilitating Child Participation.

Suggested Readings
1. Barnes, V., Child-Centered Social Work: Theory and Practice. Red Globe Pres, Kingston University, 2018
2. Tait, A. & Wasu, H., Direct Work with Vulnerable Children: Playful Activities and Strategies for Communication, London: Jessica Kingsley Publishers, 2012
3. Nigudkar, M.; Kashyap, L., Skills of Communicating With Children, Mumbai: TISS. Brahmane, P. (2003) Making Best of Childhood, Pune: Personality School, 2009
4. Ruch, G., Post-qualifying Child Care Social Work - Developing Reflective Practice, London: Sage, 2009
5. Hanh, T. N., Planting Seeds: Practicing Mindfulness with Children, California: Parallaz Press, 2013
6. Nigudkar, M. &Kashyap, L., Skills of Communicating With Children, Mumbai: TISS, 2009
7. Alan, S. K.; Nancy, M.; Nadeen L.K.; Elizabeth, O. L., Essentials of Assessment Report Writing, New Jersey: John Wiley and Sons, Inc, 2004
9. Gangrade, K. D., working with Community at the Grassroot level: Strategies and Programmes, New Delhi: Radha Publications, 2001
10. Datar, S.; Baviskar, R. (et al), Skill Training for Social Workers: A Manual, London: Sage, 2010
11. D’Souza, B. & Sonawat, R., Handbook for Children in Difficult Situations: Activity Manual for Marginalised Adolescent (Vol. 1) Mumbai: Tej-Prasarni, 2003
12. Graves, D. H., Writing: Teachers and Children at Work. 20th Anniversary Edition, Portsmouth: NH Heinemann, 2003
13. Butler, I. & Roberts, G., Social Work with Children and Families: Getting into Practice (2nd Ed), London: Jessica Kingsley Publishers Ltd., 2004
14. Komanduri A. & Vennam U., Family-Centred Interventions in Indian Journal of Social Work (70) 2, 2009
15. Sanders, P., First Steps in Counselling: A Students' Companion for Basic Introductory Courses. PCCS Books, 2002
16. Jones. N. Richard., Theory and Practice of Counselling and Therapy. Sage Publication, 1995
17. Jones. N. Richard, Basic Counselling Skills: A helper's Manual. Sage Publication, 2003

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	M	H	M
CO 2	M	H		H
CO 3	M		H	H
CO 4		H	M	H

VALUE ADDED COURSES

SWAW6015: ACADEMIC WRITING, RESEARCH PROPOSAL DEVELOPMENT AND DISSERTATION WRITING COURSE (15-0-15)

(2 credits -30 hours)

Course Outcomes

- Remember the concepts and meaning related to academic and professional writing. (Remembering)
- Understand the different components, stages and steps of academic writing, research proposal development and dissertation writing. (Understanding)
- Able to apply the skill of professional and academic writing into practice. (Applying)
- Able to analyse different types of writing in professional life. (Analyzing)
- Able to review and evaluate writing styles in keeping with the framework of different professional and academic writing. (Evaluating)
- Able to write academic articles, develop research proposal, dissertations and professional reports. (Creating)

Module 1: Introduction to academic writing and publication (8 hours)

Academic writing – academic writing, citations, referencing – APA, MLA, Chicago etc., peer review process and types – single blind, double blind, open peer review; publishing in journals (Indexed and UGC CARE List), edited books and books; authorship and ethics of publication.

Module 2: Research Proposal Development, Presentation and Approval (14 hours)

Research proposal – Background of study, review or literature, statement of the problem/research concern, significance of the study, rationale of the study, research hypotheses, research questions, research objectives, definition of terms, research methodology – design, population, sampling, tools and techniques of data collection, sources of data, analysis, interpretation and representation of data, ethical concerns of research (Academic Integrity and Ethical Review Board), likely outcomes, limitation of the study and research timeline. Process of research proposal approval – presentation, feedback, revision, re-presentation and approval. The role of research guide in research process.

Module 3: Dissertation Writing, Presentation and Defense (8 hours)

Dissertation writing - scientific setting, sections of research dissertation, declarations and consent forms, chapterisation, annexures and reference. Drafts, mentoring by guide, printing, final submission, presentation, defense and viva voce examination.

Suggested Reading

1. American Psychological Association. (2020). Publication Manual of the American Psychological Association, Vol. 7. APA: Washington DC.
2. Ethical Principles of Psychologists and Code of Conduct. (2021), American Psychological Association. Source: https://www.apa.org/ethics/code
3. First Steps Toward Your Dissertation. (ND). Sage Publications, UK. Source: https://us.sagepub.com/sites/default/files/upm-assets/7155_book_item_7155.pdf.
4. UGC. (2019). Consortium for Academic Research and Ethics (CARE). UGC. New Delhi.
5. UGC. (2020). Guidance Document Good Academic Research Practices. UGC: New Delhi.

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	M	H	M
CO 2	M	H	M
CO 3	H	H	H
CO 4	M	M	M
CO 5	M	M	M
CO 6	M	M	H

SWRB6014: RESULTS BASED MANAGEMENT OF PROJECTS AND PROGRAMMES (15-0-15)

(2 Credits 30 hours)

Course Outcomes:

- Understand the importance and process of Result based management of projects and programmes and formulating projects using the Logical Framework Analysis
- Develop an understanding of the problems and issues faced by the poor and the marginalized

- Develop an insight into the different strategies and approaches commonly adopted by Development Organisations for Project Management
- Learn Skills to develop project proposals, implement, monitor and evaluate project, enhance process documentation and reporting skills

Module I: Overview (5 hours)
Overview of Results based Management and Project Cycle Management: Identification, Design, Implementation, Reviewing, Monitoring, Evaluation, Learning the lesions

Module 2: Project Identification (5 hours)
Project Identification :(Situational Analysis and Problem Tree Analysis)

Module 3: Project Design (10 Hours)
Capacity assessment: human, social, natural, physical, economic, cultural: Stakeholder analysis: user groups, interest groups, beneficiaries, decision makers; Primary and Secondary stakeholders: Identifying appropriate stakeholders for participation; levels of participation: Logical Framework Approach:

Module 4: Monitoring and Evaluation (4 Hours)
Methods and process of Monitoring and Evaluation

Module 5: Resource Mobilisation (6 Hours)
Internal and External Resources; Fundraising – principles, sources, ethics, methods and their implications. International sources for Funding – Concept note; application, procedure and FCRA, record keeping, documentation and legal compliance

Suggested Readings
1. Lukose P J, Results Based Management of Projects and Programmes and Fundamentals of Resource Mobilization: DVS Publications, Guwahati 2021
2. Capezio, P., Powerful Planning Skills. Mumbai: Jaico Publishing House, 2000
3. Smith, S., Plan to Win. New Delhi: Kogan Page India, 2002
4. Dale, R., Evaluation Frameworks for Development Programmes and Projects. New Delhi: Sage Publications, 2001

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3
CO 1	M	H	M
CO 2	M	H	M
CO 3	H	H	H
CO 4	H	M	H

SWWD6016: WORKING WITH DIVERSITY (15-0-15)
(2 Credits 30 hours)

Course Learning Objectives:
- Reflect on your own diversity (reflection), how it impacts on others (reflexivity) and how it informs to the development of critical cultural competence
- Understand the key theories related to the concept of diversity
- Critique the theoretical approaches of Equality, Human Rights and Diversity as they are applied in practice
- Apply the Diversity approach to current global issues including Covid-19
- Raise awareness of diversity through an application of theory to a co-created project promoting social change and human rights (Diversity Project and seminars)

Module – I (7 hours)
Defining Diversity and Difference; Theoretical and Conceptual understanding of Diversity; Models and Approaches; Levels of intervention in Diversity; Intersectionality and Structures of Diversity; Equality, Human Rights and Diversity.

Module – II (7 hours)
Perspectives of Diversity; Diversity, Difference and Disadvantage; Cultural Competence in Social Work and its Critiques; Current Strategies in Managing Diversity and its implications in Social Work;

Module III (7 hours)
Global Examples: Pandemic & Inequality; Black Lives Matter (Anti-Racism); Migration and Inclusion; Climate change and environmental issue; Resistance and solidarity in the context of indigenous (tribal/adivasi) development in India.

Module IV (9 hours)
Co-creation of Projects on Diversity and its management for social development in different global context.

Suggested Reading:

1. Thompson, N. (2011). Promoting Equality: Working with Difference and Diversity. Palgrave Macmillan. (Electronic book ordered for UEF students)
2. Thompson, N. (2016). Anti-discriminatory practice: Equality, diversity and social justice. Macmillan International Higher Education.
3. Hugman, R. (2012). Culture, values and ethics in social work: Embracing diversity. Routledge.Gast, L. E., & Patmore, A. (2012). Mastering approaches to diversity in social work. Jessica Kingsley Publishers. (Available online)
4. Marsiglia, F. F., Kulis, S. S., & Lechuga-Peña, S. (2021). Diversity, Oppression, & Change: Culturally Grounded Social Work. Oxford University Press, USA.
5. Online Journals:
Journal of Ethnic and Cultural Diversity in Social Work
Journal of Multicultural Social Work

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	M	H	M	H
CO 2	M	H	M	H
CO 3	H	H	H	M
CO 4	H	M	H	M
CO5	M	H	M	H

SWLS6017: Life Skills for competency development (15-0-15)

(2 Credits 30 hours)

Objectives:
The basic objective of the course is to introduce the students to the:

- Basic concepts and core life skills and its application
- Strategies for developing personality and competency
- Practice life skills for self-enrichment and well-being

Module 1: INTRODUCTION TO LIFE SKILLS [6 hours]

- Definition and importance of life skills
- Evolution and development of the concept of life skills:
  - Report of the Education Commissions of UNESCO: Faure Report and Delors' Report
  - UN Inter-Agency Report
  - Hamburg Declaration
  - Dakar Framework: Quality education and life skills

Module 2: CORE LIFE SKILLS: SOCIAL SKILLS, THINKING AND COPING SKILLS [12 hours]

- **Self-Awareness and Empathy**
  - Self-awareness: self-concept, self-image, self-esteem; techniques for self-exploration: Jo-Hari window, SWOT analysis
  - Empathy: sympathy, empathy & altruism; practising empathy
- **Effective Communication and Interpersonal Relationship**
- Effective communication: types and elements of communication; barriers of communication; presentation skills; questioning skills
- Interpersonal relationship: building, sustaining and ending relationships; factors affecting relationships; conflict resolution
- **High order thinking skills: Critical & Creative thinking**
  - Critical thinking: Process; strategies to enhance critical thinking
  - Creative thinking: Stages of creative thinking; strategies to enhance creative thinking
- **Problem Solving & Decision Making**
  - Problem solving: concept, stages in problem solving; models in problem-solving
  - Decision Making: process; models of decision making; decision making in a group
- **Coping Skills: Coping with Emotions and Stress**

- Coping with emotions: concept and types of emotions; coping with negative emotions and cultivating positive emotions
- Coping with Stress: concept and meaning; types and sources of stress, strategies to manage stress

Module 3: LIFE SKILLS FOR PERSONALITY DEVELOPMENT AND PRACTICUM [12 hours]

- **Life Skills for Personal Effectiveness**
  - Values: Punctuality, honesty, loyalty, dependability, reliability, integrity, respect, Constitutional values
  - Building self-confidence and self-motivation
  - Goal setting: types, steps, personal vision and goal
  - Time management
- **Topics prescribed for workshop/Skill lab**
  - Group discussion
  - Team building and team work
  - Facing interviews
  - Creativity
  - Leadership
  - Self-expression
  - Self-branding

Suggested Readings

1. Nair. A. Radhakrishnan & Gauri Hardikar, (2021), Mahatma Gandhi's Philosophy of Education and Life Skills Education: A Conceptual Study, IOSR *Journal of Research & Method in Education (IOSR-JRME)* e-ISSN: 2320–7388, p- ISSN: 2320-737x Volume 11, Issue 3 Ser. VII (May – June 2021), PP 01-11
2. Nair. A. Radhakrishnan & Gauri Hardikar, (2021), Swami Vivekananda's Philosophy of Life Skills Education, *IOSR Journal of Humanities and Social Science (IOSR-JHSS),* Volume 26, Issue 5, Series 10 (May. 2021) 01-07 e-ISSN: 2279-0837, p-ISSN: 2279-0845.
3. www.iosrjournals.org CYP (2003), *Adolescence and Life Skills*, Commonwealth Youth Programme Asia Centre, Tata Mc Graw- Hill
4. UNESCO (April 2000), *Dakar Framework for Action, Education for All: Meeting our Collective Commitments,* Dakar, Senegal.
5. Family Health International, NACO, USAID (2007), *Life Skills Education tool kit for Orphans and vulnerable children in India*
6. Hilgard, E, Atkinson R C & Atkinson R L (1976), *Introduction to Psychology (6th Ed), IBH Publishing Co. Pvt Ltd. New Delhi.*
7. Mangal S.K. (2008), *An Introduction to Psychology*, Sterling Publishers Pvt. Ltd., New Delhi.
8. Morgan and King (1993) *Introduction to Psychology*, Tata McGraw-Hill Publishing Company Ltd, New Delhi.
9. Rao P.L. (2008) Enriching Human Capital through Training and Development, Excel Books, Delhi.
10. RGNIYD. (2008). *Facilitators Manual on Enhancing Life Skills. Tamil Nadu*
11. Singh Madhu (2003), *Understanding Life Skills*, Background paper prepared for *Education for All: The Leap to Equality*
12. Stella, Cottrell (2008), *The Study Skills Handbook*, Palgrave Macmillan Ltd. (3rd Ed), New York
13. UNESCO and Indian National Commission for Co-operation with UNESCO (2001): *Life Skills in Non-formal Education: A Review*
14. Wallace R. Masters (2001) *Personal Development for Life and Work:* UK, South Western.
15. YUVA School Life Skills Programme: Handbook for Teachers, Vol. I – IV, (2008), Department of Education and State Council of Educational Research and Training, Delhi.

Web Sites:

- UNESCO – http://www.unesco.org/
- UNFPA - http://www.unfpa.org/
- UNICEF - http://www.unicef.org/
- United Nations - http://www.un.org/
- WHO - http://www.who.int/en/
- www.oecd.org

SWFT6018: FAMILY THERAPY (15-0-15)

(2 Credits 30 hours)

Module 1

Introduce the concept of Family and family therapy (7 Hours)

Family: Concept of family – Homeostasis, Family Rules, Content and Process of interaction, sequence of interaction, Specific dimensions – family context, Boundaries, Power, Decision making, Family affect, family goals, family myths and cognitive pattern, family roles, family strengths, Pathology of – boundaries, alliances, triangles, hierarchies, Characteristics of family, family life cycle, Family Therapy – Brief History of Family Therapy, definition of Family Therapy, Challenges faced by a family therapist.

Module 2

Theoretical Perspectives of Family Therapy (8 Hours)

Key Concepts, Goals and Techniques used in **Structural Family Therapy and Systemic Family Therapy**

Module 3

Basic Concepts of Family Therapy (7 Hours)

Assessment –Family Assessment Performa – family structure, leadership patterns, Role structure and function, Communication, Reinforcement, Cohesiveness, Adaptive patterns, Exploring the presenting problem, assessing for attempted solutions, The process of family therapy- Pre-session, planning and task, Initial sessions, Middle Phase of Treatment, Termination

Module 4

Techniques Used (8 Hours)

Genogram- different symbols, Asking Questions – Lineal questions, Circular Questions, Strategic Questions, Reflexive Questions, Placating, Blaming, Super-reasonable, Irrelevant Behaviour, Family Reconstruction, Reframing, Boundaries, Unbalancing, channeling, specifying, tracking and linking, filtering, Normalizing, Providing support, Confronting, Pacing, Complementarity, Realties, Constructions, Strengths, Paradoxes

Tools- Family Sculpting, Family Genograms, Ecomap

Suggested Readings

1. Gladding, Samuel T. Family Therapy. 7th Edition, Pearson Education, Inc. NY : 2011
2. Patterson, JoEllen., Lee, Williams., Edwards, Todd, M., Chamow, Larry & Grauf-Grounds, Claudia. Essential Skills in family Therapy: From the first Interview to Termination. 3rd Edition, The Guildford Press, NY: 2018
3. Nicholas, Michael, P. & Davis, Sean, D. Family Therapy: Concepts and Methods, 11th Edition, Pearson Education, Inc. USA:2017
4. Rivett, M., Buchmuller, Joanne & Oliver, Karon. Family Therapy: Skills and Techniques in Action. Routlege, NY:2018
5. Antony, D., John., Psychotherapies in Counselling, Anugraha Publications. Tamil Nadu:2003

SWCD6019: INTRODUCTION TO COMMUNICATION FOR DEVELOPMENT (C4D) FOR SOCIAL WORK(15-0-15)

(2 Credits 30 Hours)

Course description

This course will introduce students to the field of communication for development (c4d). C4d is an evidence-based process that utilizes a mix of communication tools, channels and approaches to facilitate participation and engagement with children, families, communities, networks for positive social and behaviour change in both development and humanitarian contexts. It draws on learnings and concepts from the social, behavioural and communication sciences.

This course will bring together ideas of activists/professionals and academicians in the field to cover the theoretical and practical components of the subject. The students will learn the theory, history and practice of communication for development and its application for social and behaviour communication through puppet-making, or street-play or grassroots' comics. The students will be assessed while showcasing their skills in a community setting.

Learner objectives

- Understand, define and describe key theories around communication, development, culture, behaviour and social change
- Learn from organizations/practitioners/activists who effectively use different media techniques for disseminating development results, awareness-raising and public debate; and
- Showcase the skills of communication for development and social change in a community setting.

Participants

The course is open to everyone pursuing post-graduate study programme at assam don bosco university. A maximum of 30 students will be able to enroll in the course per batch.

Module 1: principles and concepts in communication for development (5 hours)

Introduction to c4d, planning, implementation and management of c4d projects

Module 2: behavior and social change theories in c4d (5 hours)

Behavior and social change theory in c4d, interpersonal-level change theories, community-level change theories, theory-led c4d research and planning

Module 3: c4d research, monitoring, and evaluation (5 hours)
Research, monitoring and evaluation concepts; participatory research; the c4d research, monitoring and evaluation framework

Module 4: presentation of a c4d project in a community setting (15 hours)
The learners will work in groups on a communication for development and social change project (using puppetry/street play/grassroot comics) and present it in a community setting.

Course outcomes
1. the learner is able to state the meaning and applications of communication for development in social work practice and research. (remembering)
2. The student is able to explain the uses of communication for development and its use in social work practice.(understanding)
3. the learner is able to apply the knowledge and skill of communication for developmentfor intervention projects aimed at social change. (applying)
4. the student is able to analyse and adopt appropriate media for carrying out communication for development applications in appropriate contexts. (analysing)
5. the learner is able to assess the appropriate use of communication for development to find participatory solutionsto different social and cultural issues affecting communities. (evaluating)
6. the learner is able to design and execute a communication for developmentproject for social and behaviour change communication. (creating)

Mapping of cos to syllabus

Course Outcomes	MODULE 1	MODULE 2	MODULE 3	MODULE 4
CO 1	H	H	H	H
CO 2	M	M	M	
CO 3	M	M		M
CO 4			M	M
CO 5		M		
CO 6	M			M

Suggested readings

1. Consortium for education communication (2014). *Development communication*. Youtube: https://www.youtube.com/watch?v=3zxoo0c0nmu
2. Kumar, s. (2002).*methods for community participation: a complete guide for practitioners.* Delhi: vistaar.
3. Steeves, h. L., & melkote, s.r. (2015). *Communication for development: theory and practice for empowerment and social justice.* New delhi: sage.
4. Unicef (2018).*communication for development (c4d) - case study compendium 2013-17.* Delhi: unicef india. (available at: https://www.unicef.org/india/media/1421/file/c4d-compendium.pdf)
5. Wilkins, k.g.,tufte, t., & obregon, r. (2014).*the handbook of development communication and social change.* Delhi: wiley.

PRACTICUM

SWFR6008: CONCURRENT FIELDWORK I (6 credits):200 hours of Fieldwork in 15 weeks(0-0-16)

Expected Outcomes:

- Students are exposed to the community and community issues
- The students understand the dynamics and issues in the community and become aware of the sensitivities of people while working with them.
- Students get a close feel of the community and community settings
- They also get a firsthand experience of the programmes and projects implemented in the communities by NGOs and government agencies and the impact that these have on the community.
- Understand the tension between tradition and change that the communities in the region are likely to experience, and how it is handled.

Process

The field work practice in the first semester consists of orientation visits, lab sessions for skills training and placement.

- In the first semester, the focus of field work is the community.
- The students are placed in communities and in NGOs, Service Organizations and Government Agencies working with communities, and in those settings where they can be.
- They also interact with the agency personnel and the community members
- They, with the help of the agency and the field work supervisor, identify an issue and work on it following the principles of community organization. The students are expected to be creative and innovative in assisting the agency and community in whatever way possible.
- Normally a student spends fifteen hours over two days per week in field work. However, keeping in mind the peculiar situation of transport and communications in the region and the expenses involved, the field work practice may be arranged in other convenient ways as the department deems fit.
- After each session of field work the students write a report of their activities and submit to the concerned field work supervisor. The supervisor conducts individual and group field work conferences regularly.
- At the end of the semester the student submits a summary report for the semester and an external viva voce examination is conducted.

SWFW6009: CONCURRENT FIELD WORK II (0-0-16)

(6 credits- 200 hours of fieldwork in 15 weeks)

Expected Outcome:

Ensures that the student understands the way these institutions and agencies function and practice the skills of working with individuals and different groups.

Process

- The field work practice in the second semester will consist of lab sessions for skills training and placement. The focus will be on the practice of Social Case Work and Group works.
- The students shall be placed in NGOs, Government Departments, Service Organizations and Communities working with individuals and families, and in those settings where they can be exposed to issues related to individuals and groups. Normally a student spends fifteen hours over two days per week in field work.
- The student is expected to complete 5 cases in casework and follow up one group with at least 5 sessions.
- Besides this, the student shall be involved in the activities of the institution and fulfill the responsibilities that are asked of him/her by the agency/ field supervisor.
- After each session of field work the students shall write a report of their activities and submit to the concerned field work supervisor. The supervisor shall conduct individual and group field work conferences regularly.
- At the end of the semester the student shall submit a summary report for the semester and an external viva voce examination is conducted.

SWCA0047/SWCA6010: COMPUTER APPLICATIONS FOR SOCIAL SCIENCES (Lab)(0-0-2)

(2 Credits- 30 hours)

Course Outcome:

- Learn the basic computer applications; those are useful for a social worker. (Remembering)
- Learn and do data analysis for research using a Statistical Analysis Package. (Applying)

Module I (7 hours)
Word Processing: Meaning, Features, advantages; Structure of a Word Processor window; Creating document, saving opening and printing, find and replace. Creating table; Mail merge - main document, data source and merging

Module II (8 hours)
Spreadsheet Package: Cell, rows and columns; Range, structure of a spreadsheet window; Creating, saving opening and printing a spreadsheet, creating tables, charts; data analysis using formulae in a spreadsheet.

Module III (5 hours)
Presentation package: Creating presentations in a presentation package, text, tables, charts, Animation, running slide show, saving the slides, printing presentations; Internet and browsing, E-Mail, blogging, use of Internet in Research

Module IV (10 hours)
Data analysis using statistical software packages.

Suggested Reading:
1. Simon Slavin (Author), Richard Schoech. Human Services Technology: Understanding, Designing, and Implementing Computer and Internet Applications in the Social Services. NY: Haworth. (1999).
2. Connie Morrison, Dolores Wells. Computer Literacy Basics: A Comprehensive Guide to Ic3. www.Alibris.com

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H	H	H	
CO 2	H	M		H

SWFW6010: CONTINUOUS FIELD WORK I (0-0-200)
(6 credits; 200 hours of Fieldwork in one month)

Expected Outcome:
- The students focus on their Area of Concentration / Specialization .
- Enable the students to become more proficient in the field and apply relevant skills and techniques in handling real situations.
- Opportunities to implement programmes

The process
1. The students shall be placed in the field for twenty five days of consecutive field work.
2. The field work settings shall be Communities, NGOs, Service Organizations, Hospitals, Clinics and Governmental Agencies.
3. The students will identify Organisations or Communities which will be approved by the Department.
4. The students are expected to apply all the methods of social work such as Social Casework, Group Work, Community Organization, Research and Administration, wherever applicable depending upon the organization and their services.
5. The students shall be involved in the activities of the Institution and fulfill the responsibilities as requested by the Agency Supervisor.
6. The students shall prepare a daily report of the field work activities implemented and share them through e-mail with the concerned Faculty Supervisor at the end of each day.
7. The Supervisor shall provide the necessary feedback and guidance to the students by also making personal visits if possible, to the field where they are placed.
8. At the end of the continuous field work placement, the students shall submit a consolidated or summary report highlighting the main activities implemented and the major learning from the field placement.
9. Every student shall also appear for an external viva voce examination at the end of the semester.

SWCF6012: CONTINUOUS FIELD WORK II (0-0-200)
(6 credits: 200 hours fieldwork in one month)

Expected Outcome:
- The students focus on their Area of Concentration / Specialization.
- Enable the students to become more proficient in the field and apply relevant skills and techniques in handling real situations.
- Opportunities to implement programmes

The process
- The students shall be placed in the field for twenty five days of consecutive field work.

- The field work settings shall be Communities, NGOs, Service Organizations, Hospitals, Clinics and Governmental Agencies.
- The students will identify Organisations or Communities which will be approved by the Department.
- The students are expected to apply all the methods of social work such as Social Casework, Group Work, Community Organization, Research and Administration, wherever applicable depending upon the organization and their services.
- The students shall be involved in the activities of the Institution and fulfill the responsibilities as requested by the Agency Supervisor.
- The students shall prepare a daily report of the field work activities implemented and share them through e-mail with the concerned Faculty Supervisor at the end of each day.
- The Supervisor shall provide the necessary feedback and guidance to the students by also making personal visits if possible, to the field where they are placed.
- At the end of the continuous field work placement, the students shall submit a consolidated or summary report highlighting the main activities implemented and the major learning from the field placement.
- Every student shall also appear for an external viva voce examination at the end of the semester.

SWIN6013: INTERNSHIP (0-0-200)
Pass/No Pass (200 hours fieldwork in one month)

Process
- After the Examinations at the end of the 4th Semester or as per the prevailing socio-political situations, the students shall be placed with an NGO or Agency for a period of not less than one month for practical experience and application of their skills.
- While Internship is not credited, it is mandatory for the completion of the MSW programme.
- The students shall contact an agency of his/her choice and get the choice of agency approved by the department.
- Students shall endeavor to choose an agency that is primarily in tune with their AOC and which has credentials in the concerned field.
- At the end of every week the student shall send a brief report to the supervisor and at the end of the internship a summary report shall be submitted.
- The summary report shall contain the short description of the agency, the social service skills applied in his/her work and the student’s learning outcome.
- The report shall be submitted in the format prescribed by the department and shall be submitted together with the certificate from the agency confirming his/her internship in a prescribed format.

SWRP6020: RESEARCH PROJECT PHASE I
(3 credits)
Every student shall undertake a research project work which has bearing on his/her AoC under the supervision and guidance of a faculty member. The preliminary work may begin at the end of the second semester. The students are expected to complete the Literature Survey followed by a Synopsis presentation during the Phase I. The dates, the mode and components of evaluation and the weightages attached to them shall be published by the Department/Institute at the beginning of the semester.

SWRP6021: RESEARCH PROJECT PHASE II
(3 credits)
Every student shall undertake a research project work which has bearing on his/her AoC and present a written thesis on the research work under the supervision and guidance of a faculty member. The preliminary work may begin at the end of the second semester. The students are expected to complete the data collection before the fourth semester. The thesis is to be submitted to the department before the date notified. The mode and components of evaluation and the weightages attached to them shall be published by the Department/Institute at the beginning of the semester. There shall be a viva voce examination on the research project.

SWSL0200: PARTICIPATORY SERVICE LEARNING-RURAL PRACTICUM (30-0-50)
Credits: 2 (30 Hours)

Course Outcomes
- Understanding the meaning and objectives of service learning and participatory approach to social development (Remembering and Understanding)
- Learn and apply various methods, techniques and strategies for participatory rural/urban mapping, development and communication (Applying)
- Appraising the spatial, temporal and relational aspects of communities in the village/urban settings by application of

participatory learning, action and reflection (Evaluating)

- Being familiar with culture, tradition, customs and social change and transformation processes of a rural/urban locality(Creating);
- Engage in inter-cultural teamwork to study, understand and promote development in rural areas (Applying)

Module I: Introduction to Service Learning (5 Hours)
Concept of Service Learning— definition, principles, models of different Higher Education Institution Service Learning; Service Learning as a medium of Social change.

Module II: Introduction to participatory learning, action and reflection (5 Hours)
What is participation? Participatory approach to social development; Principles of community participation; Participatory Appraisal Methods.

Module III: Participatory community mapping (10 Hours)
Spatial maps- social map, transect, resource map, mobility map; Temporal maps- historical timeline, seasonal maps, daily activity maps, trends analysis; Relational maps- chapatti diagram, well-being ranking, pair-wise ranking, problem tree analysis. Community Dream Map.

Module IV: Participatory community development practice (10 Hours)
Rapport building, project identification, definition and planning, participatory implementation and monitoring, evaluation and Exit.

Suggested Readings

1. Chambers. R. (1983). Rural development: putting the last first. New Delhi: Routledge.
2. Jacoby, B. (2010). Service learning in higher education: concepts and practices. Michigan: Jossey-Bass Publishers.
3. Jacob, Islary. (2020). Pregnancy and Pregnancy care Practice: The lived Experience of the Bodos Mittal Publications, New Delhi.
4. Kelly, A., & Westoby, P. (2018). Participatory development practice: using traditional and contemporary frameworks. London: Practical Action Publishing.
5. Kumar, S. (2002). Methods for community participation: a complete guide for practitioners. New Delhi: Vistaar
6. Lukose P J, (2015) Social analysis: A guide for the Social Workers, Media House Publications, New Delhi
7. Lukose P J, (2015). A to Z in Projects Cycle Management: A Results Based Approach, Media House, Publications, New Delhi
8. Speck, B.W., & Hoppe, S.L. (2004). Service-learning: history, theory and issues. Connecticut: Greenwood Publishing Group.
9. https://www.washington.edu/carlson/students-3/browse-service-learning-positions/
10. https://ccel.umn.edu/

Mapping of COs to Syllabus

Course Outcomes	Module 1	Module 2	Module 3	Module 4
CO 1	H		M	H
CO 2	M	H	H	
CO 3		M	H	
CO 4	M		M	H
CO5	M		H	

SWCP6022: Community Development Project I

SWCP6023: Community Development Project II

EDPC0201: INDIAN POLITY AND CONSTITUTION

Course Outcomes

At the end of this course students are able to:

1. Understand and analyse different governmental systems, the historical background and philosophy of the Indian Constitution
2. Understand and compare Indian Constitution with Constitution of other countries
3. Understand and analyse the Constitutional provisions for the Indian territory, citizenship, fundamental rights and duties and the procedure to amend the Indian Constitution
4. Understand and analyse the Indian federal structure, different levels of government and the Administration of special areas
5. Understand and analyse the Judicial system of India, rights and liabilities of the government and public servants, the functionalities of public service commissions and the electoral process in India
6. Understand and analyse the Constitutional provisions for the protection of SCs, STs and minorities and the contemporary issues of languages and cultures in India

Module - I

Governmental systems: Monarchy, Plutocracy, Theocracy, Democracy, Oligarchy, Authoritarianism, Totalitarianism, Parliamentary & Presidential, Unitary & Federal; The historical background and making of Indian Constitution; The philosophy and Features of the Indian Constitution; The Preamble; Comparison of Indian Constitution with Constitution of USA, UK, Australia and France

Module – II

Territory of the Indian Union; Citizenship; Fundamental Rights and Fundamental Duties; Directive Principles of the State Policy; Procedure of Amendment to the Constitution

Module – III

Polity: The Nature of the Federal system; Government of the Union; Government of the States; Administration of the Union Territories; Local Government; Administration of special areas (Scheduled areas and Tribal Areas)

Module – IV

The Judicature: The Supreme Court; The High Court; Subordinate Courts; Rights and liabilities of the government and public servants; Public Service Commissions; Elections; Constitutional provisions for the protection of Minorities; Scheduled Caste and Scheduled Tribes; The issues of Languages and culture.

Suggested Readings:

1. Austin, Granville. *Working A Democratic Constitution: The Indian Experience*. Oxford University Press, 2000.
2. Basu, Durga Das. *Introduction To The Constitution Of India*. Lexis Nexis Butterworths Wadhwa Nagpur, 2020.
3. Basu, Durga Das, and S. S Subbramani. *Commentary On The Constitution Of India: Articles 79 To 123*, 1950
4. Bhatia, Gautam. *The Transformative Constitution: A Radical Biography In Nine Acts*. 2019.
5. *Boyron, Sophie. The Constitution of France: A Contextual Analysis, Bloomsbury Publishing, 2012*
6. Chandrasekhar Rao, R. V. R, and V Sivalinga Prasad. *Indian Constitution And Polity*. Sterling Publishers, 1991.
7. Cheryl, Saunders. The Constitution of Australia: A Contextual Analysis (Constitutional Systems of the *World* Book 4). Hart Publishing; 1st edition, 2010
8. Choudhry, Sujit et al. *The Oxford Handbook Of The Indian Constitution*. 2016.
9. Courtney, Leonard Henry Courtney. *The Working Constitution Of The United Kingdom*. J.M. Dent, 1920.
10. Katju, Justice Markandey. *Whither Indian Judiciary*. 2018
11. Khosla, Madhav. *India'S Founding Moment: The Constitution Of A Most Surprising Democracy*. 2020.
12. Thiruvengadam, Arun K. *Constitution Of India - A Contextual Analysis*. 2017.
13. Wood, Gordon S. *The Creation Of The American Republic, 1776-1787*. The University Of North Carolina Press, 2011.