B.S. Abdur Rahman
Crescent
Institute of Science & Technology
Deemed to be University u/s 3 of the UGC Act, 1956

REGULATIONS 2017

CURRICULUM AND SYLLABI

B.TECH.
ELECTRICAL AND ELECTRONICS ENGINEERING

VISION AND MISSION OF THE INSTITUTION

VISION

B.S. Abdur Rahman Crescent Institute of Science and Technology aspires to be a leader in Education, Training and Research in Engineering, Science, Technology and Management and to play a vital role in the Socio-Economic progress of the Country.

MISSION

- To blossom into an internationally renowned Institution
- To empower the youth through quality education and to provide professional leadership
- To achieve excellence in all its endeavors to face global challenges
- To provide excellent teaching and research ambience
- To network with global institutions of Excellence, Business, Industry and Research Organizations
- To contribute to the knowledge base through Scientific enquiry, Applied research and Innovation

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION AND MISSION

VISION

To achieve excellence in the programs offered by the Department of Electrical and Electronics Engineering through quality teaching, holistic learning and innovative research.

MISSION

- To offer Under Graduate, Post Graduate & Research programs of industrial and societal relevance.
- To provide knowledge and skill in the Design and realization of Electrical and Electronic circuits and systems.
- To impart necessary managerial and soft skills to face the industrial challenges.
- To pursue academic and collaborative research with industry and research institutions in India and abroad.
- To disseminate the outcome of research and projects through publications, seminars and workshops.
- To provide conducive ambience for higher education, teaching and research.

PROGRAMME EDUCATIONAL OBJECTIVES

- To provide fundamental knowledge of mathematics and science to understand the basic concepts of Electrical and Electronics Engineering.
- To impart theoretical and practical knowledge in the broad areas of Power Generation, transmission, Distribution and Utilization.
- To provide knowledge and skill in using Electrical and Electronic components circuits and systems.
- To develop skills for devising and evaluating solutions including design of components system and their analysis using appropriate tools.

  To enhance the spirit of enquiry through projects and internships to develop creativity, self confidence and team spirit.
- To inculcate self learning capability to enable the students to constantly update themselves with the technological developments.
- To impart necessary managerial and soft skills to face the challenges in core industries and software companies.

PROGRAMME OUTCOMES

On successful completion of the programme, the graduates will

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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

- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- 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.
- Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 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.
- 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.
- 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.
- Design, Simulate and Analyse the Electrical and Magnetic Systems in the areas of Electrical and Electronics Engineering and arrive at appropriate solutions.
- Competent to work professionally in an Industrial Environment.

REGULATIONS - 2017

B.TECH. DEGREE PROGRAMMES

1.0 PRELIMINARY DEFINITIONS & NOMENCLATURE

In these Regulations, unless the context otherwise requires:

i) **"Programme"** means B.Tech. Degree Programme.

ii) **"Branch"** means specialization or discipline of B.Tech. Degree Programme like Civil Engineering, Mechanical Engineering, etc.,

iii) **"Course"** means a theory or practical subject that is normally studied in a semester, like Mathematics, Physics, Engineering Graphics, Computer Practice, etc.,

iv) **"Institution"** means B.S.Abdur Rahman Crescent Institute of Science and Technology.

v) **"Dean (Academic Affairs)"** means the Dean (Academic Affairs) of B.S.Abdur Rahman Crescent Institute of Science and Technology.

vi) **"Dean (Student Affairs**)" means the Dean (Students Affairs) of B.S.Abdur Rahman Crescent Institute of Science and Technology.

vii) **"Controller of Examinations"** means the Controller of Examination of B.S.Abdur Rahman Crescent Institute of Science and Technology who is responsible for conduct of examinations and declaration of results.

2.0 ADMISSION

2.1a) Candidates for admission to the first semester of the eight-semester B.Tech. degree programme shall be required to have passed the Higher Secondary Examination of the (10+2) curriculum (Academic stream) prescribed by the appropriate authority or any other examination of any university or authority accepted by the Institution as equivalent thereto.

2.1b) Candidates for admission to the third semester of the eight-semester B.Tech. programme under lateral entry scheme shall be required to have passed the Diploma examination in Engineering / Technology of the Department of Technical Education, Government of Tamil Nadu or any other examination of any other authority accepted by the Institution as equivalent thereto.

2.2 Notwithstanding the qualifying examination the candidate might have passed, the candidate shall also write an entrance examination prescribed by the

Institution for admission. The entrance examination shall test the proficiency of the candidate in Mathematics, Physics and Chemistry on the standards prescribed for Ten plus Two academic stream.

2.3 The eligibility criteria such as marks, number of attempts and physical fitness shall be as prescribed by the Institution from time to time.

3.0 BRANCHES OF STUDY

3.1 Regulations are applicable to the following B.Tech. degree programmes in various branches of Engineering and Technology, each distributed over eight semesters with two semesters per academic year.

B.TECH. DEGREE PROGRAMMES:

1. Aeronautical Engineering
2. Automobile Engineering
3. Civil Engineering
4. Computer Science and Engineering
5. Electrical and Electronics Engineering
6. Electronics and Communication Engineering
7. Electronics and Instrumentation Engineering
8. Information Technology
9. Manufacturing Engineering
10. Mechanical Engineering
11. Polymer Engineering
12. Biotechnology
13. Cancer Biotechnology
14. Food Biotechnology

4.0 STRUCTURE OF THE PROGRAMME

4.1 Every Programme will have a curriculum with syllabi consisting of theory and practical courses such as,

i) Basic Sciences (BS)

ii) Humanities & Social Sciences (HS)

iii) Management Sciences (MS)

iv) Engineering Sciences Fundamentals (ESF)

v) Engineering Core Courses (EC)

vi) Professional Electives (PE)

vii) General Electives (GE)

viii) Workshop practice, laboratory work, industrial training, seminar presentation, project work, etc.

4.2 Each course is normally assigned certain number of credits :

- one credit per lecture period per week
- one credit per tutorial period per week
- one credit for two to three periods and two credits for four periods of laboratory or practical sessions
- one credit for two periods of seminar / project work per week
- one credit for two weeks of industrial training.

4.3 Each semester curriculum shall normally have a blend of lecture courses, laboratory courses and laboratory integrated theory courses of total not exceeding 26 credits.

4.4 For the award of the degree, a student has to earn a minimum total credits specified in the curriculum of the relevant branch of study. The minimum credits to be earned will be between 174 and 180, depending on the program.

4.5 The medium of instruction, examinations and project report shall be in English, except for courses in languages other than English.

5.0 DURATION OF THE PROGRAMME

5.1 A student is ordinarily expected to complete the B.Tech. programme in eight semesters (six semesters in the case of lateral entry scheme), but in any case not more than 14 continuous semesters reckoned from the date of first admission (12 semesters in the case of lateral entry student).

5.2 Each semester shall consist of a minimum of 90 working days.

5.3 Semester end examination will normally follow within a week after the last working day of the semester.

6.0 CLASS ADVISOR AND FACULTY ADVISOR

6.1 CLASS ADVISOR

A faculty member will be nominated by the HOD as Class Advisor for the class throughout the period of study except first year.

The Class Advisor shall be responsible for maintaining the academic, curricular and co-curricular records of students of the class throughout their period of study.

However, for the first and second semester, the class advisors (First year class advisors) will be nominated by the first year coordinator.

6.2 FACULTY ADVISOR

To help the students in planning their courses of study and for general counseling, the Head of the Department of the students will attach a maximum of 20 students to a faculty member of the department who shall function as faculty advisor for the students throughout their period of study. Such faculty advisor shall guide the students in taking up the elective courses for registration and enrolment in every semester and also offer advice to the students on academic and related personal matters.

7.0 COURSE COMMITTEE

7.1 Each common theory course offered to more than one group of students shall have a "Course Committee" comprising all the teachers teaching the common course with one of them nominated as course coordinator. The nomination of the course coordinator shall be made by the Head of the Department / Dean (Academic Affairs) depending upon whether all the teachers teaching the common course belong to a single department or to several departments. The Course Committee shall meet as often as possible and ensure uniform evaluation of the tests and arrive at a common scheme of evaluation for the tests. Wherever it is feasible, the Course Committee may also prepare a common question paper for the test(s).

8.0 CLASS COMMITTEE

A class committee comprising faculty members handling the classes, student representatives and a senior faculty member not handling the courses as chairman will be constituted branch-wise and semester-wise

8.1 The composition of class committees for first and second semester will be as follows:

i) The first-year coordinator shall be the chairman of the class committee

ii) Faculty members of all individual courses of first / second semester

iii) Six student representatives (male and female) of each class nominated by the first-year coordinator.

iv) The class advisor and faculty advisors of the class.

8.2 The composition of the class committee for each branch from 3rd to 8th semester will be as follows:

i) One senior faculty member preferably not handling courses for the concerned semester, appointed as chairman by the Head of the Department

ii) Faculty members of all courses of the semester

iii) Six student representatives (male and female) of each class nominated by the Head of the Department in consultation with the relevant faculty advisors

iv) All faculty advisors and the class advisors.

v) Head of the Department

8.3 The class committee shall meet at least four times during the semester. The first meeting will be held within two weeks from the date of commencement of classes, in which the nature of continuous assessment for various courses and the weightages for each component of assessment will be decided for the first and second assessment. The second meeting will be held within a week after the date of first assessment report, to review the students' performance and for follow up action. The third meeting will be held within a week after the second assessment report, to review the students' performance and for follow up action.

8.4 During these three meetings the student members representing the entire class, shall meaningfully interact and express opinions and suggestions to improve the effectiveness of the teaching-learning process.

8.5 The fourth meeting of the class committee, excluding the student members, shall meet within 5 days from the last day of the semester end examination to analyze the performance of the students in all the components of assessments and decide their grades in each course. The grades for a common course shall be decided by the concerned course committee and shall be presented to the class committee(s) by the concerned course coordinator.

9.0 REGISTRATION AND ENROLMENT

9.1 Except for the first semester, every student shall register for the ensuing semester during a specified week before the semester end examination of the ongoing semester. Every student shall submit a completed registration form indicating the list of courses intended to be enrolled during the ensuing semester. Late registration with the approval of the Dean (Academic Affairs) along with a late fee will be permitted up to the last working day of the current semester.

9.2 From the second year onwards, all students shall pay the prescribed fees for the year on a specific day at the beginning of the semester confirming the registered courses. Late enrolment along with a late fee will be permitted up to two weeks from the date of commencement of classes. If a student does not enroll, his/her name will be removed from rolls.

9.3 The students of first semester shall register and enroll at the time of admission by paying the prescribed fees.

9.4 A student should have registered for all preceding semesters before registering for a particular semester.

10.0 COURSE CHANGE / WITHDRAWAL

10.1 CHANGE OF A COURSE

A student can change an enrolled course within 10 working days from the commencement of the course, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

10.2 WITHDRAWAL FROM A COURSE

A student can withdraw from an enrolled course at any time before the first assessment for genuine reasons, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

11.0 TEMPORARY BREAK OF STUDY FROM PROGRAMME

A student may be permitted by the Dean (Academic Affairs) to avail temporary break of study from the programme up to a maximum of two semesters for reasons of ill health or other valid grounds. A student can avail the break of study before the start of first assessment of the ongoing semester. However the total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 5.1). If any student is debarred for want of attendance or suspended due to any act of indiscipline, it will not be considered as break of study. A student who has availed break of study has to rejoin in the same semester only.

12.0 CREDIT LIMIT FOR ENROLMENT & MOVEMENT TO HIGHER SEMESTER

12.1 A student can enroll for a maximum of 32 credits during a semester including Redo /Pre do Courses

12.2 The minimum earned credit required to move to the higher semester shall be

- Not less than 20 credits, to move to the 3rd semester

- Not less than 40 credits, (20 for lateral entry) to move to the 5th semester
- Not less than 60 credits, (40 for lateral entry) to move to the 7th semester

13.0 ASSESSMENT PROCEDURE AND PERCENTAGE WEIGHTAGE OF MARKS

13.1 Every theory course shall have a total of three assessments during a semester as given below:

Assessment No.	Course Coverage in Weeks	Duration	Weightage of Marks
Assessment 1	1 to 6	1.5 hours	25%
Assessment 2	7 to 12	1.5 hours	25%
Semester End Exam	Full course	3 hours	50%

13.2 Appearing for semester end theory examination for each course is mandatory and a student should secure a minimum of 40% marks in each course in semester end examination for the successful completion of the course.

13.3 Every practical course will have 60% weightage for continuous assessments and 40% for semester end examination. However a student should have secured a minimum of 50% marks in the semester end practical examination.

13.4 For laboratory integrated theory courses, the theory and practical components shall be assessed separately for 100 marks each and consolidated by assigning a weightage of 75% for theory component and 25% for practical component. Grading shall be done for this consolidated mark. Assessment of theory component shall have a total of three assessments with two continuous assessments carrying 25% weightage each and semester end examination carrying 50% weightage. The student shall secure a separate minimum of 40% in the semester end theory examination. The evaluation of practical component shall be through continuous assessment.

13.5 The components of continuous assessment for theory/practical/laboratory integrated theory courses shall be finalized in the first class committee meeting.

13.6 In the case of Industrial training, the student shall submit a report, which will be evaluated along with an oral examination by a committee of faculty members, constituted by the Head of the Department. A progress report from the industry will also be taken into account for evaluation. The weightage for report shall be 60% and 40% for Viva Voce examination.

13.7 In the case of project work, a committee of faculty members constituted by the Head of the Department will carry out three periodic reviews. Based on the project report submitted by the student(s), an oral examination (viva-voce) will be conducted as the semester end examination, for which one external examiner, approved by the Controller of Examinations, will be included. The weightage for periodic review will be 50%. Of the remaining 50%, 20% will be for the project report and 30% for the Viva Voce examination.

13.8 Assessment of seminars and comprehension will be carried out by a committee of faculty members constituted by the Head of the Department.

13.9 For the first attempt of the arrear theory examination, the internal assessment marks scored for a course during first appearance will be used for grading along with the marks scored in the arrear examination. From the subsequent appearance onwards, full weightage shall be assigned to the marks scored in the semester end examination and the internal assessment marks secured during the course of study shall be ignored.

In case of laboratory integrated theory courses, after one regular and one arrear appearance, the internal mark of theory component is invalid and full weightage shall be assigned to the marks scored in the semester end examination for theory component. There shall be no arrear or improvement examination for lab component.

14.0 SUBSTITUTE EXAMINATIONS

14.1 A student who has missed, for genuine reasons, a maximum of one of the two continuous assessments of a course may be permitted to write a substitute examination paying the prescribed substitute examination fees. However, permission to take up a substitute examination will be given under exceptional circumstances, such as accidents, admission to a hospital due to illness, etc. by a committee constituted by the Dean of School for that purpose. However there is no Substitute Examination for Semester End examination.

14.2 A student who misses any continuous assessment test in a course shall apply for substitute exam in the prescribed form to the Head of the Department / Dean of School within a week from the date of missed assessment test. However the Substitute Examination will be conducted after the last working day of the semester and before Semester End Examination.

15.0 ATTENDANCE REQUIREMENT AND SEMESTER / COURSE REPETITION

15.1 A student shall earn 100% attendance in the contact periods of every course, subject to a maximum relaxation of 25% (for genuine reasons such as medical grounds or representing the Institution in approved events etc.) to become eligible to appear for the semester-end examination in that course, failing which the student shall be awarded “I” grade in that course. The cases in which the student is awarded “I” grade, shall register and repeat the course when it is offered next.

15.2 The faculty member of each course shall cumulate the attendance details for the semester and furnish the names of the students who have not earned the required attendance in that course to the Class Advisor. The Class Advisor will consolidate and furnish the list of students who have earned less that 75% attendance, in various courses, to the Dean (Academic Affairs) through the Head of the Department/ Dean of School. Thereupon, the Dean (Academic Affairs) shall announce the names of such students prevented from writing the semester end examination in each course.

15.3 A student who has obtained ‘I’ grade in all the courses in a semester is not permitted to move to next higher semester. Such student shall repeat all the courses of the semester in the subsequent academic year.

15.4 A student should register to re-do a core course wherein “I” or “W” grade is awarded. If the student is awarded, “I” or “W” grade in an elective course either the same elective course may be repeated or a new elective course may be taken with the approval of Head of the Department / Dean of School.

15.5 A student who is awarded “U” grade in a course will have the option to either write the semester end arrear examination at the end of the subsequent semesters, or to redo the course in the evening when the course is offered by the department. Marks scored in the continuous assessment during the redo classes shall be considered for grading along with the marks scored in the semester-end (redo) examination. If any student obtained “U” grade in the redo course, the marks scored in the continuous assessment test (redo) for that course will be considered as internal mark for further appearance of arrear examination.

15.6 If a student with “U” grade, who prefers to redo any particular course, fails to earn the minimum 75% attendance while doing that course, then he / she will not be permitted to write the semester end examination and his / her earlier “U” grade and continuous assessment marks shall continue.

16.0 REDO COURSES

16.1 A student can register for a maximum of two redo courses per semester in the evening after regular college hours, if such courses are offered by the concerned department. Students may also opt to redo the courses offered during regular semesters.

16.2 The Head of the Department with the approval of Dean Academic Affairs may arrange for the conduct of a few courses during the evening, depending on the availability of faculty members and subject to a specified minimum number of students registering for each of such courses.

16.3 The number of contact hours and the assessment procedure for any redo course will be the same as those during regular semesters except that there is no provision for any substitute examination and withdrawal from an evening redo course.

17.0 PASSING AND DECLARATION OF RESULTS AND GRADE SHEET

17.1 All assessments of a course will be made on absolute marks basis. However, the Class Committee without the student members shall meet within 5 days after the semester-end examination and analyze the performance of students in all assessments of a course and award letter grades. The letter grades and the corresponding grade points are as follows:

Letter Grade	Grade Points
S	10
A	9
B	8
C	7
D	6
E	5
U	0
W	0
I	0
AB	0

"W" denotes withdrawal from the course.

"I" denotes inadequate attendance and hence prevention from semester-end examination

"U" denotes unsuccessful performance in the course.

"AB" denotes absence for the semester-end examination.

17.2 A student who earns a minimum of five grade points ('E' grade) in a course is declared to have successfully completed the course. Such a course cannot be repeated by the student for improvement of grade.

17.3 The results, after awarding of grades, shall be signed by the Chairman of the Class Committee and Head of the Department/Dean of Schools and it shall be declared by the Controller of Examinations.

17.4 Within one week from the date of declaration of result, a student can apply for revaluation of his / her semester-end theory examination answer scripts of one or more courses, on payment of prescribed fee, through proper application to Controller of Examination. Subsequently the Head of the Department/ Dean of School offered the course shall constitute a revaluation committee consisting of Chairman of the Class Committee as Convener, the faculty member of the course and a senior member of faculty knowledgeable in that course. The committee shall meet within a week to revalue the answer scripts and submit its report to the Controller of Examinations for consideration and decision.

17.5 After results are declared, grade sheets shall be issued to each student, which will contain the following details. The list of courses enrolled during the semester including redo courses, if any, and the grade scored, the Grade Point Average (GPA) for the semester and the Cumulative Grade Point Average (CGPA) of all courses enrolled from first semester onwards. GPA is the ratio of the sum of the products of the number of credits of courses registered and the grade points corresponding to the grades scored in those courses, taken for all the courses, to the sum of the number of credits of all the courses in the semester.

If Ci, is the number of credits assigned for the i^{th} course and GPi is the Grade Point in the i^{th} course

$$GPA = \frac{\sum_{i=1}^{n}(C_i)(GPi)}{\sum_{i=1}^{n}C_i}$$

Where n = number of courses

The Cumulative Grade Point Average CGPA shall be calculated in a similar manner, considering all the courses enrolled from first semester.

"I" and "W" grades will be excluded for calculating GPA .

"U", "I", "AB" and **"W"** grades will be excluded for calculating CGPA.

The formula for the conversion of CGPA to equivalent percentage of marks shall be as follows:

Percentage Equivalent of Marks = CGPA X 10

17.6 After successful completion of the programme, the Degree will be awarded with the following classifications based on CGPA.

Classification	CGPA
First Class with Distinction	8.50 and above and passing all the courses in first appearance and completing the programme within the Prescribed period of 8 semester for normal entry and 6 semesters for lateral entry
First Class	6.50 and above and completing the programme within a maximum of 10 semester for normal entry and 8 semesters for lateral entry
Second Class	Others

However, to be eligible for First Class with Distinction, a student should not have obtained 'U' or 'I' grade in any course during his/her study and should have completed the U.G. programme within a minimum period (except break of study). To be eligible for First Class, a student should have passed the examination in all the courses within the specified minimum number of semesters reckoned from his/her commencement of study. For this purpose, the authorized break of study will not be counted. The students who do not satisfy the above two conditions will be classified as second class. For the purpose of classification, the CGPA will be rounded to two decimal places. For the purpose of comparison of performance of students and ranking, CGPA will be considered up to three decimal places.

18.0 ELECTIVE CHOICE:

18.1 Apart from the various elective courses listed in the curriculum for each branch of specialization, the student can choose a maximum of two electives from any other specialization under any department, during the entire period of study, with the approval of the Head of the parent department and the Head of the other department offering the course.

18.2 ONLINE / SELF STUDY COURSES

Students are permitted to undergo department approved online/ self study courses not exceeding a total of six credits with the recommendation of the Head of the Department / Dean of School and with the prior approval of Dean Academic Affairs during his/ her period of study. In case of credits earned through online mode ratified by the respective Board of Studies, the credits may be transferred following the due approval procedures. The students shall undergo self study courses on their own with the mentoring of a member of the faculty. The online/ self study courses can be considered in lieu of elective courses.

19.0 SUPPLEMENTARY EXAMINATION

Final Year students can apply for supplementary examination for a maximum of two courses thus providing an opportunity to complete their degree programme. Like wise students with less credits can also apply for supplementary examination for a maximum of two courses to enable them to earn minimum credits to move to higher semester. The students can apply for supplementary examination within three weeks of the declaration of results.

20.0 PERSONALITY AND CHARACTER DEVELOPMENT

20.1 All students shall enroll, on admission, in any of the personality and character development programmes, NCC / NSS / NSO / YRC / Rotaract and undergo practical training.

- **National Cadet Corps (NCC)** will have to undergo specified number of parades.
- **National Service Scheme (NSS)** will have social service activities in and around Chennai.
- **National Sports Organization (NSO)** will have sports, games, drills and physical exercises.
- **Youth Red Cross (YRC)** will have social service activities in and around Chennai.
- **Rotaract** will have social service activities in and around Chennai.

21.0 DISCIPLINE

21.1 Every student is required to observe disciplined and decorous behavior both inside and outside the campus and not to indulge in any activity which will tend to affect the prestige of the Institution.

21.2 Any act of indiscipline of a student, reported to the Dean (Student Affairs), through the HOD / Dean will be referred to a Discipline and Welfare Committee nominated by the Vice-Chancellor, for taking appropriate action.

22.0 ELIGIBILITY FOR THE AWARD OF DEGREE

22.1 A student shall be declared to be eligible for the award of B.Tech. degree provided the student has:

i) successfully completed all the required courses specified in the programme curriculum and earned the number of credits prescribed for the specialization, within a maximum period of 14 semester (12 semesters for lateral entry) from the date of admission, including break of study

ii) no dues to the Institution, Library, Hostels

iii) no disciplinary action pending against him/her.

22.2 The award of the degree must have been approved by the Institution.

23.0 POWER TO MODIFY

Notwithstanding all that has been stated above, the Academic Council has the right to modify the above regulations from time to time.

B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND TECHNOLOGY

B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING

CURRICULUM & SYLLABUS, REGULATIONS 2017

SEMESTER I

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C	
1.	BS	MAC 1181	Differential Calculus and Geometry	3	1	0	4	
2.	HS	ENC 1181/ ISC 1181/ LNC 1181/ LNC 1182 / LNC 1183	English / Arabic / Mandarin / German / Japanese	3	0	0	3	
3.	BS	PHC 1181	Physics	3	0	2	4	
4.	BS	CHC 1181	Chemistry	3	0	2	4	
5.	ESF	GEC 1101	Engineering Graphics	2	0	2	3	
6.	ESF	GEC 1102	Engineering Design	2	0	0	2	
7.	ESF	GEC 1103	Basic Engineering Practices Laboratory	0	0	2	1	
8.	ESF	GEC 1104	Computer Programming I	1	0	2	2	**23**

SEMESTER II

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	BS	MAC 1281	Advanced Calculus	3	1	0	4
2.	BS	-	Physics Elective	2	0	2	3
3.	BS	-	Chemistry Elective	2	0	2	3
4.	ESF	GEC 1211	Basic Engineering Mechanics	3	1	0	4
5.	BS	GEC 1212	Environmental Studies	2	0	0	2
6.	ESF	GEC 1213	Computer Programming II	1	0	2	2

7.	EC	EEC 1211	Electric Circuit Analysis	3	1	0	4	
8.	EC	EEC 1212	Electric Circuits and Simulation Lab	0	0	2	1	**23**

SEMESTER III

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C	
1.	BS	MAC2181	Partial Differential Equations and Transforms	3	1	0	4	
2.	HS	-	Humanities Elective I	2	0	0	2	
3.	HS	ENC 2181	Oral Communication	0	0	2	1	
4.	EC	EEC2101	Electro Magnetic Theory	3	0	0	3	
5.	EC	EEC2102	Signals and Systems	3	1	0	4	
6.	EC	EEC2103	Electronic Devices and Circuits	3	0	0	3	
7.	EC	EEC2104	Electromechanical Energy Conversion	3	0	0	3	
8.	EC	EEC2105	Electronic Devices and Circuits Lab	0	0	2	1	
9.	EC	EEC2106	Electromechanical Energy Conversion Lab	0	0	2	1	**22**

SEMESTER IV

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	BS	-	Mathematics Elective I	3	1	0	4
2.	HS	-	Humanities Elective II	2	0	0	2
3.	HS	ENC2282	Written Communication	0	0	2	1
4.	EC	EEC2211	Power System - I	3	1	0	4
5.	EC	EEC2212	AC Machines	3	1	0	4
6.	EC	EEC2213	Power Electronics	3	1	0	4
7.	EC	EEC2214	AC Machines Lab	0	0	2	1

8.	EC	EEC2215	Power Electronics Lab	0	0	2	1	
9.	PE		Programme Elective				3	**24**

SEMESTER V

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C	
1.	MS	MSC 3181 MSC 3182	Leadership and CEO Training/ Social Entrepreneurship	3	0	0	3	
2.	GE	-	General Elective I	3	0	0	3	
3.	HS	ENC3181	Communication and soft skill I Career Choice	0	0	2	1	
4.	EC	EEC3101	Power System - II	3	1	0	4	
5.	EC	EEC3102	Measurements & Instrumentation	3	0	0	3	
6.	EC	EEC3103	Digital Systems and Integrated Circuits	3	0	0	3	
7.	EC	EEC3104	Power System Simulation Lab	0	0	2	1	
8.	EC	EEC3105	Measurements & Instrumentation Lab	0	0	2	1	
9.	EC	EEC3106	Digital Systems & Integrated Circuits Lab	0	0	2	1	
10.	PE	-	Programme Elective				3	**23**

SEMESTER VI

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	MS	MSC 3181 MSC 3182	Leadership and CEO Training/ Social Entrepreneurship	3	0	0	3
2.	BS	-	Mathematics Elective II	2	0	0	2
3.	HS	ENC3281	Communication & soft skill II Confidence Building	0	0	2	1
4.	EC	EEC3211	Embedded Systems	3	1	0	4
5.	EC	EEC3212	Control Systems	3	1	0	4
6.	EC	EEC3213	Embedded Systems Lab	0	0	2	1

s	EC	EEC3214	Control Systems Lab	0	0	2	1	
8.	EC	EEC3215	Self learning	0	2	0	2	
9.	PE	-	Programme Elective				6	**24**

SEMESTER VII

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C	
1.	GE	-	General Elective II	3	0	0	3	
2.	EC	EEC4101	Power System Protection & Switchgear	3	0	0	3	
3.	EC	EEC4102	Design of Electrical Apparatus	3	1	0	4	
4.	EC	EEC4103	PLC & DCS	3	0	2	4	
5.	PE	-	Programme Elective				9	
6.	EC	EEC3216	Internship*				1**	**24**

SEMESTER VIII

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C	
1.	EC	EEC4201	Project Work	0	0	24	12	**12**

Total credits – 175

* 15 days

** Internship will be undertaken during third year summer vacation. The credit will be awarded in the 7th Semester.

PROGRAMME ELECTIVES

POWER SYSTEM

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PE	EECX01	Power Distribution System	3	0	0	3
2.	PE	EECX02	Power System Planning & Reliability	3	0	0	3
3.	PE	EECX03	Power System Dynamics	3	0	0	3
4.	PE	EECX04	Power System Transients	3	0	0	3
5.	PE	EECX05	Smart Power Grid	3	0	0	3
6.	PE	EECX06	Wind Energy Conversion Systems	3	0	0	3
7.	PE	EECX07	Flexible AC Transmission System	3	0	0	3
8.	PE	EECX08	Industrial Power System Analysis & Design	3	0	0	3
9.	PE	EECX09	Electric Energy Generation, Utilization and Conservation	3	0	0	3
10.	PE	EECX10	Restructured Power System	3	0	0	3
11.	PE	EECX11	Solar Energy Technology	1	0	0	1
12.	PE	EECX12	Micro-grid Protection	3	0	0	3
13.	PE	EECX13	Electric Vehicle Technology	3	0	0	3
14.	PE	EECX14	Power System Simulation Software	0	0	2	1
15.	PE	EECX15	Wide Area Measurement Systems	2	0	0	2
16.	PE	EECX16	Energy Auditing	2	0	0	2

POWER ELECTRONICS & DRIVES

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PE	EECX21	Special Electrical Machines	3	0	0	3
2.	PE	EECX22	CAD for Electrical Apparatus	3	0	0	3
3.	PE	EECX23	Software for Circuit Simulation	2	0	2	3
4.	PE	EECX24	Electromagnetic Field Computation and Modelling	3	0	0	3
5.	PE	EECX25	Solid State AC and DC Drives	3	0	0	3
6.	PE	EECX26	Converters, Applications and Design	3	0	0	3
7.	PE	EECX27	Power Electronics Application to Renewable Energy Systems	3	0	0	3
8.	PE	EECX28	Embedded Control of Electric Drives	3	0	0	3
9.	PE	EECX29	Power Quality	3	0	0	3
10.	PE	EECX33	IoT for Electrical Engineers	3	0	0	3

HIGH VOLTAGE ENGINEERING

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PE	EECX36	High Voltage Engineering	3	0	0	3
2.	PE	EECX37	Bio-Electrics	3	0	0	3
3.	PE	EECX38	EHVAC and HVDC Transmission Engineering	3	0	0	3
4.	PE	EECX39	High Voltage Direct Current Transmission	3	0	0	3
5.	PE	EECX40	Electromagnetic Interference and Electromagnetic	3	0	0	3

			Compatibility				
6.	PE	EECX41	Outdoor Insulators	3	0	0	3
7.	PE	EECX44	High Voltage Testing Techniques	3	0	0	3
8.	PE	EECX45	Pulsed Electric Field and Food Preservation	3	0	0	3

COMPUTER SCIENCE & INFORMATION TECHNOLOGY

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PE	ITCX81	Database Management System	3	0	0	3
2.	PE	ITCX82	Computer Networks	3	0	0	3
3.	PE	ITCX83	Java Programming	2	0	2	3
4.	PE	ITCX85	Cloud Computing	3	0	0	3
5.	PE	ITCX86	Operating Systems	3	0	0	3
6.	PE	ITCX87	Internet of Things	3	0	0	3
7.	PE	ITCX88	Python Programming	2	0	2	3

ELECTRONICS, COMMUNICATION, INSTRUMENTATION AND CONTROL

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PE	ECCX81	Image Processing	3	0	0	3
2.	PE	ECCX82	VLSI Design	3	0	0	3
3.	PE	ECCX83	Integrated Circuits and System Design	3	0	0	3
4.	PE	ECCX84	Communication System Security	3	0	0	3

5.	PE	ECCX85	Embedded Hardware & Software System Design	3	0	0	3
6.	PE	ECCX86	Digital Signal Processors	3	0	0	3
7.	PE	EICX81	Bio Instrumentation and Signal Analysis	3	0	0	3
8.	PE	EICX82	Sensors for Bio-Medical Application	3	0	0	3
9.	PE	EICX83	Intelligent Control	3	0	0	3
10.	PE	EICX84	Advanced Control System	3	0	0	3
11.	PE	EICX85	Power Plant Instrumentation	3	0	0	3
12.	PE	EICX86	Instrumentation and Control in Petrochemical Industries	3	0	0	3

Physics Elective Courses
(To be offered in II Semester)

Sl. No.	Course Code	Course Title	L	T	P	C
1.	PHCX 01	Fundamentals of Engineering Materials	2	0	2	3
2.	PHCX 02	Heat and Thermodynamics	2	0	2	3
3.	PHCX 03	Introduction to Nanoscience and Technology	2	0	2	3
4.	PHCX 04	Lasers and their applications	2	0	2	3
5.	PHCX 05	Materials Science	2	0	2	3
6.	PHCX 06	Non-Destructive Testing	2	0	2	3
7.	PHCX 07	Properties of Matter and Acoustics	2	0	2	3
8.	PHCX 08	Properties of Matter and Nondestructive Testing	2	0	2	3
9.	PHCX 09	Semiconductor Physics and Optoelectronics	2	0	2	3

Chemistry Elective Courses

(To be offered in II Semester)

Sl. No.	Course Code	Course Title	L	T	P	C
1.	CHCX01	Analytical Instrumentation	2	0	2	3
2.	CHCX02	Corrosion and its Control	2	0	2	3
3.	CHCX03	Electrical Materials and Batteries	2	0	2	3
4.	CHCX04	Engineering Materials	2	0	2	3
5.	CHCX05	Fuels and Combustion	2	0	2	3
6.	CHCX06	Fundamentals of Physical Chemistry	2	0	2	3
7.	CHCX07	Green Technology	2	0	2	3
8.	CHCX08	Organic Chemistry of Biomolecules	2	0	2	3
9.	CHCX09	Polymer Science and Technology	2	0	2	3

Maths Elective Courses

(To be offered in IV Semester)

Sl. No.	Course Code	Course Title	L	T	P	C
1.	MACX 01	Discrete Mathematics And Graph Theory	3	1	0	4
2.	MACX 02	Probability And Statistics	3	1	0	4
3.	MACX 03	Random Processes	3	1	0	4
4.	MACX 04	Applied Numerical Methods	3	1	0	4

Maths Elective Courses

(To be offered in VI Semester)

Sl. No.	Course Code	Course Title	L	T	P	C
1.	MACX 05	Mathematical Programming	2	0	0	2
2.	MACX 06	Statistical Methods for Data Analysis	2	0	0	2
3.	MACX 07	Numerical Methods for Integral and Differential Equations	2	0	0	2
4.	MACX 08	Mathematical Modelling	2	0	0	2
5.	MACX 09	Graph Theory	2	0	0	2

Humanities Elective I

(To be offered in III Semester)

Sl. No.	Course Code	Course Title	L	T	P	C
1.	SSCX01	Fundamentals of Economics	2	0	0	2
2.	SSCX02	Principles of Sociology	2	0	0	2
3.	SSCX03	Sociology of Indian Society	2	0	0	2

Humanities Elective II

(To be offered in IV Semester)

Sl. No.	Course Code	Course Title	L	T	P	C
1.	SSCX04	Economics of Sustainable Development	2	0	0	2
2.	SSCX05	Industrial Sociology	2	0	0	2
3.	SSCX06	Law for Engineers	2	0	0	2

General Elective

Group I Courses

(To be offered in V semester)

Sl. No.	Course Code	Course Title	Offering Department
1.	GECX101	Disaster Management	Civil
2.	GECX102	Total Quality Management	Mechanical
3.	GECX103	Energy Studies	Mechanical
4.	GECX104	Robotics	Mechanical
5.	GECX105	Transport Management	Automobile
6.	GECX106	Control Systems	EEE
7.	GECX107	Introduction to VLSI Design	ECE
8.	GECX108	Plant Engineering	EIE
9.	GECX109	Network Security	CSE
10.	GECX110	Knowledge management	CSE
11.	GECX111	Cyber security	IT
12.	GECX112	Genetic Engineering	LS
13.	GECX113	Fundamentals of Project Management	CBS
14.	GECX114	Operations Research	Mathematics
15.	GECX115	Nano Technology	Physics / Chemistry
16.	GECX116	Vehicle Maintenance	Automobile
17.	GECX117	Fundamentals of Digital Image Processing	ECE

Group II Courses

(To be offered in VII semester)

Sl. No.	Course Code	Course Title	Offering Department
1.	GECX201	Green Design and Sustainability	Civil
2.	GECX202	Appropriate Technology	Civil / Mechanical
3.	GECX203	Engineering System Modelling and Simulation	Mechanical
4.	GECX204	Value Analysis and Engineering	Mechanical
5.	GECX205	Industrial Safety	Mechanical
6.	GECX206	Advanced Optimization Techniques	Mechanical
7.	GECX207	Matlab Simulation	EEE
8.	GECX208	Embedded System and its Applications	ECE
9.	GECX209	Usability Engineering	CSE
10.	GECX210	Supply Chain Management	CBS
11.	GECX211	System Analysis and Design	CA
12.	GECX212	Advanced Materials	Physics & Chemistry
13.	GECX213	National Service Scheme	School of Humanities
14.	GECX214	Automotive Pollution and Control	Automobile
15.	GECX215	Motor Vehicle Act, Insurance and Policy	Automobile
16.	GECX216	Principles of Communication Systems	ECE
17.	GECX217	Lean Management	Civil
18.	GECX218	Spatial Data Modeling & Analysis	Civil

SEMESTER I

MAC 1181	DIFFERENTIAL CALCULUS AND GEOMETRY	L	T	P	C
		3	1	0	4

OBJECTIVES:

The aim of this course is to

- Introduce Eigen values and eigenvectors of matrix algebra.
- Make the student knowledgeable in the area of Three Dimensional Analytical Geometry.
- Demonstrate the application of Differential Calculus.
- Familiarize the student with the functions of several variables.
- Develop the use of ODE solvable techniques necessary for engineering applications.
- Motivate the students with some basic engineering application problems in ODE.

MODULE I MATRICES 8+2

Characteristic Equation- Eigenvalues and Eigenvectors of a real matrix –Properties of Eigenvalues and Eigenvectors – Cayley-Hamilton Theorem (without proof) – Orthogonal matrices – orthogonal transformations of a symmetric matrix to diagonal form – Reduction of quadratic form to canonical form by orthogonal transformation.

MODULE II THREE DIMENSIONAL ANALYTICAL GEOMETRY 7+3

Direction cosines and ratios – angle between two lines – equations of a plane – equations of a straight line, coplanar lines - shortest distance between skew lines - sphere – tangent plane – plane section of a sphere – orthogonal spheres.

MODULE III DIFFERENTIAL GEOMETRY 7+3

Curvature – Cartesian and polar coordinates – centre and radius of curvature – circle of curvature – involutes and evolutes – envelopes.

MODULE IV **DIFFERENTIAL CALCULUS OF SEVERAL VARIABLES** **8+2**

Functions of two variables – partial derivatives – total differential – Implicit Functions – Jacobian - Taylor's series expansion – Optima of two variables – Lagrange's multiplier method.

MODULE V **ORDINARY DIFFERENTIAL EQUATIONS** **8+2**

Linear equations of second order with constant and variable coefficients – Simultaneous first order linear equations with constant coefficients – homogeneous equations of Euler's type – method of undetermined coefficients, method of variation of parameters

MODULE VI **APPLICATIONS OF ORDINARY DIFFERENTIAL EQUATIONS** **7+3**

Solution of Ordinary Differential Equation Related to Electric Circuits – Bending of Beams- Motion of a Particle in a resisting medium – Simple harmonic motion.

L – 45; T – 15; TOTAL HOURS – 60

TEXT BOOKS:

1. Ramana, B.V, "Higher Engineering Mathematics" Tata McGraw Hill Publishing Co. New Delhi, 2006.
2. Grewal B.S., "Higher Engineering Mathematics" (43rd edition), Khanna Publishers, New Delhi, 2012.
3. John W. Cell "Engineering Problems Illustrating Mathematics" Mc Graw Hill Publishing Co., New York 1943.

REFERENCES:

1. Veerarajan.T., "Engineering Mathematics" (5th edition) Tata Mc Graw Hill Publishing Co. New Delhi, 2012
2. Kreyszig, E., "Advanced Engineering Mathematics", 10th edition, John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2001.
3. Peter V. O'Neil, "Advanced Engineering Mathematics", 7th edition, Cengage

Learning, 2011.

4. Dennis G. Zill, Warren S. Wright, “Advanced Engineering Mathematics”, 4th edition, Jones and Bartlett publishers, Sudbury, 2011.

5. Alan Jeffrey, “Advanced Engineering Mathematics”, Academic Press, USA, 2002.

6. Venkataraman, M.K., “Engineering Mathematics”, Volume I, 2nd edition, National Publishing Co., Chennai, 2003.

7. James Stewart “.Calculus” (7th edition),Brooks/Cole cengage learning,UK

OUTCOMES:

After completing the course, student will be able to

- Understand the matrix techniques and compute eigen values and eigenvectors of a given matrix.
- Do the problems based on three dimensional analytic geometry.
- Apply differential calculus in engineering problems.
- Differentiate more than one variable and their applications.
- Solve the differential equations with constant coefficient and variable coefficient.
- Form and solve differential equations.

ENC 1181 **ENGLISH** **L T P C**

3 0 0 3

OBJECTIVES:

- To train students to use appropriate vocabulary in academic and technical contexts.
- To facilitate students to speak effectively while exchanging ideas and making presentations.
- To develop students' listening skill for comprehending and analyzing information.
- To develop their reading skill through sub skills like skimming , scanning and critical reading of a text.
- To sharpen their academic writing skills.
- To expose them to the correct usage of language and help them to apply that knowledge appropriately.

MODULE I **8**

L: Listening for general information
S : Self Introduction, Introducing one another.
R: Predicting the content
W: Paragraph Writing
Language Focus: Affixes, Simple Present tense , Connective & Prepositions.

MODULE II **8**

L: Listening for specific information (from dialogues)
S:Exchanging opinion.
R: Skimming technical Passages
W: Argumentative Writing (using the concept of Flipped Learning), Letter to the Editor.
Language Focus: Idioms, use of Modals, Simple Past tense & use of "Wh" and question tags.

MODULE III **7**

L: Learning the ways of describing images and presenting specific information (focusing on note making)

S: Making Presentations using visuals.

R : Scanning short texts for gist of information

W: Letter of Invitation, Expository Writing

Language Focus: Homophones, Homographs, Simple Future & Collocations.

MODULE IV **7**

L: Understanding prepared presentation techniques through videos

S: Short Presentations.

R: Reading for coherence and cohesion

W: Letter seeking permission for Industrial Visit

Language Focus: S-V agreement, Euphemism

MODULE V **8**

L : Understanding Non- Verbal Communications while listening to narration of incidents.

S: Narrating an expereince

R: Inferential Reading

W: Process Description – Transcoding a Flow chart.

Language Focus: Interchange of Active & passive voice, Impersonal Passive voice.

MODULE VI **7**

L: Learning Story telling techniques (stories & visuals) through audio files

S: Discussion in groups

R: Reading for critical appreciation

W: Developing an idea, Slogan writing, Interpreting a Bar Chart.

Language Focus: If clause and phrasal verbs.

TOTAL HOURS - 45

REFERENCES:

1. Carol Rosenblun perry(2011). The Fine Art of Technical Writing. Create Space Independent Publishing Platform, New Delhi.
2. Dutt, P.K. Rajeevan. G and Prakash , C.L.N. (2007) A course in Communication Skills. Cambridge Univesity Press, India.

3. Kala, Abdul & Arun Tiwari (2004). Wings of Fire: An Autobiography (Simplified and A bridged by Mukul Chowdhri). Hyderabad Univeristy Press.
4. Sen, Leena. (2004) Communication Skills. Prentice Hall, New Delhi.
5. Matt Firth, Chris Sowton et.al. (2012). Academic English: An Integrated Skills Course for EAP. Cambridge University Press, Cambridge.

OUTCOMES:

After completion of the course, students will have the ability to

- Demonstrate their range of vocabulary in academic and technical contexts
- Exchange ideas and make presentations
- Comprehend and respond appropriately to listening tasks.
- Read a text efficiently and process information.
- Create and draft different kinds of academic documents
- Communicate effectively using grammatically correct expressions.

ISC1181 **ARABIC** **L T P C**

3 0 0 3

OBJECTIVES:

- To read and write in Arabic language.
- To learn vocabulary of different fields
- To develop situational communication skills.

MODULE I PREPARATORY ARABIC 7

Introducing Arabic Alphabets.

Listening and Reading.

Audio & Video aided listening, Tajweed listening,

Writing Arabic Alphabets (connected & unconnected).

Introducing words.

Reading simple sentences.

Learning names of the things in and around the class room.

Exercises.

MODULE II FUNCTIONAL ARABIC 7

Listening Arabic texts, stories and action verbs

Communicating Simple sentences.

Jumla' Ismiyya and Jumla' Fi'liyya

Situational Conversation:

Greetings, Introduction.

Classroom, College, Picnic.

Dining and Kitchen.

Reading skills.

Exercises

MODULE III FUNCTIONAL ARABIC 8

Implication of effective listening.

Audio aids.

Writing Simple sentences.

Communicating ordinal and cardinal numbers.

Situational communication:

Playground, library.

Forms of plural – Sample sentences.

Introduction to tenses.

Exercises.

MODULE IV FUNCTIONAL ARABIC 8

Communication:

Family, travel

Market, Prayer hall

Writing skills:

Note making.

Sequencing of sentences.

Developing answers from the questions.

Exercises.

MODULE V TECHNICAL ARABIC 8

Importance of technical communication.

Reading and writing skills.

Audio & Video aided listening.

Introduction to Arabic terms related to administration.

Situation communication:

Air travel, Office administration, passport, visa.

Exercises

MODULE VI TECHNICAL ARABIC 7

Situation communication:

Contractual work, machineries and equipments..

Computer, internet browsing.

Banking,

Exercises.

TOTAL HOURS - 45

TEXT BOOKS:

1. Arabic for professionals and employees, Kilakarai Bukhari Aalim Arabic College,

Chennai, India, 2013.

REFERENCES:

1. Arabic Reader for Non Arabs (Ummul Qura University, Makkah), Kilakarai Bukhari Aalim Arabic College, 2005.

OUTCOMES:

On successful completion of the course, the student will be able to:

- Write correct sentences in Arabic.
- Communicate in Arabic at primary level in working situations in the fields of engineering and administration.

LNC1181	**MANDARIN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To improve the proficiency of students in Mandarin language.
- To develop their knowledge of vocabulary.
- To train them in using appropriate grammatical forms during communications.
- To empower them for successful communication in social and academic contexts.
- To make them appreciate the language usage in real life situations.

MODULE I **8**

· General Introduction to Chinese • Pinyin and Tones • Introduction to the Writing System: basic strokes and stroke order · Numbers 1-100, song · Days of the Week · Months of the Year

MODULE II **8**

· Chinese names and related culture · Chinese family structures and values · Greetings

· Introducing Yourself · Family members · Occupations

MODULE III **7**

· Languages and Nationalities · Daily Routine · Chinese breakfast · Negative Sentences and Interrogative Sentences · Asking for Personal Information · The Verb *shi* and Basic Sentence Structures

MODULE IV **7**

· Answering an Affirmative-negative Question · Food and drinks · Transportation · Likes and dislikes · Adverbs *bu*, *jiu* and *dou* · Verb-absent Sentences

MODULE V **8**

·*Jisui* and *duoda* Questions · S+V+O Construction · Routines and Daily Activities

·*Haishi* Questions · Modal Verbs · Hobbies and Habits

MODULE VI **7**

· Making Suggestions with *haoma* ·Colors · Clothing · Body parts · Talking about Likes and Dislikes · Measurement Words in Chinese

TOTAL HOURS - 45

TEXT BOOKS:

1.Ma, Yanmin, and Li, Xinying. *Easy Steps to Chinese, Vol*. *1 Textbook*. Beijing: Beijing Language and Culture University Press, 2006. Print.

2. Ma, Yanmin, and Li, Xinying. *Easy Steps to Chinese, Vol. 1 Workbook*. Beijing: Beijing Language and Culture University Press, 2006. Print.

OUTCOMES:

On completion of the course, students will be able to

- Exhibit proficiency in Chinese Language.
- Use vocabulary in appropriate contexts.
- Use appropriate grammatical forms effectively.
- Use the language in social and academic contexts.
- Appreciate the use of language forms.

LNC1182 GERMAN L T P C

3 0 0 3

OBJECTIVES:

- To improve the proficiency of students in German language.
- To create awareness of using vocabulary among students.
- To expose them to correct grammatical forms of the language.
- To empower them for successful communication in social and academic contexts.

MODULE I 8

Introduction to German alphabets, phonetics and pronunciation- Introducing themselves and others using simple sentences and answer to some basic personal questions-: Introduction to different types of articles and verbs, Nouns

MODULE II 8

Understanding and responding to everyday queries like instruction, questions, -number & gender, pronouns, present and past tense.

MODULE III 7

Short telephone messages, requests etc., if spoken slowly and clearly-- Detailed overview of articles, adjectives with/without articles, Prepositions

MODULE IV 7

Ask and giving directions using simple prepositions- Ability to fill basic information on forms while registering for courses / classes.

MODULE V 8

Ability to extract and understand relevant information in a public announcement, broadcast, newspaper, radio etc-- dative & accusative

MODULE VI 7

Ability to describe about people, work, immediate environment, education and other topics related to personal needs in a concise manner-- Understanding of matters that are familiar and are encountered regularly like instances at school, work, at public places, places of leisure etc.

TOTAL HOURS - 45

TEXT BOOKS:

1. Course book : Tangram aktuell 1 – Lektion 1–4 (Kursbuch + Arbeitsbuch mit Audio-CD zum Arbeitsbuch), Rosa-Maria Dallapiazza, Eduard von Jan, Til Schönherr, Hueber Publisher, ISBN 978-3-19-001801-7
2. Practice book: Tangram aktuell 1 – Lektion 1–4 (Kursbuch + Arbeitsbuch mit Audio-CD zum Arbeitsbuch), Rosa-Maria Dallapiazza, Eduard von Jan, Til Schönherr, Hueber Publisher, ISBN 978-3-19-001801-7.

REFERENCES:

1. NETZWERK A1 TEXTBOOK, Deutsch als Fremdsprache, Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, Langenscheidt and Klett, ISBN : 9788183076968
2. STUDIO D A1 (SET OF 3 BOOKS + CD), Hermann Funk. Cornelsen, ISBN: 9788183073509
3. Willkommen! Beginner's course. Paul Coggle, Heiner Schenke. 2nd edition. (chapter 1 - 6) ISBN: 9781444165159 –
4. Willkommen! Beginner's course. Paul Coggle, Heiner Schenke. ISBN: 978-1-444-16518-0
5. An Introduction to the German Language and Culture for Communication, Updated Edition Lovik, Thomas A., J. Douglas Guy & Monika Chavez. Vorsprung -. New York, Houghton Mifflin Company, 1997/2002. ISBN 0-618-14249-5.

OUTCOMES:

On completion of the course, students will be able to

- Show their proficiency in German Language.
- Use appropriate vocabulary in real life contexts.
- Use appropriate grammatical forms while communicating with people.
- Effectively use the language in social and academic contexts.

LNC1183	JAPANESE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To train students to use appropriate vocabulary in academic and technical contexts.
- To facilitate students to speak effectively while exchanging ideas and making presentations.
- To develop their reading skill through sub skills like skimming, scanning and critical reading of a text.
- To sharpen their academic writing skills.
- To expose them to the correct usage of language and help them to apply that knowledge appropriately.

MODULE I **7**

Introduction of the Japanese writing system, i.e. *Hiragana*, *Katakana* and *Kanji*, word-building, writing foreign names and loan words in Katakana.

MODULE II **8**

Oral practice of pronunciation and intonation of Japanese sounds, Japanese greetings, self introduction, identifying things, time of the day, calendar; counting using Japanese numerical classifiers; describing things;

MODULE III **7**

Making comparisons; talking of daily activities, kinship terms used for address and reference, seasons, giving and receiving, shopping; making requests, talking of one's likes and dislikes.

MODULE IV **8**

Extensive practice of basic patterns at the lower intermediate level through drills and exercises.

MODULE V **7**

Comprehension of passages in simple Japanese and writing of composition in Japanese applying lower intermediate grammatical patterns.

MODULE VI **8**

Diverse texts based on Japanese culture, customs, history, food habits, and science etc, for the development of communicative competence of students; skimming, scanning of texts with emphasis on advanced sentence patterns, grammatical structures and idiomatic phrases, reading and writing of approximately

TOTAL HOURS - 45

REFERENCES:

1. Nihongo I, Kokusaigakuyukai, and other supplementary material
2. Exersice book 1of Nihongo 1, and other supplementary material
3. Nippon, the Land and its People & Encyclopedia of Contemporary Japanese
4. Japani: Japanese Conversation for Improving Spoken Proficiency, By P.A. George, Inoue Yoriko and Itsuko Nandi, Books Plus.
5. Chukyu Nihongo, Tokyo Gaikokugo Daigaku; Nihongo II, Kokusaigakuyukai, and other supplementary material.

OUTCOMES:

After completion of the course, students will have the ability to

- Demonstrate their range of vocabulary in academic and technical contexts
- Exchange ideas and make presentations
- Comprehend and respond appropriately to listening tasks.
- Read a text efficiently and process information.
- Create and draft different kinds of academic documents
- Communicate effectively using grammatically correct expressions.

PHC 1181	PHYSICS	L	T	P	C
		3	0	2	4

OBJECTIVES:

To make students conversant with the

- basic concepts of crystal physics and its structures
- production and applications of ultrasonic waves
- study of thermal conductivities of good and bad conductors
- phenomenon of wave optics and its applications
- principle of fibre optic communication and its applications to sensors
- wave mechanics principle and its applications in electron microscopy
- green energy physics and its environmental impacts to society

MODULE I CRYSTAL PHYSICS 8

Crystalline and amorphous solids – Unit Cell – Seven Crystal Systems – Bravais Lattice – Miller Indices – Interplanar Spacing – Characteristics of Unit Cell - Calculation of Number of atoms per unit cell, Atomic Radius, Coordination Number and Packing Factor for SC, BCC, FCC and HCP and Diamond structures –Defects in crystals-Point defects –Edge and screw dislocations and their significance - Surface Defects.

MODULE II ULTRASONICS AND THERMAL PHYSICS 8

Introduction to Ultrasonics - Properties - Production methods - Magnetostriction Oscillator method- Piezoelectric Oscillator method – Detection of Ultrasonics – Thermal method – Piezoelectric method – Kundt’s tube method – Applications of Ultrasonics – Acoustic Grating – SONAR – Depth of sea – Velocity of blood flow, Ultrasonic Flaw detector (qualitative).

Transmission of heat – Conduction, Convection and Radiation – Thermal Conductivity of good Conductor – Forbe’s method- Thermal Conductivity of bad Conductor – Lee’s Disc method.

MODULE III APPLIED OPTICS 8

Interference – Air Wedge – Michelson’s Interferometer – Determination of wavelength of light and thickness of thin transparent sheet.

Introduction to Laser – Characteristics of Laser – Spontaneous and Stimulated Emissions – Einstein's Coefficients - Population inversion – Pumping Mechanism – Laser Action – Types of Laser: He-Ne laser, CO_2 laser and Nd: YAG laser - Applications: Laser Materials Processing.

MODULE IV FIBRE OPTICS 7

Optical fibre – Principle and propagation of light in optical fibre – Numerical aperture and acceptance angle – Types of optical fibres – Attenuation – Absorption, scattering losses, Bending losses and Dispersion in Optical fibres – Fiber Connectors and Couplers - Applications – Fibre optic communication system (block diagram only)- Fibre optic sensors - displacement and pressure sensors (qualitative) - Medical endoscope.

MODULE V QUANTUM MECHANICS 7

Black body radiation – Planck's theory of radiation – Deduction of Wien's displacement law and Rayleigh – Jean's law from Planck's theory –Dual nature of matter – de Broglie's wavelength- Physical significance of wave function – Schrodinger wave equation – Time independent and time dependent wave equation – Particle in one dimensional box – Harmonic oscillator(qualitative).

MODULE VI RENEWABLE ENERGY SOURCES 7

Present Energy sources and sustainability - Solar energy - Solar photovoltaics - Solar cells – Bioenergy - Biomass – production of liquid fuels from biomass – Wind energy – Wind turbines – energy and power from wind turbines - Geothermal energy - Ocean energy: Wave energy – Wave energy conversion devices – Tidal energy – Tidal power basics – power generation –Tidal energy potential – Environmental benefits and impacts of renewable energy sources

PRACTICALS

1. Determination of Velocity of Ultrasonic waves in a given liquid using Ultrasonic Interferometer.
2. Determination of wavelength of ultrasonic waves using Kundt's tube method.
3. Determination of thickness of a thin wire using Air Wedge method.
4. Determination of wavelength of light using spectrometer diffraction grating.
5. Determination of angle of divergence of a laser beam using He-Ne laser.
6. Determination of particle size of lycopodium powder using semiconductor laser.

7. Determination of wavelength of laser light using semiconductor laser diffraction.
8. Determination of Acceptance angle and Numerical Aperture using fiber optic cable.
9. Determination of thermal conductivity of a good conductor by Forbe's method.
10. Determination of thermal conductivity of a bad conductor by Lee's disc method.
11. Determination of solar cell characteristics.

L – 45; P – 30; TOTAL HOURS – 75

REFERENCES :

1. Gaur R.K. and Gupta S.L., "Engineering Physics'', 8th edition, Dhanpat Rai Publications (P) Ltd., New Delhi, 2013.
2. Palanisamy P.K., Physics for Engineers, Vol1 & Vol2, 2nd Edition, Scitech Publications, 2003.
3. Serway R.A. and Jewett, J.W. "Physics for Scientists and Engineers with Modern Physics". Brooks/cole Publishing Co., 2010.
4. Tipler P.A. and Mosca, G.P., "Physics for Scientists and Engineers with Modern Physics", W.H. Freeman, 2007.
5. Markert J.T., Ohanian. H. and Ohanian, M. "Physics for Engineers and Scientists". W.W. Norton & Co. 2007.
6. Godfrey Boyle, "Renewable Energy: Power for sustainable future", 2nd edition, Oxford University Press, UK, 2009.

OUTCOMES:

At the end of the course, students will be able to

- understand the different types of crystal structures
- apply the concept of ultrasonic principle in engineering and medical field
- calculate thermal conductivities of good and bad conductors
- differentiate the various laser systems and its applications in engineering and medical field
- apply the principle of fibre optics for communication and sensor applications
- formulate wave mechanics principle for applications in electron microscopy
- Correlate the different renewable energy sources for societal needs.
- To complement the knowledge acquired in the theory class.
- To correlate the experimental results for application.

CHC1181	**CHEMISTRY**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

OBJECTIVES:

The students should be conversant with

- the basic problems like hardness, alkalinity, dissolved oxygen associated with the water used for domestic and industrial purpose and treatment process involved.
- the synthesis, properties and applications of nanomaterials.
- the importance of renewable energy sources like solar, wind, biogas, biomass, geothermal, ocean and their limitations.
- the basic analytical techniques like UV-Visible, FT-IR, NMR, AAS, AES, Circular Dichroism and XRD etc.
- photochemistry concepts related to physical processes and chemical reactions induced by photon absorption and their applications.
- basic principles of electrochemistry, cell construction and evaluation and to understand general methodologies for construction & design of electrochemical cell

MODULE I WATER TECHNOLOGY 9

Impurities present in water, hardness : types of hardness, demerits of hard water in boilers, estimation of hardness by EDTA method (problems) – alkalinity : estimation of alkalinity (problems) – dissolved oxygen: estimation of dissolved oxygen – conditioning methods : external treatment method: – lime soda and zeolite process (principle only), Ion exchange process – Internal treatment : colloidal, carbonate, phosphate and calgon methods – drinking water: standards (BIS), treatment of domestic water {screening, sedimentation, coagulation, filtration, disinfection }– desalination: electrodialysis, reverse osmosis.

MODULE II NANOCHEMISTRY 6

Introduction – distinction between molecules, bulk materials and nanoparticles – classification based on dimension with examples – synthesis (top-down and bottom-up approach} : sol-gel, thermolysis (hydrothermal and solvothermal), electrodeposition, chemical vapour deposition, laser ablation – properties and applications (electronic, magnetic and catalytic) – risk factors and future perspectives.

MODULE III ENERGY SOURCES 8

Energy: past, today, and future – a brief history of energy consumption – present energy scenario of conventional and renewable energy sources – renewable energy : needs of renewable energy, advantages and limitations of renewable energy – solar energy: basics, solar energy in the past , photovoltaic, advantages and disadvantages – bioenergy: conversion, bio degradation, biogas generation, biomass gasifier, factors affecting biogas generation, advantages and disadvantages – geothermal energy: geothermal resources (hot dry rock and magma resources, natural and artificial), advantages and disadvantages – wind energy: wind resources, wind turbines, advantages and disadvantages – ocean energy: wave energy, wave energy conversion devices, ocean thermal energy, advantages and disadvantages.

MODULE IV PHOTOCHEMISTRY 7

Introduction: absorption and emission, chromophores, auxochromes – laws of photochemistry : Grotthus-Draper law, Stark Einstein law – quantum yield (problems) –photo physical processes : fluorescence and phosphorescence - Jablonski diagram (electronic states and transitions) – quenching, annihilation – photosensitization: principle and applications – chemiluminescence, bioluminescence.

MODULE V ANALYTICAL TECHNIQUES 7

Spectroscopy: electromagnetic radiation and spectrum – types of transitions – types of spectra (atomic and molecular with their chemical usefulness) – Beer-Lamberts law (problems) – principles, instrumentation and applications of: Colourimetry – UV-Vis spectrophotometer – atomic absorption spectroscopy – atomic emission spectroscopy – principles and applications of: IR, NMR, mass and X-ray diffraction analysis.

MODULE VI ELECTROCHEMISTRY 8

Electrochemistry - types of electrodes (principle and working) : gas (SHE), metal/metal ion electrode, metal-metal insoluble salt (calomel electrode), ion-selective (glass electrode and fluoride ion selective electrode) – Electrolytic and galvanic cells, construction of cell, EMF measurement and applications (problems), standard cell (Weston-cadmium), reversible and irreversible cell, concentration cell. Determination of fluoride ion using fluoride ion selective electrode – Chemically modified electrodes (CMEs) : concept, approaches and applications.

PRACTICALS

1. Estimation of hardness in given water sample.
2. Estimation of the alkalinity of the given water sample.
3. Estimation of strong acid by conductometry.
4. Estimation of Fe^{2+} present in the given sample by potentiometry.
5. Verification of Beer-Lamberts law and estimation of Cu^{2+} present in unknown sample.
6. Estimation of sodium and potassium present in the given sample by flame photometry.
7. Determination of molecular weight and degree of polymerisation of a polymer by viscosity method.
8. Synthesis of thermosetting polymer.

L – 45; P – 30; TOTAL HOURS – 75

REFERENCES:

1. S. Vairam, P. Kalyani and Suba Ramesh, “Engineering Chemistry”, Wiley India Ltd., New Delhi, 2011.

2. G.A. Ozin and A.C. Arsenault, “Nanochemistry: A Chemical Approach to Nanomaterials”, RSC Publishing, Thomas Graham House, Cambridge, 2005.

3. P.C Jain & Monica Jain, Engineering Chemistry Dhanpatrai Publishing Company (P) Ltd., New Delhi (2013).

4. S S Umare & S S Dara, A text Book of Engineering Chemistry, S. Chand& Company Ltd, New Delhi, 2014.

5. G.D.Rai, “Non conventional energy sources,” Khanna Publishers, New Delhi, 2011.

6. John Twidell and Tony Weir, “Renewable Energy Resources, Taylor & Francis Ltd, London, United Kingdom, 2005

7. Principles of molecular photochemistry: An introduction, Nicholas J. Turro, V.Ramamurthy and Juan C. Scaiano, University Science Books, Sausalito, CA, 2009.

OUTCOMES:

The students will be able to

- solve problems related to hardness, alkalinity, dissolved oxygen associated with the water and describe the treatment processes.
- classify nanomaterials and apply the nanochemistry approach to synthesize the nanomaterials.
- explain the principle and enumerate the advantages and disadvantages of various renewable energy sources.
- state the principle and illustrate the instrumentation of various analytical techniques.
- apply the concepts of photochemistry to elaborate various photo-physical and photochemical reactions.
- construct a electrochemical cell and describe the various types of electrodes and determine the fluoride content.

GEC 1101	ENGINEERING GRAPHICS	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To introduce the students of all engineering programs, the basic concepts of engineering drawing, which is the basic communication medium for all engineers
- To provide practical exposure on important aspects like drawing analytic curves, orthographic projections, section of solids, development of surfaces, isometric projection, perspective projection and free hand drawing.
- To introduce computerized drafting.

MODULE I BASICS AND ENGINEERING CURVES 10

Drawing instruments, dimensioning, BIS conventions, types of lines, simple geometric constructions.
Conic sections: ellipse, parabola, hyperbola.
Special curves: cycloid, epicycloid, hypocycloid and involutes.

MODULE II ORTHOGRAPHIC PROJECTION 8

Orthographic projection – first angle, second angle, third angle and fourth angle projections –setup - assumptions, principle. Free hand sketching of orthographic views of simple machine parts as per first angle projection. Orthographic projection of points in all quadrants. Some commands and demonstration of drafting packages.

MODULE III PROJECTION OF STRAIGHT LINES AND PLANES 10

Projection of straight lines in first quadrant – true length and true inclinations – Rotating line and trapezoidal methods –traces of straight line.
Projection of plane lamina in first quadrant and its traces

MODULE IV PROJECTION OF SOLIDS 10

Projection of solids in first quadrant: Axis inclined to one reference plane only- prism, pyramid, cone, cylinder – change of position and auxiliary projection methods.

MODULE V SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES 12

Section of solids: prism, pyramid, cone, cylinder, and sphere – sectional view – true

shape of section Solids in simple position and cutting plane inclined to one reference plane only.
Development of surface of truncated solids: prism, pyramid, cone cylinder – frustum of cone, pyramid and simple sheet metal parts.

MODULE VI PICTORIAL PROJECTIONS 10

Isometric projection: Isometric scale – isometric axes- iso sheet - Isometric projection and view of prism, pyramid, cylinder, cone, frustums, truncated solids and simple products
Perspective projection: station point – vanishing point – Perspective projection and views of prism, pyramid, cylinder and frustums by Visual ray method.

L – 30; P – 30; TOTAL HOURS – 60

TEXT BOOKS:

1. N.D. Bhatt, ‘Engineering Drawing’ Charotar Publishing house, 53rd Edtion, (2014)

REFERENCES:

1. K.V. Natarajan, ‘A text book of Engineering Graphics’, Dhanalakshmi publishers, Chennai. (2009)
2. Venugopal. K, and V. Prabhu Raja, Engineering Graphics, New Age International (P) Ltd., Publication, Chennai. (2011)

OUTCOMES:

- Students should be able to read the specifications and standards of technical drawing and able to draw conic sections and special curves.
- Students should be able to understand the insight of orthographic projection and to draw the various views of orthographic projection of a point and various components.
- Students should be able to draw the orthographic views of straight lines and plane figures.
- Students should be able to draw the orthographic views of simple solids.
- Students should be able to draw the sections of solids and development of solid surfaces.
- Students should be able to draw the isometric and perspective projection of simple solids and components.

GEC 1102	ENGINEERING DESIGN	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To understand the role of design in Engineering
- To understand the basic design concepts
- To understand the role of innovation in design

MODULE I DESIGN AS A CENTRAL ACTIVITY IN ENGINEERING 08

Product design – products and processes – product design methodology Design of systems; Software design

MODULE II NEED ANALYSIS AND CONCEPT DEVELOPMENT 07

Voice of customers – product specification - need analysis Bench marking Product architecture – concept generation and evaluation;

MODULE III CASE STUDIES IN ENGINEERING DESIGN 08

Product design – process design; system design; software design -Ergonomics – usability

MODULE IV INNOVATION AND DESIGN 07

Role of innovation in Engineering – incremental changes and systemic changes; scientific approach to driving innovation – case studies.

TOTAL HOURS – 30

REFERENCES:

1. Clive L. Dym and David C. Brown, "Engineering Design: Representation and Reasoning", 2nd Edition, Cambridge University Press, New Delhi, 2011.
2. Daniel G. Dorner, G. E. Gorman and Philip J. Calvert, "Information Needs Analysis: Principles and practice in information organizations", Published by Faced Publishing, London. 2015.
3. Cliff Matthews, "Case Studies in Engineering Design", John Wiley & Sons Pvt. Ltd, New York, 1998.
4. Bengt-Arne Vedin, "The Design-Inspired Innovation Workbook", World Scientific, 2011.

5. Navi Radjou, Jaideep Prabhu and Simone Ahuja, “Jugaad Innovation”, Published by Random House India, 2012.

OUTCOMES:

The students will be able to

- Apply the basic knowledge of design in engineering products / process / service.
- Analyse the problems and give innovative solutions.
- Correlate the basic knowledge of design in the real-world problems.
- Apply innovative approaches to engineering design.

GEC1103	BASIC ENGINEERING PRACTICES LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES:

- To provide a practical exposure to basic engineering practices like carpentry, fitting, plumbing, welding and making of simple electrical and electronic circuits
- To have an understanding on the use of various tools, instruments and methods
- To enable the students to appreciate the practical difficulties and safety issues

CIVIL ENGINEERING PRACTICE

1. Study of plumbing in general household and industrial systems
2. Making a small window frame with Lap and Mortise & Tenon Joints
3. Introduction to power tools

MECHANICAL ENGINEERING PRACTICE

1. Fabrication of a small Table frame with Butt, Lap and Fillet Joints
2. Machining of a simple component like a table weight using lathe
3. Mold preparation for simple component

ELECTRICAL ENGINEERING PRACTICE

1. Comparison of electrical lamps and study of house hold Electrical Gadgets (Fluorescent lamp, Fan and Wet grinder).
2. Stair case wiring and Godown Wiring
3. Domestic wiring
4. Earthing and its significance
5. Study of protection circuits and Inverter fed UPS / Emergency Lamp.

ELECTRONICS ENGINEERING PRACTICE

1. Identifications symbolic representation of active and passive electronic components
2. Soldering and tracing of electronic circuits and checking its continuity
3. Assembling of A.C. to D.C, D.C to A.C. Circuits in bread Board and Mini

project.

TOTAL HOURS – 30

OUTCOMES:

Upon the completion of the course, students should be able to

- Appreciate the practical skills needed even in making of simple objects, assemblies and circuits.
- Attend minor defects especially in items used in day to day life.
- Aware of the safety aspects involved in using tools and instruments.

GEC 1104 COMPUTER PROGRAMMING I

L	T	P	C
1	0	2	2

OBJECTIVES:

- To identify the hardware and software components of the computer.
- To know the basic concept of operating system and get knowledge about different operating systems.
- To learn various database concepts and operations
- To develop efficient algorithms for solving a problem.
- To implement the algorithms in C language.
- To use arrays in solving problems.

MODULE I COMPUTER FUNDAMENTALS 7

Introduction -. Number System - Planning the computer program - Computer Software - Basic operating system concepts - Database Operations

MODULE II PROGRAMMING IN C 8

Introduction to C Programming Language – Operators - Control statements - Iterative statements - Arrays.

LIST OF EXPERIMENTS:

1. Computer organization –Hardware in a typical computer Identification – Booting- error messages and what it means
2. Types of Operating systems – Windows and Linux
3. Structure of a basic program - Hello world program – Debugging it
4. Data types: Type conversions
5. Input / Output: Formatted functions – Unformatted functions – Library functions
6. Properties of operators – Priority of operators – Arithmetic relational logical and bitwise operators
7. If – if else- nested if else- goto- switch case – nested switch case – for loops – nested for loops – while loop – do-while loop – break and continue statement
8. Arrays – Operation with arrays
9. Sorting and searching.

L – 15; P – 30; TOTAL HOURS – 45

REFERENCES:

1. Ashok N Kamthane, “Computer Programming”, Pearson Education, 2nd Edition, ISBN 13: 9788131704370, 2012

2. Paul J. Deitel, Deitel & Associates, “C How to Program”, Pearson Education, 7th Edition, ISBN-13: 978-0132990448, 2012

OUTCOMES:

Students who complete this course will be able to

- Recognize Modular design, logic flow, data abstraction
- Analyze the working of the programming constructs, functions, and I/O.
- Write down programs for sorting and searching algorithms
- Write down programs developing cycle for different applications
- Debug the programs and solve some practical problems in programming
- Develop programs using arrays.

SEMESTER II

MAC 1281	**ADVANCED CALCULUS**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

OBJECTIVES:

The aims of this course are to

- train the students in solving problems using multiple integration.
- provide knowledge in using special functions to find out the area and volume of a region.
- acquire knowledge in tangent and normal vectors.
- gain knowledge in finding the areas of a curve and surface using vector integration.
- learn about the analytic functions and their properties along with bilinear transformation.
- know complex integration using Cauchy's theorems.

MODULE I **MULTIPLE INTEGRATION AND ITS APPLICATIONS** **8+2**

Multiple integrals– Cartesian and Polar coordinates – change of order of integration – Multiple integral to compute area and volume.

MODULE II **TRANSFORMATION OF COORDINATES AND SPECIAL FUNCTIONS** **7+3**

Change of variables between Cartesian, polar, cylindrical and spherical coordinates - Beta and Gamma functions – Properties and applications.

MODULE III **VECTOR DIFFERENTIATION** **7+3**

Operations on vectors – Scalar Product, Vector Product, Projection of Vectors - Angle between two vectors - Gradient, divergence and curl

MODULE IV **VECTOR INTEGRATION** **8+2**

Line, surface and volume integrals – Green's Theorem, Gauss Divergence Theorem and Stokes Theorem (statement only) – verification and evaluation of integrals.

MODULE V ANALYTIC FUNCTION 8+2

Analytic function - Necessary and Sufficient condition (statement only) – Cauchy-Riemann equations in polar coordinates - properties of analytic function – determination of analytic function – conformal mapping (w = z+a, az and 1/z) and bilinear transformation.

MODULE VI COMPLEX INTEGRATION 7+3

Statement and application of Cauchy's integral theorem – Cauchy's integral formula – Taylor's series and Laurent's series expansion – singularities - classification – residues - Cauchy's residue theorem – contour integration – Unit circle and semi circular contours (excluding poles on the real axis).

L – 45; T – 15; TOTAL HOURS – 60

TEXT BOOKS:

1. Veerarajan.T., "Engineering Mathematics "(5th edition) Tata Mc Graw Hill Publishing Co. New Delhi, 2012
2. Grewal B.S., "Higher Engineering Mathematics" (43rd edition), Khanna Publishers, New Delhi, 2012.
3. John W. Cell "Engineering Problems Illustrating Mathematics" Mc Graw Hill Publishing Co., New York 1943

REFERENCES:

1. Kreyszig, E., "Advanced Engineering Mathematics", 10th edition, John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2001.
2. Peter V. O'Neil, "Advanced Engineering Mathematics", 7th edition, Cengage Learning, 2011.
3. Dennis G. Zill, Warren S. Wright, "Advanced Engineering Mathematics", 4th edition, Jones and Bartlett publishers, Sudbury, 2011.
4. Alan Jeffrey, "Advanced Engineering Mathematics", Academic Press, USA, 2002.
5. Ramana, B.V., "Higher Engineering Mathematics" Tata Mc Graw Hill Publishing Co. New Delhi, 2006.

6. Venkataraman, M.K., “Engineering Mathematics”, Volume 2, 2nd edition, National Publishing Co., Chennai, 2003.
7. James Stewart “.Calculus” (7th edition),Brooks/Cole cengage learning,UK.

OUTCOMES:

After completing the course, student will be able to

- compute the area and volume using multiple integrals.
- apply special functions to solve integration problems.
- apply differentiation in scalar and vector fields.
- find area and volume of a region using vector integration.
- verify analyticity, conformity and bilinearity of complex functions.
- evaluate complex integrals.

GEC 1211	BASIC ENGINEERING MECHANICS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To impart knowledge about the basic laws of statics and dynamics and their applications in problem solving
- To acquaint both with scalar and vector approaches for representing forces and moments acting on particles and rigid bodies and their equilibrium
- To give on exposure on inertial properties of surfaces and solids
- To provide an understanding on the concept of work energy principle, friction, kinematics of motion and their relationship

MODULE I VECTOR APPROACH TO MECHANICS 07

Introduction - Units and Dimensions- Vectors – Vectorial representation of forces and moments –Vector Algebra and its Physical relevance in Mechanics - Laws of Mechanics – Parallelogram and triangular Law of forces -Lame's theorem, Coplanar Forces – Resolution and Composition of forces- Equilibrium of a particle.

MODULE II EQUILIBRIUM OF PARTICLE 06

Forces in space - Equilibrium of a particle in space - Equivalent systems of forces – Principle of transmissibility – Single equivalent force

MODULE III EQUILIBRIUM OF RIGID BODY 06

Free body diagram – Types of supports and their reactions – requirements of stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis –Vectorial representation of moments and couples – Scalar components of a moment –Varignon's theorem - Equilibrium of Rigid bodies in two dimensions - Examples

MODULE IV PROPERTIES OF SURFACES 08

Determination of Areas – First moment of area and the Centroid of sections – Rectangle, circle, triangle from integration – T section, I section, Angle section, Hollow section by using standard formula – second and product moments of plane area – Physical relevance - Rectangle, triangle, circle from integration - T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia- Mass moment of

Area

MODULE V FRICTION 08

Introduction to friction- types of friction- Laws of Coloumb friction- Frictional force – simple contact friction – Rolling resistance –ladder friction

MODULE VI LAWS OF MOTION 10

Review of laws of motion – Newton's law – Work Energy Equation of particles– Impulse and Momentum – Impact of elastic bodies.

L – 45; T – 15; TOTAL HOURS – 60

REFERENCES:

1. Beer, F.P and Johnston Jr. E.R, "Vector Mechanics for Engineers, Dynamics & Statics", Third SI Metric Edition, Tata McGraw-Hill International Edition, 2001.
2. Hibbeller, R.C., Engineering Mechanics, Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., 2000.
3. Irving H. Shames, Engineering Mechanics – Statics and Dynamics, IV Edition Pearson Education Asia Pvt. Ltd., 2003.

OUTCOMES:

On completion of this course students should be able

- Analyse and resolve forces, moments and solve problems using various principles and laws of Mechanics
- Apply the concept of equilibrium to particles and solve problems
- Apply the concept of equilibrium to rigid bodies and solve problems
- Analyse and determine the properties of surfaces
- Analyse and evaluate the fractional forces between the bodies
- Apply the laws of motion in solving dynamics problems

GEC 1212 **ENVIRONMENTAL STUDIES**

L	T	P	C
2	0	0	2

OBJECTIVES:

The student will be conversant with the

- various natural resources, availability, utilisation and its current scenario
- different ecosystems, energy transfer, values, threats and conservation of biodiversity
- levels of different pollutants and its impact and the causes and effects of natural disasters
- impacts of human population, impact assessment, human rights and environmental acts and sustainable development

MODULE I **NATURAL RESOURCES** **8**

Land resources: land degradation, soil erosion and desertification - Forest resources: use and over-exploitation, deforestation - Water resources: use and over-utilisation of surface and ground water, conflicts over water (inter-state and international), dams (benefits and problems), water conservation (rainwater harvesting and watershed management) - Mineral resources: use and exploitation, environmental effects of extracting and using mineral resources, mining - Food resources: world food problems, changes in land use by agriculture and overgrazing, modern agriculture and its effects, fertilizer and pesticide problems, water logging and salinity - Energy resources: increasing energy needs, renewable and non-renewable, use of alternate energy sources.

MODULE II **ECOSYSTEM AND BIODIVERSITY** **8**

Ecosystem- energy flow in the ecosystem - food chains, food webs and ecological pyramids - characteristics, structure and function of (a) Terrestrial ecosystems (forest, grassland, desert) and (b) Aquatic fresh water ecosystems (pond, lake, river) (c) Aquatic salt water ecosystems (ocean, estuary) - ecological succession.

Biodiversity - genetic, species and ecosystem diversity – hot-spots of biodiversity – biogeographic classification of India - endangered, endemic, extinct and invasive species of India - red data book - values of biodiversity: consumptive, productive, social, ethical, aesthetic and option values - threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts - conservation of biodiversity: in-situ and ex-situ conservation of biodiversity

MODULE III ENVIRONMENTAL POLLUTION AND NATURAL DISASTER 8

Definition, cause, effects and control measures of (a) air pollution (b) water pollution (c) soil pollution (d) marine pollution (e) noise pollution (f) thermal pollution (g) nuclear hazards - ill-effects of fireworks and upkeep of clean environment - solid waste management: types (urban, industrial, biomedical and electronic wastes), collection, processing and disposal (incineration, composting and land-fill) - natural disaster and management: flood, cyclone, drought, landslide, avalanche, volcanic eruptions, earthquake and tsunami.

MODULE IV HUMAN POPULATION, HEALTH AND SOCIAL ISSUES 6

Population and population growth, population variation among nations, population explosion, family welfare programme.

Human health: air-borne, water borne diseases, infectious diseases, risks due to chemicals in food and environment.

Sustainable development - environmental legislation and laws: water act, air act, wildlife protection act, forest conservation act, environment protection act - environmental impact assessment, steps in EIA - human rights - women and child welfare.

Case studies related to current situation

TOTAL HOURS – 45

TEXT BOOK:

1. Erach Bharucha, Textbook for Environmental Studies For Undergraduate Courses of all Branches of Higher Education for University Grants Commission, Orient Blackswan Pvt Ltd, Hyderabad, India, 2013.
2. Benny Joseph, Environmental Studies, Tata McGraw-Hill Education, India, 2009.
3. Ravikrishnan A, Environmental Science and Engineering, Sri Krishna Publications, Tamil Nadu, India, 2015.
4. Raman Sivakumar, Introduction to Environmental Science and Engineering, McGraw Hill Education, India, 2009.
5. Venugopala Rao P, Principles of Environmental Science and Engineering,

Prentice Hall India Learning Private Limited; India, 2006.

6. Anubha Kaushik and Kaushik C.P., Environmental Science and Engineering, New Age International Pvt Ltd., New Delhi, India, 2009.

REFERENCES:

1. Masters G.M., Introduction to Environmental Engineering and Science, Prentice Hall, New Delhi, 1997.
2. Henry J.G. and Heike G.W., Environmental Science and Engineering, Prentice Hall International Inc., New Jersy, 1996.
3. Miller T.G. Jr., Environmental Science, Wadsworth Publishing Co. Boston, USA, 2016.

OUTCOMES:

The student will be able to

- predict the scenario of various natural resources and suggest remedies to curb the exploitation of these resources.
- identify food chain and web and its role in various ecosystems, assess the impacts on biodiversity and provide solutions to conserve it.
- analyse the impacts of pollutants in the environment and propose suitable method to alleviate the pollutants and the natural disasters.
- assess on the impact of human population and the health related issues and the ethics to be followed for sustainable life.

GEC 1213 COMPUTER PROGRAMMING II

L	T	P	C
1	0	2	2

OBJECTIVES:

- To provide knowledge about the benefits of Object-Oriented Programming over Procedure oriented programming.
- To learn various File operations
- To expose fundamental concepts of object-oriented programming in classes, invoking methods and functions.
- To prepare students to get full use of code reusability using object-oriented programming.
- To implement the basic concepts of object-oriented programming using C++concepts.

  To focus on solving problems based on analyzing, designing and implementing programs in C and C++.

MODULE I PROGRAMMING IN C 7

Functions - Storage Classes - Structures and Unions – Pointers -Self Referential Structures and Linked Lists - File Processing.

MODULE II PROGRAMMING IN C++ 8

Programming in C++ - Overview of OOP in C – Inheritance - Polymorphism - Type Casting – Exceptions.

LIST OF EXPERIMENTS:

1. Functions
2. One dimensional arrays, Pointers
3. Recursion
4. Multi dimensional arrays, Linked lists.
5. Operating on Files.
6. Simple C++ program with Control statements.
7. Getting input from user console.
8. Classes, Object and Constructors.
9. Method overloading.

Inheritance

L – 15; P – 30; TOTAL HOURS – 45

REFERENCES:

1. Bjarne Stroustrup," The C++ Programming Language", Addison Wesley, 4th edition, ISBN-13: 978-0321563842, 2013.
2. Brian W. Kernighan and Dennis M. Ritchie, " The C Programming Language", Prentice Hall, ISBN 0-13-110362-8, 2015.
3. Bjarne Stroustrup, "Programming: Principles and Practice Using C++ ", Addison Wesley, 2nd edition, ISBN-13: 978-0321992789, 2014.
4. Brian W. Kernighan and Dennis M. Ritchie, " The C Programming Language (Ansi C Version)", Prentice Hall India Learning Private Limited, 2nd edition, ISBN-13: 978-8120305960, 1990.

OUTCOMES:

Students who complete this course will be able to

- Develop efficient algorithms for solving problems
- Handle files in C
- Use simple data structures like arrays and linked lists in solving problems.
- Write simple programs using concepts of object-oriented programming.
- Implement algorithms in C++ Language.
- Demonstrate the Object-Oriented Programming concepts applied in networking, web development and Database applications.

EEC1211	**ELECTRIC CIRCUIT ANALYSIS**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

OBJECTIVES:

- To impart knowledge on the network elements, types of networks, analysis of complex circuits using Mesh current & Nodal voltage method.
- To expose the students to the solution methods of AC and DC circuits.
- To provide an insight into solution of RLC circuits, analysis of coupled circuits.
- To prepare students to use the concept of two port network in solving electrical circuits.
- To impart knowledge about transients in electrical circuits.

MODULE I ANALYSIS OF DC CIRCUITS 9

Review of concepts of voltage, current, power and energy. Introduction to DC circuits-Ohms law, Voltage-Current relations for resistor, inductor, capacitor. Kirchhoff's laws- Mesh analysis, presence of dependent and independent sources, circuits with current sources - Node analysis, presence of dependent and independent sources - source transformation, star-delta transformation.

MODULE II ANALYSIS OF AC CIRCUITS 9

Introduction to AC circuit, steady state analysis of RL, RC and RLC series and parallel circuits, Impedance, phasor diagrams, power and power factor, series resonance, Parallel resonance,

Q factor, Selectivity. Solving AC circuits using mesh and node analysis, Analysis of coupled circuits, Analysis of balanced and unbalanced three phase circuits.

MODULE III NETWORK THEOREMS 10

Superposition theorem, Compensation theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Tellegen's theorem, Millman's theorem, Reciprocity theorem; Application of network theorems in solving DC and AC circuits.

MODULE IV TRANSIENT ANALYSIS 6

Transient response of RL, RC and RLC circuits using Laplace transform with DC and AC excitations considering zero and non zero initial conditions.

MODULE V TWO PORT NETWORKS 6

Characterization of two port networks in terms of Z, Y, h and ABCD parameters network equivalents – relation between network parameters – T and pi representation.

MODULE VI FILTERS 5

Classification of filters: Classification of Pass Band and Stop Band – Characteristic impedance in the pass and stop bands- Design of constant K low pass and high pass filters – m derived filters.

L – 45; T – 15; TOTAL HOURS – 60

REFERENCES:

1. Electrical and Electronic Technology, Edward Hughes, PH (UK) 9th edition (2004), 11th revised edition (2012).
2. Vincent Del Toro, "Principles of Electrical Engineering", 2nd Edition, Prentice - Hall of India, 1984
3. William H.Hayt, Jr.Jack E.Kemmerly, Steven M.Durbin, "Engineering Circuit Analysis", 6th Edition, Tata McGraw - Hill Edition, 2002.
4. Joseph A.Edminster, Mahmood Nahvi, 'Electric Circuits', Schaum's Series, Tata McGraw Hill publishing Co. Ltd., New Delhi 2001.
5. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", Tata McGraw Hill, 2007.
6. R.C. Dorf, 'Introduction to Electric Circuits', John Wiley & Sons Inc, New York, 2nd Edition, 2003.
7. Roy Choudury D, Networks and Systems, New Age International, 2nd edition, 2010.

OUTCOMES:

At the end of the course, the student will be able to

- Solve DC electric circuits with independent and controlled sources.
- Perform steady state analysis on AC single phase and three phase circuits and to design resonant circuits.
- Reduce circuits into equivalent circuits by applying network theorems.
- Apply Laplace transform to perform transient analysis.
- Compute Z, Y, h and ABCD parameters of two port networks.
- Realize RL, RC and LC networks and to design different types of filters.

EEC1212	**ELECTRIC CIRCUITS AND SIMULATION LAB**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

OBJECTIVES:

- To impart hands on experience in verification of Electric Circuit laws and Theorems
- To verify Electric Circuit laws and theorems using Mat Lab / PSpice
- To implement power measurement methods for three phase circuits.

LIST OF EXPERIMENTS:

1. Verification of Kirchhoff's Voltage and Current Laws
2. Verification of Thevinin's and Norton's Theorem
3. Verification of Superposition and Maximum Power Transfer Theorem
4. Study of Oscilloscope and measurement of sinusoidal voltage, frequency and power factor
5. Study of the effect of Q on frequency response of series and parallel resonant circuits
6. Measurement of real power, reactive power, power factor and impedance of RL, RC and RLC circuits using 3 voltmeters and 3 ammeters
7. Power measurement in a three-phase circuit using two wattmeter method
8. Verification of Kirchhoff's Voltage and Current Laws using MatLab / PSpice
9. To obtain Thevenin's and Norton's equivalent circuits using PSpice / MatLab
10. To verify Maximum power Transfer theorem and Superposition theorem using PSpice / MatLab
11. Simulation of three phase power measurement by two wattmeter method using MatLab

TOTAL HOURS – 30

REFERENCES:

1. Saroj K Dash, Smruti R Khuntia, Basic Electrical Engineering with MATLAB, Yes Dee Publication, Chennai.

2. Muhammad H. Rashid, Introduction to PSpice Using OrCAD for circuits and Electronics, Prentice Hall of India Pvt Ltd, 2008, Third Edition.

OUTCOMES:

At the end of the course, the student will be able to

- Conduct basic laboratory experiments involving electrical circuits using laboratory test equipments such as power supplies, signal generators, oscilloscopes, multimeters etc.
- Implement and verify network theorems
- Implement three phase power measurement method using two wattmeter method
- Relate physical observations and measurements involving electrical circuits to theoretical principles.
- To simulate various electric circuits using PSpice and MaTLab simulation.

For electric circuits the performance evaluations can be done using simulation tools.

SEMESTER III

		L	T	P	C
MAC 2181	**PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS**	**3**	**1**	**0**	**4**

OBJECTIVES:

The aims of this course are to

- Familiarize in solving partial differential equation of first, second and higher orders.
- Introduce basics and engineering applications of Fourier series, Laplace Transform, Fourier Transform and Z- Transform.

MODULE I PARTIAL DIFFERENTIAL EQUATIONS 8 + 2

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solution of standard types of first order partial differential equations – Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients.

MODULE II FOURIER SERIES 8+2

Fourier Series and Dirichlet's conditions - General Fourier series - Half range Fourier series - Parseval's identity - Harmonic Analysis.

MODULE III FOURIER TRANSFORMS 7+3

Fourier integral theorem (without proof) - Fourier transform pair - Fourier Inverse Transform – Properties - Convolution theorem - Parseval's identity.

MODULE IV APPLICATIONS OF FOURIER SERIES AND FOURIER TRANSFORMS 7+3

Applications of Fourier series and Fourier Transform to solution of PDEs having constant coefficients with special reference to Heat & Wave equations, Discrete & point Spectrum and Single pulse.

MODULE V LAPLACE TRANSFORM 8+2

Introduction to Laplace transform - Existence of Laplace Transform - Properties of Laplace Transforms - Initial & Final Value Theorems - Inverse Laplace Transform - Convolution Theorem – Circuits to signal square wave: Integral equations with unrepeated complex factors – Damped forced vibrations: repeated complex factors – Resonance - Solution of differential equations

MODULE VI Z – TRANSFORM 7+3

Introduction and Definition of Z-transform - Properties of Z- Transform - Convolution Theorem of Z-Transform - Inverse Z–transform - Convolution Theorem of Inverse Z-Transform - Formation of difference equations - Solving Difference Equations using Z-Transform.

L – 45; T – 15; Total Hours –60

TEXT BOOKS:

1. Kreyszig .E., "Advanced Engineering Mathematics", 10th edition, John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2001.
2. Grewal B.S., "Higher Engineering Mathematics", 42nd edition, Khanna Publishers, New Delhi, 2012.
3. Ramana, B.V, "Higher Engineering Mathematics" Tata Mc Graw Hill Publishing Co. New Delhi, 2006.

REFERENCES:

1. Veerarajan.T., "Engineering Mathematics", 5th edition, Tata Mc Graw Hill Publishing Co. New Delhi, 2012.
2. Peter V. O'Neil, "Advanced Engineering Mathematics", 7th edition, Cengage Learning, 2011.
3. Dennis G. Zill, Warren S. Wright, "Advanced Engineering Mathematics", 4th edition, Jones and Bartlett publishers, Sudbury, 2011.
4. Alan Jeffrey, "Advanced Engineering Mathematics", Academic Press, USA, 2002.

OUTCOMES:

After completing the course, student will be able to

- solve the partial differential equations.
- derive a Fourier series of a given periodic function by evaluating Fourier coefficients.
- apply integral expressions for the forward and inverse Fourier transform to a range of non-periodic waveforms.
- solve wave equation and heat flow equation.
- solve ordinary differential equations using Laplace transform.
- solve difference equation using Z-transform.

ENC2181	**ORAL COMMUNICATION**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

OBJECTIVES:

- To expose students to a range of professional contexts through podcasts for learning appropriate expressions.
- To train them in making poster presentations.
- To enable them to make effective business presentations.
- To help them learn persuasive and negotiation skills.
- To train them to debate on issues of current relevance
- To train them to participate in group discussions on current affairs

MODULE I **4**

Orientation to the Importance of Oral Communication -– Verbal and non-verbal communication -Paralinguistic features.

One-minute presentations (using Audacity/Voicethread) – Just a minute (JAM) on random topics

MODULE II **4**

Negotiating and persuading through effective arguments – to arrive at a conclusion (pair-work)

Understanding Negotiation, persuasion and marketing skills through Podcasts

Listening to short conversations and monologues for understanding real life conversations

MODULE III **4**

Making Poster presentations on current issues

Understanding nuances of making effective presentations (TED Videos)

MODULE IV **6**

Deliberation on social and scientific issues – Debates (focus on rebuttal skills and deconstructing arguments)

Viewing videos on debates (NDTV Discussions)

MODULE V **6**

Discussing social issues or current affairs in groups

Viewing group discussions and listening for specific information

MODULE VI **6**

Making full length presentation (through Voicethread) with the focus on one's career plans and prospects (discipline specific)

Listening to interviews for understanding speakers' perception (on industry related issues)

P – 30; Total Hours –30

REFERENCES:

1. Hancock, Mark (2012). *English Pronunciation in Use*. Cambridge University Press, UK.
2. Anderson, Kenneth & et.al (2007). *Study Speaking: A Course in Spoken English for Academic Purposes* (Second Edition). Cambridge University Press, UK.
3. Hurlock, B.Elizabeth (2011). *Personality Development*. Tata McGraw Hill, New York.
4. Dhanavel,S.P (2015). *English and Soft Skills*. Orient Blackswan, Chennai.
5. Whitby, Norman (2014). *Business Benchmark: Pre-Intermediate to Intermediate.* Cambridge University Press, UK.

OUTCOMES:

On completion of the course, students will be able to

- Listen to business conversations and do related tasks.
- Deliver effective poster presentations.
- Make effective business presentations.
- Use persuasive and negotiating skills for justifying arguments.
- Participate effectively in debates.
- Speak English intelligibly, fluently and accurately in group discussions.

EEC2101	**ELECTROMAGNETIC THEORY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To introduce the basic mathematical concepts related to electromagnetic vector fields.
- To provide knowledge on the concepts of electrostatics, magneto statics, electrical potential, energy density and their application.
- To impart knowledge on the concepts of Faraday’s law, induced EMF and Maxwell’s equations.
- To deliver knowledge on the concepts of electromagnetic wave and Poynting vector.

MODULE I CO-ORDINATE SYSTEM AND VECTOR CALCULUS 7

Cartesian Coordinates, Circular Cylindrical Coordinates, Spherical Coordinates, Constant-Coordinate Surfaces, Differential Length, Area, and Volume, Line, Surface, and Volume Integrals, Del Operator, Gradient of a Scalar, Divergence of a Vector and Divergence Theorem, Curl of a Vector and Stokes's Theorem, Laplacian of a Scalar, Classification of Vector Fields

MODULE II ELECTROSTATIC FIELDS 7

Coulomb's Law and Field Intensity, Electric Fields due to Continuous Charge Distributions, Electric Flux Density, Gauss’s Law—Maxwell's Equation, Applications of Gauss's Law, ElectricPotential, Relationship between E and V—Maxwell's Equation, An Electric Dipole and Flux Lines, Energy Density in Electrostatic Fields

MODULE III ELECTRIC FIELDS IN MATERIAL SPACE 9

Properties of Materials, Convection and Conduction Currents, Conductors, Polarization in Dielectric, Dielectric Constant and Strength Linear, Isotropic, and Homogeneous Dielectrics Continuity Equation and Relaxation Time, Boundary Conditions. Poisson's and Laplace's Equations - Uniqueness Theorem - General Procedure for Solving Poisson's or Laplace's Equation - Resistance and Capacitance - Method of Images.

MODULE IV MAGNETOSTATIC FIELDS 8

Biot-Savart's Law, Ampere's Circuit Law—Maxwell's Equation, Applications of

Ampere's Law , Magnetic Flux Density—Maxwell's Equation, Maxwell's Equations for Static EM Fields, Magnetic Scalar and Vector Potentials , Derivation of Biot-Savart's Law and Ampere's Law, Forces due to Magnetic Fields, Magnetic Torque and Moment, A Magnetic Dipole, Magnetization in Materials, Classification of Magnetic Materials, Magnetic Boundary Conditions, Inductors and Inductances, Magnetic Energy, Magnetic Circuits, Force on Magnetic Materials.

MODULE V ELECTRO MAGNETIC INDUCTION 8

Faraday's Law, Transformer and Motional EMFs, Displacement Current, Maxwell's Equations in Final Forms, Time-Varying Potentials, Time-Harmonic Fields.

MODULE VI ELECTROMAGNETIC WAVE PROPAGATION 7

Waves in General, Wave Propagation in Lossy Dielectrics, Plane Waves in Lossless Dielectrics, Plane Waves in Free Space, Plane Waves in Good Conductors, Power and the Poynting Vector, Reflection of a Plane Wave at Normal Incidence, Reflection of a Plane Wave at Oblique Incidence.

Total Hours –45

REFERENCES:

. Matthew N.O. Sadiku & S.V.Kulkarni ,Principles of Electromagnetics, Oxford University Press, Asian Edition, 2015.

2. Zahn Markus, Electromagnetic Field Theory: A Problem-Solving Approach. Malabar, FL: Krieger Publishing Company, 2003.

3.William Hayt , “Engineering Electromagnetics”, McGraw Hill, New York,1989.

4. John D. Kraus, “Electromagnetics”, McGraw Hill, 1999.

5.Joseph A.Edminister, M.S.E, “Schaum’s Outline of Theory and Properties ofElectromagnetics”, McGraw Hill Book Company,1998.

6.http://ocw.mit.edu/terms

7. nptel.ac.in/courses/108104087

OUTCOMES:

At the end of the course, the student is expected to

- Relate the concepts of vector calculus and coordinate systems in the study of electromagnetics.
- Appreciate the fundamental laws and concepts of electrostatic fields.
- Apply the fundamental laws of electrostatics to material space and to solve electrostatic boundary value problems.

- Explain the fundamental laws and concepts of magnetostatic fields.
- Apply the concepts of Maxwell's equations in electromagnetic field theory.
- Correlate the concepts of wave propagation in various media.

EEC 2102	SIGNALS AND SYSTEMS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To introduce the students to the concept of Signals and Linear Time-Invariant Systems
- To illustrate various mathematical tools such as Fourier, Laplace, z-Transform etc. for signal processing applications
- To impart the fundamentals of digital filter and its design.

MODULE I INTRODUCTION TO SIGNALS AND SYSTEMS 10

Signals: classification (analog and digital, energy and power, even and odd, periodic and aperiodic, deterministic and random, stationary and non-stationary) - standard signals (unit step, unit impulse, ramp, exponential, sinusoids) - transformations of the independent variable.

Systems: system classification (continuous and discrete, causal and non-causal, stable and unstable, stable/unstable oscillatory, linear and non-linear, time-invariant and variant, invertible etc.) - continuous and discrete time LTI systems - Impulse response of an LTI system - convolution integral, graphical convolution - LTI system properties - interconnection of LTI systems - Differential and Difference Equation representation of LTI systems

MODULE II FOURIER SERIES AND FOURIER TRANSFORM 9

Fourier Series representation of signals - properties of Fourier Series - Continuous / discrete - Time Fourier transform and its properties - Frequency Response of CT-LTI Systems - phase delay and group delay – Discrete Time Fourier Transform (DTFT) and its properties - Discrete Fourier Transform (DFT) and its properties – Fast Fourier Transform (FFT).

MODULE III SAMPLING 6

Representation of a Continuous-Time Signal by Its Samples - Shannon's Sampling Theorem - reconstruction of a signal from its samples using interpolation - effect of under sampling - Aliasing - discrete-time processing of continuous time signals.

MODULE IV LAPLACE TRANSFORM 7

Unilateral and Bilateral Laplace transform - region of convergence (ROC) - properties of Laplace transforms - poles and zeros - inverse Laplace transformation – brief introduction to solving differential equations with initial conditions - the concept of transfer function, Causality and Stability.

MODULE V Z- TRANSFORM 6

Z-Transform, z-Plane and ROC - properties of z-Transform - poles and zeros - inverse z-Transform - Transfer Function of DT-LTI Systems. Causality and Stability.

MODULE VI INTRODUCTION TO DIGITAL FILTERS 7

Representation of linear digital networks – different types of filters - network structures for infinite impulse response (IIR) and finite impulse response (FIR) filters – introduction to design of IIR and FIR filters.

L – 45; T – 15; Total Hours –60

REFERENCES:

1. Alan V. Oppenheim, Alan S. Willsky, S. Hamid Nawab, "Signals & Systems", 2nd Edition, Pearson Education,1997.
2. Simon Haykin, Barry Van Veen, "Signals and Systems", 2nd Edition, John Wiley & Sons Pvt Ltd., 2004.
3. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing - Principles, Algorithms and Applications", 3rd Edition, Prentice Hall of India, 2000
4. Hwei P. Hsu, "Signals and Systems", 2nd Edition, Schaum’s Outlines, McGraw Hill, 1995.
5. . M. J. Roberts, "Signals and Systems Analysis using Transform method and MATLAB", 1st Edition, Tata McGraw Hill, 2003.
6. K. Lindner, "Signals and Systems", 2nd Edition, McGraw Hill International, 1999.
7. Chi-Tsong Chen, "Signals and Systems", 3rd Edition, Oxford University Press, 2004.
8. Roger E. Ziemer, William H. Tranter, D.R. Fannin, "Signals & Systems: Continuous and Discrete", 4th Edition, Prentice Hall, 1998.
9. Ashok Amhardar, "Analog and Digital Signal Processing", 2nd Edition, Thomson, 2002.

OUTCOMES:

On completion of the course the students will be able to

- Classify, identify and mathematically represent different types of signals and systems.
- Use Laplace transform to analyze continuous time systems.
- Apply z- transform to analyze discrete time systems.
- Use Fourier series and Fourier transform to analyze the different signals and systems.
- Discretize analog signals and reconstruct them back from the samples
- Follow the design procedure to design digital filters.

		L	T	P	C
EEC2103	**ELECTRONIC DEVICES AND CIRCUITS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To familiarize the student with the principle of operation, capabilities and limitation of various electronic devices and their applications.
- To familiarize the student with the principle of operation of operational amplifier and its various application circuits
- To familiarize the student with the principle of operation of feedback amplifiers and oscillators

MODULE I PN JUNCTION DIODE 8

Diodes- PN junction- current equation, junction capacitance, breakdown characteristics, V-I characteristics, PN junction diode ratings. Diode Applications- Clippers, clampers and rectifiers (Half wave and Full wave). Zener diode - V-I characteristics, applications- LED and Photo diode

MODULE II BIPOLAR JUNCTION TRANSISTOR (BJT) 7

Physical behavior of a BJT – Ebers–Moll model - Modes of transistor operation – Common Base, Common Emitter and Common Collector configurations, Input and output characteristics, Early effect, Thermal runaway. AC and DC load lines - Need for stability of Q -Point, Bias stability –fixed bias, collector to base bias, self-bias. Transistor switching times, Transistor as a switch and an amplifier rating, photo transistors.

MODULE III FIELD EFFECT TRANSISTOR (FET) 7

JFET operation - V-I characteristics, transfer characteristics, regions of operation. DC analysis - JFET biasing, JFET as a switch, Voltage variable resistor and an amplifier. MOSFET- Constructional details- Operation of Enhancement and Depletion type MOSFET, V-I characteristics, Transfer characteristics, MOSFET biasing, MOSFET as a switch, resistor and amplifier, generalized small signal model.

MODULE IV OPAMP FUNDAMENTALS AND CHARACTERISTICS 7

Operational amplifier: block diagram representation, Transfer characteristics of a typical Op Amp circuit, ideal Op Amp characteristics -Non-ideal characteristics- DC characteristics – Input bias current-Input offset voltage- Input offset current- Thermal drift- AC characteristics- Frequency response- Frequency compensation- Slew rate, Internal circuit operation of operational amplifier - differential amplifier.

MODULE V OP AMP APPLICATIONS 9

Mathematical operations using operational amplifier - inverting amplifier, non inverting amplifier, summer, subtractor, multiplier, divider, integrator, differentiator, zero crossing detector - Instrumentation amplifier - Precision rectifier - comparator -Schmitt Trigger, Astable and Monostable Multivibrator, Active Filters: I and II order low pass filter.

MODULE VI FEEDBACK AMPLIFIERS AND OSCILLATOR USING OPAMP 7

Amplifier classification - Feedback concept - Characteristics - effect of feedback on input and output characteristics. Oscillator-Principle, Stability of feedback circuits using Barkhausen criteria, RC oscillator- Wien bridge oscillator and Phase shift oscillator, LC oscillator - Hartley oscillator, Colpitts oscillator, Crystal oscillator.

Total Hours –45

REFERENCES:

1. Boylestead L.R., Nashelsky L., “Electronic Devices and Circuit Theory”, Pearson Education India Series, New Delhi, 10th Edition, 2009.
2. Gupta.J.B. “Electronic Devices and Circuits”, 3rd Edition, S.K. Kataria& Sons, New Delhi, 2010.
3. Millman J., C.C. Halkias, Sathyabratha Jit, “Electronic Devices and Circuits”,Tata McGraw-Hill Publishing company limited, 2nd Edition, 2007.
4. R. Gayakwad, Op-Amps and Linear Integrated Circuits, 4th ed., Pearson Education, Delhi, 2000.
5. R. Coughlin and F. Driscoll, Operational Amplifiers and Linear IntegratedCircuits, 6th ed., Pearson Education, Delhi, 2003
6. D. R. Choudhury and S. Jain, Linear Integrated Circuits, New Age International, New Delhi, 2002

OUTCOMES:

At the end of the course, the student is expected to

- apply the fundamentals of PN junction and Zener diode to design practical circuits.
- apply the concepts of BJT to design practical circuits.
- analyse the working of FET and its applications.
- characterize opamp behaviour in practical circuits.
- synthesize opamp circuits to perform various mathematical operations.
- design feedback amplifiers and oscillators using opamps.

EEC2104	**ELECTROMECHANICAL ENERGY CONVERSION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To relate the concepts of electromechanical energy conversion principles to working of electrical machines.
- To impart knowledge on working and classification of DC machines; determination of their characteristics and methods of speed control of motors.
- To estimate the various losses taking place in DC machines and to study the different testing methods to arrive at their performance.
- To familiarize the constructional details, the principle of operation, prediction of performance, the methods of testing the transformers and three phase transformer connections.

MODULE I ELECTROMECHANICAL ENERGY CONVERSION SYSTEMS 8

Principles of Electromechanical Energy Conversion-Conservative force field-Energy Balance Relationships in Electromechanical Systems-Conservation of Energy-Concept of co-energy.

MODULE II DC GENERATOR 8

Construction – Principle of Operation – classification– types of armature windings – EMF equation -OCC & Load characteristics – Power Flow diagram – Losses and efficiency- Armature reaction – Commutation

MODULE III DC MOTOR 8

Construction – Principle of operation – Torque – Types and characteristics – Power Flow diagram – Starters – Speed Control - Solid state DC drives (Qualitative treatment only).

MODULE IV BRUSHLESS DC MOTORS 6

Brushless Concept – Construction and operation of Brushless DC motors (BLDCM) – Characteristics – Concept of control of BLDCM – Control Circuitry – Applications

MODULE V TRANSFORMER 8

Construction and principle of operation – EMF equation – Transformer on no load and load –Phasor diagram - Equivalent circuit - Voltage regulation – Losses &

Efficiency - Auto Transformer - All day efficiency- 3-phase transformer- connections-applications.

MODULE VI TRANSFORMER TESTING &PARALLEL OPERATION 7

OC and SC tests — computation of Voltage regulation, losses & efficiency using OC and SC tests - polarity test – Sumpner's test - Parallel Operation of transformers.

Total Hours – 45

REFERENCES:

1. Fitgerald, A.E., Charles Kingsely Jr. Stephen D.Umans, “Electric Machinery”, McGraw Hill Books Company,6th edition 2002.
2. Hill Stephen, Chapman.J, “Electric Machinery Fundamentals”, McGraw Hill Book Co., New Delhi, 4th edition 2005.
3. Nagrath I. J and Kothari D. P. ‘Electric Machines’, Fourth Edition, Tata McGraw Hill Publishing Company Ltd, 2010.
4. M.N.Bandyopadhyay, Electrical Machines Theory and Practice, PHI Learning PVT LTD., New Delhi, 2009.

OUTCOMES:

At the end of this course, the student will possess knowledge and skills on the following:

- apply the concepts of electromagnetism in electromechanical energy conversion systems.
- analyze the performance and characteristicsof DC Generators.
- compare performance characteristics of DC Motors for various applications.
- test and troubleshoot DC Motors and DC Generators.
- analyze the performance and characteristics of BLDCM and Transformers.
- compute voltage regulation, losses and efficiency of transformers by conducting appropriate test.

		L	T	P	C
EEC 2105	**ELECTRONIC DEVICES AND CIRCUITS LAB**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

OBJECTIVES:

- To get practical exposure of the various electronic devices and its applicationcircuitry.
- To design and implement rectifiers and oscillators.
- To provide hands-on experience on opamp application circuits.

LIST OF EXPERIMENTS:

1. VI characteristics of PN junction diode and Zener diode.
2. Characteristics of BJT.
3. Characteristics of LED and photo transistor.
4. Characteristics of JFET.
5. Frequency response of FET amplifier.
6. Analysis of Bridge Rectifier.
7. Measurement of important Opamp parameters such as CMRR, slew rate, open loop gain, input and output impedances, GBW product.
8. Gain of inverting and non-inverting amplifier
9. Op Amp application circuits - Integrator and differentiator
10. Astable and Schmitt Trigger using Opamp.
11. Design of RC Phase shift oscillator using Opamp.
12. Design of Hartley and Colpitts oscillator using Opamp.

Total Hours –30

OUTCOMES:

The student should have the ability to

- practically construct and verify the various characteristics of semiconductor devices
- demonstrate the working of amplifiers.
- demonstrate the working of various oscillator circuits.
- analyze applications of photo diode and photo transistor.
- demonstrate the working of a bridge rectifier.
- demonstrate the working of opamp application circuits.

EEC2106	ELECTROMECHANICAL ENERGY CONVERSION LAB	L	T	P	C
		0	0	2	1

OBJECTIVES:

- To experimentally verify the performance and characteristics of DC machines and 1-phase transformers.
- Know the necessity to predetermine the performance of DC machines and transformers.
- To apply DC machines and transformers to various applications.

LIST OF EXPERIMENTS

1. OCC and Load characteristics of a separately excited DC generator.
2. OCC and Load characteristics of a self-excited DC shunt generator.
3. Load characteristics of a DC shunt motor.
4. Load characteristics of a DC series motor.
5. Load characteristics of a DC compound motor.
6. Speed control of DC shunt motor.
7. Swinburne’s test.
8. Hopkinson's test
9. Load test on a 1-phase transformer.
10. OC and SC tests on a 1-phase transformer.
11. Sumpner’s test.
12. Polarity test and 3-phase transformer connections.
13. Speed control of BLDC motors.

Total Hours – 30

OUTCOMES:

At the end of the course, the student will have ability to:

- Plot the OCC and load characteristics of DC generators.
- Conduct load test on various types of DC motors.
- Choose appropriate speed control methodology for DC and BLDC motors.
- Predetermine the efficiency of DC machines by conducting indirect tests.
- Predetermine the efficiency of transformers by conducting indirect tests.
- Identify the polarity of different three phase transformer connections.

SEMESTER IV

ENC2282	**WRITTEN COMMUNICATION**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

OBJECTIVES:

- To help students identify content specific vocabulary and learn its usage.
- To expose them to reading for specific purposes, especially in professional contexts.
- To expose them to the process of different kinds of formal writing.
- To help them learn corporate correspondence for different purposes.
- To train them in preparing effective applications with résumé
- To make them write different types of reports.

MODULE I **4**

Introduction - process of writing – Fundamentals of academicand professional writing –Understanding short, real world notices, messages, etc.

MODULE II **4**

Reading industry related texts (ex. Manufacturing, textile, hospitality sector etc.) for specific information.
Writing Instructions and recommendations

MODULE III **6**

Understanding format and conventions of writing email, memo, fax, agenda and minutes of the meeting.
Writing email, memo, fax, agenda and minutes of the meeting for various purposes (industry specific)

MODULE IV **6**

Viewing letter of application and Résumé, letter calling for an interview, letter of inquiry and Promotional letter
Writing Functional résumé and letter of application using Edmodo,

MODULE V **6**

Viewing a Video and reading a case study (industry specific) – collaborative writing using Edmodo –reading and information transfer
Writing reports- Survey, feasibility and progress – exposure to discipline specific

reports

MODULE VI **4**

Writing Statement of purpose (Higher Education)-- Justifying and writing about one's preparedness for job (Statement of Purpose highlighting strengths and weaknesses) – Peer evaluation skills through Edmodo.

P – 30; Total Hours –30

REFERENCES:

1. Riordan,D (2013). *TechnicalReport Writing Today*. Cengage Learning, 10th edition. USA.
2. Oliu, W. E., Brusaw, C.T., & Alred, G.J.(2012). *Writing that Works: Communicating Effectively on the Job* . Bedford/St. Martin's. Eleventh Edition.
3. Garner, B.A. (2013). *HBR Guide to Better Business Writing (HBR Guide Series)*. Harvard Business Review Press. USA.
4. Sharma, R.C. & Krishna M. (2002). *Business Correspondence and Report Writing*. Tata MacGraw – Hill Publishing Company Limited, New Delhi.
5. Macknish, C. (2010). *Academic and Professional Writing for Teachers*. McGraw-Hill Education. USA.
6. Whitby, Norman (2014). *Business Benchmark: Pre-Intermediate to Intermediate.* Cambridge University Press, UK.

OUTCOMES:

On completion of the course, the students will have the ability to

- Identify content specific vocabulary and also use them in appropriate contexts.
- Demonstrate reading skills with reference to business related texts.
- Draft professional documents by using the three stages of writing.
- Create different types of documents for various corporate correspondences.
- Write effective letter of applications, résumé and statement of purpose.
- Write business related reports efficiently.

EEC2211 **POWER SYSTEM - I**

L	T	P	C
3	1	0	4

OBJECTIVES:

- To provide the students the knowledge and skills to model and analyze the transmission lines in electric power systems.
- To provide fundamental design considerations for insulator strings, cables and overhead lines.
- To make the students understand the different bus-bar arrangements in substations and distribution schemes
- To provide the knowledge and skills to model large-scale power systems.

MODULE I INTRODUCTION AND TRANSMISSION LINE PARAMETERS 12

Structure of electric power system - Generation, transmission and distribution - EHV AC and HVDC transmission – break-even distance.

Transmission line parameters of single and three phase transmission lines with single and double circuits: resistance, inductance and capacitance of solid, stranded and bundled conductors - symmetrical and unsymmetrical spacing – transposition of conductors - self and mutual GMD - skin and proximity effects – communication interference.

MODULE II MODELING AND PERFORMANCE OF TRANSMISSION LINES 12

Classification of lines: short, medium and long lines - equivalent circuits and mathematical models - attenuation constant, phase constant, surge impedance - transmission efficiency and voltage regulation - real and reactive power flow in lines – power angle diagram - surge-impedance loading - shunt and series compensation - Ferranti effect and corona loss.

MODULE III INSULATORS, CABLES AND MECHANICAL DESIGN OF OVERHEAD LINES 11

Insulators: Types - voltage distribution in insulator string - string efficiency - improvement of string efficiency.

Underground cables: Constructional features of LT and HT cables – capacitance-dielectric stress and grading - thermal characteristics.

Mechanical design of overhead lines: Sag in overhead lines - calculation of sag and tension – supports at equal and unequal heights – effects of wind and ice.

MODULE IV SUBSTATION AND DISTRIBUTION SYSTEM 10

Types of substations - bus-bar arrangements - substation bus schemes: single bus scheme, double bus with double breaker, double bus with single breaker, main and transfer bus, ring bus, breaker-and-a-half with two main buses, double bus-bar with bypass isolators - radial and ring-main distributors – interconnectors - AC distribution: AC distributor with concentrated load; three-phase, four-wire distribution system

MODULE V POWER SYSTEM REPRESENTATION 8

Balanced three phase systems and per phase analysis, per phase models of generator, load, transmission line and transformers - equivalent circuit of transformers with off-nominal tap ratio - single line diagram – per unit system - impedance and reactance diagrams.

MODULE VI NETWORK MODELING 7

Network modeling by network matrices - Bus admittance matrix: formation of bus admittance matrix by inspection method (two rule method) - basic graph theory – node incidence matrix – formation of bus admittance matrix by singular transformation.

L – 45; T – 15; Total Hours –60

REFERENCES:

1. Kothari I, D P, "Power System Engineering", Tata Mcgraw Hill, 2nd Edition,2008.
2. S.N. Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall of India Pvt. Ltd, New Delhi, 2002.
3. Luces Fualkenberry, Walter Coffer, 'Electrical Power Distribution and Transmission', Pearson Education, 1996.
4. John J. Grainger and Stevenson Jr. W.D., 'Power System Analysis', McGraw Hill International Edition, 1994.
5. Hadi Saadat, 'Power System Analysis', Tata Mc Graw Hill, 2002.
6. Stagg, G.W. and El-Abiad, A.H., 'Computer Methods in Power System Analysis', McGraw Hill International Book Company.
7. M.A. Pai, 'Computer Methods in Power System Analysis' McGraw Hill Education (India) Pvt. Ltd., 2006.

OUTCOMES:

At the end of the course, the students will be able to

- Calculate the electrical parameters of the single and phase transmission lines with different configurations.
- Model short, medium and long transmission lines and analyze their performance.
- Follow the fundamental design considerations for insulator strings, cables and laying of transmission lines.
- Choose appropriate bus schemes for substations and distribution schemes, based on the requirement.
- Draw and interpret single line diagrams and per unit impedance diagrams of a given power system with all the related equipment.
- Model an electrical power network using bus admittance matrix.

EEC2212	AC MACHINES	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To give exposure to the students about synchronous machines including their constructional details, principle of operation and performance analysis.
- To learn the characteristics of induction machines and relate their use for various applications.
- To enable the students to compute various parameters of AC rotating machines by performing suitable experiments.
- To enable the students to solve analytical problems on AC machines.

MODULE I SYNCHRONOUS GENERATOR 8

Construction – Principle of Operation – EMF equation – Synchronous impedance – Voltage Regulation-Application.

MODULE II PERFORMANCE STUDY OF SYNCHRONOUS GENERATOR 8

Armature Reaction – Parallel operation – Synchronizing current and torque – Effect of change in excitation and mechanical input – Two reaction theory – Slip test.

MODULE III SYNCHRONOUS MOTOR 9

Principle of Operation – Starters – Power developed and torque – Power stages and efficiency – Motor on load with varying excitations and varying loads – V and inverted V curves- Application.

MODULE IV THREE PHASE INDUCTION MOTOR 8

Construction – Types – Principle of operation –Slip-torque characteristics - Various torques - T_{st}, T_{max} etc., – Losses and efficiency –Starters and Speed Control-Application.

MODULE V PREDICTION OF PARAMETERS FOR THREE PHASE INDUCTION MOTOR 8

No load and blocked rotor tests – Equivalent circuit – Circle diagram –
Cogging torque and crawling- induction machines with deep bar and double cage rotors.

MODULE VI SINGLE PHASE INDUCTION MOTOR 5

Constructional details of single phase induction motor - Double revolving field theory and operation - Equivalent circuit - No load and blocked rotor test - Performance analysis - Starting methods of single-phase induction motors.

L – 45; T – 15; Total Hours –60

REFERENCES:

1. Edward Hughes, Electrical Technology, Tata McGraw Hill Publication, 2001.
2. H. Cotton, Electrical Technology, Tata McGraw Hill Publication, 1999.
3. A.E. Fitzgerald et.al. Electrical Machinery, Tata McGraw Hill Publications, 2003.
4. Alexander S. Langsdorf, “Theory of Alternating current Machinery” SecondEdition, TATA McGRAW-HILL, 1983.
5. P.S.Bhimbra, Electrical Machinery, Khanna Publishers, 2014.

OUTCOMES:

At the end of this course, the student will have ability to:

- Identify different types of synchronous and induction machines.
- Explain how synchronous and induction machines works.
- Do basic calculation on synchronous and induction machines.
- Identify areas of application of synchronous and induction machines
- Assess the performance of Induction motor using equivalent circuits.
- Analyze the performance of single phase induction motor.

EEC2213	**POWER ELECTRONICS**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

OBJECTIVES:

- To experimentally reinforce and support the fundamental concepts in Power Electronics.
- To provide an important bridge between theory and application and promoting active design-based learning.
- To expose the students to the digital controller based controlling techniques.
- To introduce the students to state-of-the-art industrial-grade experimentation tools.
- To equip the next generation of power electronics design engineers with the skills to tackle problems make them more adaptable for industry with less effort on job training.

MODULE I PHASE CONTROLLED RECTIFIERS 9

Construction and characteristics of DIAC, SCR - Understanding the specification parameters of SCR and DIAC - Case study: MOC 30XX series optically isolated Thyristor drivers – single phase controlled rectifiers: single pulse, two pulse and semi converters with R and R-L Loads – three phase controlled rectifiers: three pulse and six pulse converters with R and R-L loads -Design of RC Snubber.

MODULE II AC TO AC CONVERTERS 9

Construction and characteristics of TRIAC - Understanding the specification parameters of TRIAC - AC Voltage controllers: SCR based single phase AC phase angle controller with R and RL loads – Integral controller –AC voltage controller for Incandescent Light Dimming and Motor Speed Control - Digital AC Lamp intensity controller with zero crossing detection - Matrix converter.

MODULE III DC-DC CONVERTERS 9

Construction and characteristics of Fast recovery diode, MOSFET and IGBT- Understanding the specification parameters of Fast recovery diode, MOSFET and IGBT- High side and Low side switching- High side, Low side and half bridge gate drivers – optically isolated gate drivers – Basics and generation of PWM - operation of Non-Isolated DC/DC Converters: Buck, Boost and Buck-Boost converters \

MODULE IV INVERTERS 6

Single phase and Three phase (both 120°and 180°Modes) Inverters - Sine-PWM - Space Vector PWM – Multilevel inverters: Capacitor-Clamped Inverter – Cascaded H-Bridge Inverter- Uninterruptible power supplies.

MODULE V SWITCH MODE POWER SUPPLIES 6

operation of Isolated DC/DC Converters: Flyback Converter - Forward Converter - Bridge Converters. Design Specifications - SMPS Transformer Design –Selection of the Semiconductors: Selection of the Output Rectifiers and Power Switch - Design of the SMPS Controller - UC3843current mode PWM controller Implementation.

MODULE VI MODELING AND SIMULATION OF POWER ELECTRONIC CONVERTER USING PSIM 6

Phase controlled Rectifiers – DC-DC converters - closed loop control of Choppers and fly back converters– SPWM inverters.

L – 45; T – 15; Total Hours –60

REFERENCES:

1. Ned Mohan,Undeland and Robbin, "Power Electronics - converters, Application and design”, John Wiley and sons.Inc, New York,1995.
2. Rashid M.H., “Power Electronics Circuits, Devices and Applications ", PrenticeHall India, New Delhi, 1995.
3. Rashid M.H., "Power Electronics Hand Book", Academic Press, USA 2007.
4. Ned Mohan, "Power Electronics: A First Course”, John Wiley and sons.Inc, New York, 2012.
5. P.S.Bimbra, "Power Electronics", Khanna Publishers, 11th Edition, 2003.
6. DC/DC Book of Knowledge Practical tips for the User By Steve Roberts © 2014 All rights RECOM Engineering GmbH & Co KG, Austria.
7. *Marty Brown* Mokorola Semiconductor “Practical Switching Power Supply Design” Academic PressA Harcourl Science and Technology Company525 B Street. Suite IWO. San Diego. California 92101-4495. USA 1990.

OUTCOMES:

At the end of the course, the student is expected to

- Select appropriate power electronics device and control IC for different applications.

- analyze and design controlled rectifiers and AC voltage regulators.
- analyze and design DC- DC converters and inverters.
- use micro controller in power electronic applications.
- design Switch Mode Power Supplies.
- modify and scale the converter design to fit real time applications and simulate power electronic circuits using PSIM software.

EEC2214	**AC MACHINES LAB**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

OBJECTIVES:

- To experimentally verify the performance and characteristics of Alternator, Synchronous motor, 3-phase induction motor.
- To perform tests on the various types of electric motors and generators
- To introduce students to the operating principles, methods of starting and area of applications of synchronous and induction machines.
- To perform speed control in various AC machines.
- To synchronize AC machines and to regulate the voltage.

LIST OF EXPERIMENTS:

1. Regulation of alternators by EMF method.
2. Regulation of alternators by MMF method.
3. Regulation of alternators by Potier Triangle method.
4. Load test on a 3-phase alternator.
5. Regulation of a salient pole alternator by Slip test.
6. Synchronization of alternators
7. V and inverted V curves of a synchronous motor.
8. Load test on a 3-phase squirrel cage induction motor.
9. No load and blocked rotor tests on a 3-phase induction motor to draw the equivalent circuit and circle diagram.
10. Load test on single phase induction motor.
11. Performance study of induction generator.

Total Hours –30

OUTCOMES:

At the end of the course, the student will have the ability to:

- estimate voltage regulation of alternators by EMF, MMF and Potier triangle methods.
- evaluate the performanceof synchronous and induction machines by plotting their characteristic curves.
- analyze the working of any electrical machine under loaded and unloaded conditions.

EEC2215 POWER ELECTRONICS LAB

L	T	P	C
0	0	2	1

OBJECTIVES:

- To acquire knowledge on design and operation of several common circuits relevant to the field of power electronics.
- To provide the students with hands-on experience in design and prototyping the power electronic converters.
- To expose the students to the Micro Controller based controlling techniques.
- To describe the real time implementation of DC-DC converters and Inverters.
- To provide an introduction to the dSPACE Control Desk and MATLAB/Simulink software.

LIST OF EXPERIMENTS:

1. Design and fabrication of Half wave controlled rectifier using RC Firing Circuit.
2. Design and fabrication of SCR and TRIAC gate driving circuits using MOC 30XX series optically isolated Thyristor drivers.
3. Design and fabrication of zero crossing detector circuit for SCR and TRIAC triggering.
4. Design and Implementation of digital control of Half wave controlled rectifier using PIC Microcontroller.
5. Design and Implementation of TRIAC based AC Lamp intensity control and Heat Control Using PIC Microcontroller.
6. Design and fabrication of gate driving stage using half bridge gate driver IC with High speed opto-coupler.
7. Designing and fabrication of gate driving stage using optically isolated gate driver IC.
8. Design and fabrication of Buck Converter.
9. Design and fabrication of Boost Converter.
10. Design and fabrication of Flyback Converter.
11. Design and fabrication of Half bridge Inverter using Half bridge gate driver IC.
12. Design and fabrication of H- Bridge Inverter.
13. ControlDesk and Matlab/Simulink software

Total Hours –30

OUTCOMES:

At the end of the course the student is expected to:

- Design the driving and interfacing stages of switching power converters and inverters.
- Implement and interface digital controller in power electronics circuits.
- Fabricate the different types of converters and inverters.
- Implement fabricated converters and inverters to control the AC and DC Motors.
- Be Proficient in using the dSPACE Control Desk and Matlab /Simulink software.

SEMESTER V

MSC 3181	LEADERSHIP & CEO TRAINING	L	T	P	C
		3	0	0	3

OBJECTIVES:

The course aims at

- Bringing about positive transformation in students' attitude.
- Building unique leadership competencies that would ensure successful transition of students across all career stages.
- Sensitizing students to identify their strengths & weakness and training them to deal with it.
- Assisting students in enhancing their expressive ability and inducing a high level of self-confidence to manage both business and emotions
- Training students to become more adaptable and flexible to changing business environment

MODULE I INTRODUCTION TO LEADERSHIP 12

Leadership concept - meaning, definitions, importance of leadership, leadership traits. Leadership functions- general functions, listening, observing, managing and decision making. Components of leadership - leaders, followers and situation. Leadership theories – Trait theory, Skills theory, Style theory, Situational theory, Transformational theory, Transactional theory, Path Goal Theory and LMX. Assessing emotional intelligence and exploring the capabilities and inherent traitsthrough psychometric tests - Multi factor leadership questionnaire and personal reflections

MODULE II LEADERSHIP STYLE AND COMMUNICATION 8

Leadership styles-visionary, Coaching, Affiliative, Democratic, Pacesetting Commanding, Transformational, Transactional. Autocratic, Participative, Laissez-Faire Leader versus Managers. Leadership communication - Rationale, tactic, assertive, formal, informal, communication in crisis- leadership and negotiations, Leadership Presentations-convincing and impressive style

MODULE III LEADERSHIP ROLES 8

Facets of leadership- Leader as an individual – personality and leadership, values, attitudes and ethics of a leader. Leader as a relationship builder- empowering people to meet higher order needs, initiating organization wide motivational programs, involvement with all stakeholders- focusing on organization growth. Leader as an inspirer- motivation and leadership, recognizing and appreciating contributions, empowering others to lead Leader as an innovator –leader's role in shaping culture and values in an organization. Leader as a Liaison- Leader as team player.

MODULE IV LEADERSHIP CHALLENGES AND STRATEGIES 9

Challenges in leadership: Perception of organization culture and values, interpreting the power dynamics in the organization, establishing work life balance. Bad leadership – Reasons and impact. -Case Study of Marissa Mayer-Yahoo.Inc Organizational transformation through efficient leaders-Case study of Apple Inc. Blue Ocean Leadership-Steps to Blue ocean Leadership-Four Pillars of Blue Ocean leadership-Blue Ocean leadership grid.

MODULE V LEADERSHIP AND CEO TRAINING 8

Leader as a CEO: Traits of a successful CEO, Key responsibilities of a CEO, the path to be a CEO ,Training on Board Room Discussions, Meeting the CEO –Live sessions with industry CEO's. Requirements of Leadership: - Cognitive skills, Interpersonal skills, Business skills, Strategic skills. Role of Emotional Intelligence in taking up key-positions in the organization.

MODULE VI TEACHING PEDAGOGY

Nurturing – Based on the identified strengths and weaknesses, training will be given to enhance the strengths and overcome the weakness.

Assessment - Continuous evaluation will be effected through group discussions, oratory assignments and situational enactments. Pre-and post-training assessment through peer reviews and faculty feedback.

Sustained development – Training will be imparted for self-development and monitoring of leadership skills to ensure sustained applicability of the skills learnt.

Total Hours –45

REFERENCES:

1. Andrew J DuBrin. "Leadership: Research Findings, Practice, and Skills", 8th Edition, South-Western College Pub, 2015.
2. Yukl G , "Leadership in Organisations", 8th Edition, Pearson Education, 2013.
3. Richard L Daft , "Leadership", 5th Edition, South Western Cengage Learning 2012.
4. Stephen P. Robbins and Timothy A. Judge. "Organizational Behaviour",

15th Edition, New Delhi: Pearson, 2013.

5. Fred Luthans, “Organizational Behavior, An Evidence Based Approach”, 12th Edition, New Delhi: McGraw Hill Education, 2013.

6. Emotional Intelligence, Why it can matter no more than IQ by Daniel Goleman (include a book) Publisher: Bloomsbury Publishing India Private Limited; Latest edition (2017)

7. Primal Leadership: Unleashing the Power of Emotional Intelligence by Prof Daniel Goleman , Richard Boyatzis and McKee ,Harvard Business Review Press.

Recommended Readings:

1. Jim Collins, (2001). “Good To Great: Why Some Companies Make the Leap...And Others Don't”, Random House Publishers India Pvt.Ltd, New Delhi.
2. George, B. with Sims, P. True North: Discover Your Authentic Leadership, The Times Group Books; First edition (1 October 2015)
3. Kim, W. C., & Mauborgne, R. A. (2014). Blue ocean strategy, expanded edition: How to create uncontested market space and make the competition irrelevant. Harvard business review Press.
4. Leadership Wisdom by Robin Sharma Jaico Publishing House;

OUTCOMES:

The students will be able to

- Explore through self-introspection one’s own leadership style, their strength and weakness
- Gain self confidence to lead a team in the organization
- Realize the role of leadership in making or breaking of an organization
- Acquire the practice of self introspection and development of leadership competencies thorough continuous efforts
- Manage their own emotions as well as other resulting in successful relationship building with all stakeholders

MSC 3182	SOCIAL ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To be able to understand the field of social entrepreneurship and Social problems
- To be able to describe and understand the traits of social entrepreneurs
- To recognize the social business opportunities
- To synthesize the resource mobilization ways for social entrepreneurship
- To understand the social entrepreneurship models
- To recognize the impact of social entrepreneurship on societies.

MODULE I INTRODUCTION TO SOCIAL ENTREPRENEURSHIP 7

Introduction - Emergence and Development of Social Entrepreneurship. Social Problems in India: An Overview. Social Development: The Indian Scenario. Emergence of Social Entrepreneurs and Sustainable Solutions to Social Problem. Characteristics and Context of Social Entrepreneurship. The Role of Social Entrepreneurship in Societies & Economies.

MODULE II SOCIAL ENTREPRENEURSHIP: DRIVERS AND CHALLENGES 7

The Drivers of Social Entrepreneurship. Elements of the Social Entrepreneurial Personality. Challenges of financial constraints. Challenge to attract and cultivate talented workers. Challenge of evaluation of social entrepreneur impact. Challenge of scaling and its impact. Cases.

MODULE III SOCIAL ENTREPRENEURSHIP: OPPORTUNITY RECOGNITION 7

Opportunity Recognition and Planning Process. Opportunities for Social Entrepreneurs. The Nature of Social Entrepreneurial Opportunities. Social Problems into Opportunities. Idea development and conceptualization of social problem. Cases

MODULE IV RESOURCE MOBILIZATION FOR SOCIAL VENTURE 8

Resources at Initial Stage. Social Network as a role of Social Capital. Team and Collective Efforts. Need and Determination of Important Resources. Resource of Knowledge, Skills and Abilities. overview of venture capital and angel investment.

Cases

MODULE V BUSINESS MODELS AND BUSINESS PLAN FOR SOCIAL ENTERPRISES 8

Design Principles of Social Entrepreneurship Business Models, Evaluation of the Root Cause of a Societal Problem. Developing business plan for social ventures. Developing an investor presentation. Feasibility study and report. How to start a business - Procedures for registration of small scale industry

MODULE VI THE IMPACT OF SOCIAL ENTREPRENEURSHIP ON SOCIETIES AND CASES 8

Static Impact of Social Entrepreneurship. Impact of Charitable NGOs vs. Social Entrepreneurship, Impact of For-Profit Companies vs. Social Entrepreneurship. Social entrepreneurship report preparation by students.
Case Study of Social Entrepreneurs

Total Hours –45

REFERENCES:

1. “Social Entrepreneurship : New models of sustainable social change” . Alex Nicholls, Oxford University Press 2006
2. The Process of social value creation : A multiple case study on Social Entrepreneurship in India , Archana Singh Springer 2016
3. “Social Entrepreneurship and social business” Christine K Volkmann, Springer Gabler 2012
4. “Social Entrepreneurship” Manuel London ,Routlege, 2010.

OUTCOMES:

The students can be able to

- Conceptualize social entrepreneurship in terms of a theoretical frameworkbetween changing social values and institutions
- Think and communicate about social values
- Learn about practical models of social change to launch, lead, manage, and evaluate a social venture
- Analyze funding needs and sources for the social venture
- Experience the ideas can be critically and collaboratively examined prior to commitment.

ENC 3181	COMMUNICATION AND SOFT SKILLS - I CAREER CHOICE	L	T	P	C
		0	0	2	1

OBJECTIVES:

- To create awareness of industrial trends and market demands.
- To encourage students to explore career opportunities in an industry and evaluate themselves in relation to industry preparedness

MODULE I 6

Knowledge about specific industry-Discussion with industry experts --Self evaluating career prospects through survey questionnaire (based on his/her eligibility for taking up a job (industry preparedness)

MODULE II 6

. Knowing case studies of industries(pertaining to students' choice of career)- Reading and discussing about job markets-goal setting, working on creativity.

MODULE III 4

SWOC analysis and discussing outcomes--exploring mini projects or case studies of latest industries.

MODULE IV 6

Writing statement of purpose pertaining to career choice---- Outcomes

MODULE V 8

Project or case study presentations (Presentation in pairs) -mini project report or case study report.

Total Hours – 30

REFERENCES:

1. Brown,D.(2002). Career Choice and Development. Wiley,J. & Sons.USA
2. Lore,N.(1998). The Pathfinder: How to Choose or Change Your Career for a Lifetime of Satisfaction and Success. Simon & Schuster.USA.
3. Shell, G.R.(2013). Springboard Launching your Personal Search for Success.Portfolio.USA.

OUTCOMES:

After the completion of the course, students would be able to

- Speak about their career choice.
- Self evaluate their strengths and weaknesses and speak about it.
- Make effective presentations on case studies or relating to projects.
- Write the statement of purpose relating to their career choice.

EEC3101	**POWER SYSTEM - II**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

OBJECTIVES:

- To provide the student the computational skills required to model and analyze large-scale power systems under normal and abnormal operating conditions.
- To make the students understand the usage of efficient numerical techniques suitable for computer application which are required for planning and operation of power systems.
- To provide the fundamentals of power system control and economic operation.

MODULE I POWER FLOW ANALYSIS 11

Introduction to power system analysis: power flow, fault and stability analyses.

Power flow analysis: Problem definition - bus classification - derivation of power flow equation in rectangular and polar forms - review of Gauss-Siedel and Newton-Raphson methods for solution of non-linear algebraic equations.

Power flow solution by Gauss-Siedel, Newton-Raphson, Decoupled and FDPF methods - computation of slack bus power, transmission loss and line flows – development of power flow diagrams.

MODULE II SYMMETRICAL FAULT ANALYSIS 10

Need for short circuit study - symmetrical short circuit analysis by internal emf and Thevenin's equivalent circuit methods - short circuit current and MVA calculation - Thevenin's impedance and bus impedance matrix - bus impedance matrix building algorithm (without mutual impedance) - symmetrical short circuit analysis by bus impedance matrix - selection of circuit breakers.

MODULE III SYMMETRICAL COMPONENTS AND UNSYMMETRICAL FAULT ANALYSIS 10

Symmetrical components - sequence impedances of synchronous machines, transformers, transmission lines and loads - formation of sequence networks for unsymmetrical fault analysis.Unsymmetrical fault analysis: LG, LL and LLG faults with and without fault impedance - effect of ground impedance.

MODULE IV STABILITY ANALYSIS 10

Basic concepts of steady state, transient and dynamic stabilities - swing equation for

SMIB system - power angle equation and curve- steady state stability limit - transient stability: equal area criterion, critical clearing time and angle - numerical solution of swing equation by modified Euler method - methods to improve steady state and transient stabilities.

MODULE V POWER SYSTEM OPERATION AND CONTROL 12

Types of load – load characteristics – load curves and load duration curves – generation reserves - Energy control center: functions – monitoring, data acquisition and control system hardware configuration – SCADA and EMS functions – power system security – various operation states.

Real power control: Fundamentals of speed governing mechanism and its modeling – speed load characteristics – load sharing between two synchronous generators in parallel – need for frequency control - automatic generation control - concept of control area – load frequency control in single and two area systems - modeling and static analysis.

Introduction to reactive power control: Generation and absorption of reactive power – role of excitation systems and AVR.

MODULE VI ECONOMIC OPERATION OF POWER SYSTEMS 7

Economic dispatch: concept of incremental cost - incremental cost curves - classical economic dispatch without and with losses - loss coefficients.

Unit commitment: need, constraints, solution methods – unit commitment by priority listingscheme.

L – 45; T – 15; Total Hours –60

REFERENCES:

1. John J. Grainger and Stevenson Jr. W.D., 'Power System Analysis', McGraw Hill International Edition, 1994.
2. Hadi Saadat, 'Power System Analysis', Tata Mc Graw Hill, 2002.
3. Stagg, G.W. and El-Abiad, A.H., 'Computer Methods in Power System Analysis', McGraw Hill International Book Company.
4. M.A. Pai, ‘Computer Methods in Power System Analysis’ McGraw Hill Education (India) Pvt. Ltd., 2006.
5. Olle I. Elgerd, 'Electric Energy and System Theory - An Introduction', Tata McGraw Hill Publishing Company, New Delhi. 1983.
6.. Kirchmayer .L.K. 'Economic Operation of Power System', John wiley & Sons, 1953.
7. Allen J.Wood, Bruce F.Wollenberg, 'Power Generation Operation and Control',

John Wiley and Sons, 1984.
8. Kothari, D.P and Nagrath, I.J., 'Modern Power System Analysis', Third Edition, Tata McGraw Hill Education, New Delhi, 2003.
9. Kundur, 'Power System Stability and Control', McGraw-Hill Pub. Co., 1994.

OUTCOMES:

The students will be able to

- Write a program to perform load flow analysis using Gauss Seidel / Newton Raphson method for simple systems.
- Perform symmetrical fault analysis in power systems.
- Transform unbalanced power systems into a set of balanced systems using symmetrical component transformation for unsymmetrical fault analysis.
- Analyze the given power system for small signal / transient stability and compute critical clearing angle and critical clearing time for simple systems using equal area criterion.
- Perform load frequency control in single and two area systems with the understanding of basic concepts in power system operation.
- Prepare generation schedules considering economic operation of power systems.

EEC3102 MEASUREMENTS AND INSTRUMENTATION

L	T	P	C
3	0	0	3

OBJECTIVES:

To impart Knowledge on -

1. Various instrument systems and their errors in them.
2. Various signal conditioning circuits.
3. Principle of various active and passive transducers.
4. Various storage and display devices.
5. Instruments for measuring the various electrical quantities.
6. Working principles of biomedical instruments that are actually in use at the present day.

MODULE I INTRODUCTION 7

Functional elements of an Instrument - Static and Dynamic characteristics - Errors in measurement - statistical evaluation of measurement of data - Standards and Calibration.

MODULE II TRANSDUCERS 9

Classification of transducers - selection of transducer - resistive, capacitive and inductive transducer - Piezo- electric transducer - optical and digital transducers. Transducers for measurement of displacement,temperature,level, pressure, velocity and acceleration.

MODULE III SIGNAL CONDITIONING CIRCUITS AND DISPLAYS 9

Bridge Circuits - differential and Instrumentation amplifier -filter circuits- V/f and f/V converters - multiplexing and demultiplexing - data acquisition systems - digital CRO.

MODULE IV ELECTRICAL INSTRUMENTS 6

Principle and types of analog and digital ammeters and voltmeters – Single and three phase watt meters and energy meter –magnetic measurements –

MODULE V BIOMEDICAL INSTRUMENTS 6

Introduction to biomedical instruments - Blood pressure measurement methods - Blood flow measurement methods - CT scanner - MRI scanner.

MODULE VI ASSISTING AND THERAPEUTIC EQUIPMENTS 8

Pacemakers - Defibrillators - Ventilators - Nerve and muscle stimulators - Diathermy - Audio meters - Dialyzers (Haemodialysis Machine)

Total Hours –45

REFERENCES:

1. Doebelin E.O., "Measurement Systems - Application and Design", McGraw Hill Publishing Company, 1990.

2. Murthy, D.V.S., "Transducer and Instrumentation", Prentice Hall of India Pvt. Ltd., 1995.

3. Stout ,M.B., "Basic Electrical Measurement", Prentice Hall of India

4 Morris, A.S ,"Principle of Measurement and Instrumentation", Prentice Hall of India, 1999.

5 Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, 'Bio-Medical Instrumentation and Measurements', II Edition, Pearson Education, 2002 / PHI.

6 R.S.Khandpur, 'Handbook of Bio-Medical instrumentation', Tata McGraw Hill Publishing Co Ltd., 2003.

7 M.Arumugam, 'Bio-Medical Instrumentation', Anuradha Agencies, 2003.

OUTCOMES:

At the end of the course, the student is expected to

1. understand the functional blocks of various Instruments and their standards.
2. Study and select transducers based on their working principle.
3. Understand the working of signal conditioning circuits.
4. Understand the working principles of electrical instruments.
5. Understand the working of Biomedical instruments
6. Understand the working of therapeuticequipment.

EEC3103	**DIGITAL SYSTEMS & INTEGRATED CIRCUITS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To introduce basic postulates of Boolean algebra, the methods for simplifying Boolean expressions and shows the correlation between Boolean expressions
- To outline the formal procedures for the analysis and design of combinational circuits and sequential circuits.

MODULE I Number Systems and Boolean Algebra 8

Review of binary, octal and hexadecimal number systems - conversion methods- number representations - signed, unsigned, fixed point, floating point numbers – Binary code BCD, Gray code - error detection and correction codes - parity codes- Boolean algebra – basic postulates, theorems – canonical forms-Simplification of Boolean function using Karnaugh map and Quine-McClusky method – Implementations of logic functions using gates, NAND –NOR implementations –Multi level gate implementations- Multi output gate implementations.

MODULE II Combinational Logic Design 8

Design Procedure**-** Implementation of combinational logic functions –Half adder, full adder– Half subtraction – full subtract or – parallel adder, Carry look ahead adder – binary adder – Magnitude comparator – encoder and decoders – multiplexers – code converters – parity generator/checker- implementation of combinational circuits using de-multiplexers.

MODULE III Analysis of Sequential Circuits 8

General model of sequential circuits- flip-flops- latches – level triggering, edge triggering- master slave configuration - concept of state – state diagram - state table, state reduction procedures -Design of synchronous sequential circuits -up/down, modulus counters - shift registers - Ring counter - Johnson counter - timing diagram – serial adder - parity checker - sequence detector.

MODULE IV Monolithic IC Processes and fabrication 7

Basic planar processes-fabrication of a typical circuit, Refining and growth of Si ystals, Si wafer preparation, Diffusion of dopant impurities, Ion implantation, thermal oxidation, photo lithography, fine line lithography, relative plasma etching, chemical vapor deposition, metallization.

MODULE V VHDL MODELING AND DESIGN FLOW 7

Introduction to VLSI - Basics of Verilog, operators, hierarchy procedures and assignments, timing controls and delays, tasks and functions, control statements. VHDL: Syntax and semantics, identifiers, and literals, entities and architectures, packages and libraries interface, type and other declarations, sequential statements, operators, arithmetic operators, VHDL and logic synthesis, Verilog and logic synthesis – Sequential, Data flow, and Structural Modeling – Functions, Procedures and attributes - Test benches, Synthesizable, and non synthesizable statements - packages and configurations - Modeling in VHDL with examples of circuits such as counters, shift registers, bidirectional bus.

MODULE VI PROGRAMMABLE LOGIC DEVICES & SEQUENTIAL LOGIC PRINCIPLES 7

Introduction to the CPLDs - Study of architecture of CPLD and Study of the Architecture of FPGA. Sequential Circuits – Meta-stability Synchronization – Design of Finite State. Machines and State minimization - FSM CASE STUDIES - Traffic Light control - Lift Control and UART STA and DTA.

Total Hours –45

REFERENCES:

1. M. Morris Mano ,Michael D. Ciletti “Digital Design With an Introduction to the Verilog HDL”,5th Edition, Pearson Education, 2013.
2. William Stallings, "Computer Organization and Architecture", 8th Edition, Pearson Education Asia, 2010.
3. Charles H. Roth, "Fundamentals of Logic Design", 7th Edition, Global Engineering: Tim Anderson, 2014.
4. Donald P. Leach and Albert Paul Malvino, "Digital Principles and Applications", 6th Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2009.
5. R.P. Jain, "Modern Digital Electronics", Tata McGraw Hill, 4th Edition. New Delhi, 2010. 4. Thomas L. Floyd, "Digital Fundamentals", 10th Edition Pearson Education, Inc, New Delhi, 2008
6. Donald D. Givone, "Digital Principles and Design", Tata McGraw Hill Publishing company limited, New Delhi, 2003.

OUTCOMES:

Students will be able to :

- Apply the concepts and techniques associated with the number systems and codes and to minimize the logical expressions using Boolean postulates.

- To design various combinational and sequential circuits.
- An in-depth understanding of fundamentals of Op-amps and its application circuits.
- Develop design skills to design various circuits using different data conversion systems using op-amps
- Knowledge regarding the various signal generator circuits and the power amplifiers using op-amp

EEC3104	**POWER SYSTEM SIMULATION LAB**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

OBJECTIVES:

To develop simple C programs for the following basic requirements and to acquire experience in the usage of standard packages for the following analysis / simulation / control functions.

a) Formation of bus admittance and impedance matrices and network solution.

b) Power flow solution of small systems using simple method, Gauss-Seidel P.F.method.

c) Unit Commitment and Economic Dispatch.

d) Steady-state analysis of large system using NRPF and FDPF methods.

e) Quasi steady-state (Fault) analysis for balanced and unbalanced faults.

f) Transient stability simulation of multimachine power system.

g) Simulation of Load-Frequency Dynamics and control of power system.

LIST OF EXPERIMENTS:

1. Computation of Parameters and Modeling of Transmission Lines
2. Formation of Network Matrices and Solution of Networks.
3. Power Flow Analysis I: Solution of Power Flow using Gauss-Seidel Method.
4. Power Flow Analysis II: Solution of Power Flow using Newton-Raphson and Fast-Decoupled Methods.
5. Short Circuit Analysis.
6. Transient and Small Signal Stability Analysis: Single-Machine Infinite Bus System.
7. Transient Stability Analysis of Multi machine Power Systems.
8. Electromagnetic Transients in Power Systems.
9. Load - Frequency Dynamics of Single and Two-Area Power Systems.
10. Unit Commitment and Economic Dispatch in Power Systems.

TOTAL HOURS: 30

OUTCOMES:

At the end of the course, the student will be able to

- Determine the performance characteristics of a long transmission line and its reactive power requirement.
- Perform load flow studies using Gauss Seidal, Newton Raphson and fast

decoupled method.

- Perform contingency analysis and selection methods to improve system security.
- Solve various faults on power system elements using fault analysis techniques.
- Perform transient and small signal stability study.
- Perform load frequency dynamics of single area and two area power systems.
- Implement optimal scheduling using economic dispatch programme.

EEC3105	MEASUREMENTS AND INSTRUMENTATION LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES:

• To select appropriate instruments for the measurement of various process parameters.

• To calibrate various instruments.

LIST OF EXPERIMENTS

1. Study of Displacement and pressure transducers.
2. Design of AC Bridges (Schering and Maxwell).
3. Design of DC Bridges (Wheatstone and Kelvin).
4. Design of Instrumentation Amplifiers.
5. Study of A/ D and D/A converters.
6. Study of Transients.
7. Calibration of Single Phase Energy meter.
8. Calibration of Current Transformer.
9. Measurement of three phase Reactive Power and Power factor.
10. Measurement of Iron Loss.

TOTAL HOURS: 30

OUTCOMES:

To enable the student to

1. Study the various types of transducers and their characteristics
2. Design Instrumentation amplifiers.
3. Calibrate the various instruments
4. Measure the electrical quantities like power and power factor
5. Design Inductive and capacitive bridge circuits.
6. Measure the iron loss in a specimen.

EEC3106	**DIGITAL SYSTEMS & INTEGRATED CIRCUITS LAB**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

OBJECTIVES:

- To provide hands-on experience on design, testing, and analysis of various digital circuits.
- To provide hands-on experience on design, testing, and analysis of Op Amp Circuits

LIST OF EXPERIMENTS:

1. Design and implementation of combinational circuits using basic gates and universal gates for arbitrary functions.
2. Design and implementation of multiplexers and Demultiplexers.
3. Design and implementation of Code converters
4. Design and implementation of encoder and decoder
5. Design and implementation of synchronous counters and Asynchronous Counters.
6. Study of ADCs and DACs: Verification of A/D conversion using dedicated ICs.
7. Astable and Monostable Multivibrators and Schmitt Trigger using 555 timers.
8. Memory chips

a. Simple exercises like READ and WRITE involving memory chips

b. Expansion of Memory Size

9. Simulation and verification of Combinational Circuits using verilog HDL

- Simple Gates
- Simple Boolean Expressions
- Adder and subtractor
- Parallel Adder design

10. Simulation and verification of sequential Circuits using verilog HDL

- Flip-flops
- Registers
- Counters

11. Design of traffic light controller using VHDL

TOTAL HOURS: 30

OUTCOMES:

At the end of the course, the student is expected to

• Be trained to design and implement combinational and sequential digital circuits.

• Have skills to design and implement various signal generation circuits

SEMESTER VI

ENC 3281	COMMUNICATION AND SOFT SKILLS - II CONFIDENCE BUILDING	L	T	P	C
		0	0	2	1

OBJECTIVES:

- To develop professional skills like work ethics, analytical skills, presentation skills etc.
- To train them in problem solving skills and leadership skills pertaining to industries.
- To train them in team building skills.
- To train in setting up career goals

MODULE I **6**

Brief about Multinational companies- Analysing work ethics of multinational companies and small industries- discussing as pairs-Knowledge about etiquette (different types)

MODULE II **6**

Visit to an Industry and prepare reports --Critically reading of industry specific journal articles and write ups-- preparing reports.

MODULE III **4**

Analysing problem solving situations in industries (relating to application of core subject to specific jobs) and discussing about them- working on a sample case

MODULE IV **6**

Developing Leadership in team projects-- debating about various aspects of leadership: for example, responsibility and reliability-time management

MODULE V **8**

Team building skills-- group discussions pertaining to industries-- presenting career goals. --preparing for interviews- interpersonal skills

Total Hours – 30

REFERENCES:

1. Covey,S.R. (2004). The 7Habits of Highly Effective People: Powerful Lessons in Personal Change. Free Press.UK
2. Fine, P.M.& Alice Olins. (2016).Step up: Confidence, Success and Your Stellar Career in 10 Minutes a Day. Vermilion.UK
3. Pai, A. (1993).How to Develop Self-Confidence. Amazon.com
4. Wentz,F.H.(2012). Soft skills training: A Workbook to Develop Skills for Employment. Amazon.com

OUTCOMES:

After completing the course students would be able to

- Exhibit critical reading skills through review of industry specific articles.
- Provide solutions to problem based situations.
- Exhibit leadership qualities by debating over industry specific issues.
- Participate in group discussions confidently.
- Present their career goals.

EEC3211	EMBEDDED SYSTEMS	L	T	P	C
		3	1	0	4

OBJECTIVES:

To impart Knowledge on -

- Hardware architecture of 8085 processors.
- Concept of addressing modes, need and use of interrupts.
- Simple machine language programming using 8085.
- Different peripherals and their interfacing concepts with microcontroller
- positively and appropriately apply knowledge in doing open ended project

MODULE I INTRODUCTION TO 8085 PROCESSOR 9

Overview of 8085 microprocessor – The salient features of 8085- 8085 Architecture - Functional Block Diagram - Memory - Interrupts - Serial communication – DMA – Registers -Instruction Set -Addressing mode - Assembly language : Simple examples

.

MODULE II INTRODUCTION TO EMBEDDED SYSTEMS 8

Components of Embedded systems - Evolution in Microcontroller technology - Introduction to PIC family - Features of PIC16F877A - PIC Families - Harvard Architecture vs Von Neoman - PIC16F877A Architecture - Pin description and Oscillator Types - System Reset.

I/O PORTS AND REGISTERS OF PIC16F877A

Memory Organization - Input/output - Ports - Registers - Status Register - Option Register - Memory Organization - Port I/O configuration - Introduction to Software Tools - MikroC and Pickit2 programmer. Simple programmes in MikroC: Digital input/output and Delay loop Applications – Push Button interfacing, Flasher and Counter.

MODULE III INTERRUPTS AND ON-CHIP ANALOG TO DIGITAL CONVERTOR 8

Interrupts in PIC 16F877A - INTCON Register - Option Register - Interrupt Sources - PIE and PIR registers - Enabling Interrupts - Peripheral Interrupts - Interrupt Service Routine (ISR). - On-Chip Analog-to-Digital Converter (ADC) block diagram - PIC16F877A ADC pins - ADC Configuration- ADC PORT configuration - ADC Channel Selection – ADC voltage reference selection - Resolution - ADC conversion clock source - Interrupt control - ADC result format - ADC Registers: ADCON0 and ADCON1 - Sample Interrupt Codes in MikroC.

MODULE IV TIMER MODULES IN PIC 16F877A 9

TIMER0 module Block Diagram - Timer Calculation and TMR0 Register – Configuring the TIMER0 module using the INTCON and OPTION registers – TIMER1 module Block Diagram - Timer Calculation and TMR1H:TMR1L Register - Register Configuring the TIMER1using T1CON, PIR1 and PIE1control registers – TIMER2 module Block Diagram - Timer Calculation and TMR2 Register - Register Configuring the TIMER2 using T2CON, PIR1 and PIE1control registers - sample codes to generate time delay.

MODULE V CAPTURE/COMPARE/PWM MODULES 8

CAPTURE and COMARE modes operation block diagram - CCP1CON/CCP2CON Registers - TIMER1 mode selection - software interrupt - CCP prescaler - PWM mode- simplified PWM block diagram- PWM period - PWM duty cycle - setup for PWM operation – Generation of PWM in mikroC using the CCP module.

MODULE VI PIC 16F877A SERIAL COMMUNICATION MODULES 10

Master SSP (MSSP) Module – Control registers - SPI Mode – Master/Slave mode - Inter-Integrated Circuit (I^2C) Mode - Universal Synchronous Asynchronous Receiver Transmitter (USART) module- Master/Slave mode – Sample MikroC source codes: PIC to PIC Communication.

L – 45; T – 15; Total Hours –60

REFERENCES:

1. Douglas V.Hall, Microprocessor and Interfacing, Programming and Hardware.
2. Revised second Edition, Indian edition 2007. Tata McGraw Hill
3. Krishna Kant, " Microprocessor and Microcontroller Architecture, programming
4. and system design using 8085, 8086, 8051 and 8096, PHI, 2007
5. John Main, “PIC Microcontroller C”, 2006-2007 Edition, 2007.
6. Mikro C- Compiler for PIC Microchip controllers- mikro Electronik, 2012.
7. Martin P. Bates,” Programming 8-bit PIC Microcontrollers in C: With Interactive Hardware Simulation.
8. Martin P. Bates,” PIC Microcontrollers –An Introduction” Newnes,2011.
9. Han-Way Huang, Leo Chartrand, "PIC Microcontroller: An Introduction to Software & Hardware Interfacing", Delmar Cengage Learning, 2004.
10. Ramesh Gaonkar, "Fundamentals of Microcontrollers and Applications.

OUTCOMES:

At the end of the course, the student is expected to possess knowledge and achieve skills on the following:

- Internal organization of some popular microprocessors/microcontrollers.
- Hardware and software interaction and integration.
- Design of microprocessors/microcontrollers-based systems.
- Interface PIC microcontroller with hardware for given application.
- Develop small microcontroller based applications.
- analyze a problem and formulate appropriate computing solution for microcontroller based applications.

EEC 3212	CONTROL SYSTEMS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To analyze the system modeling and various methods of representation.
- To provide adequate knowledge on time response analysis of systems and steady state error calculations.
- To educate the necessity for frequency domain analysis using numerous plots.
- To provide knowledge on the design procedure of compensators and its applications.
- To provide knowledge on state space approach, state of systems, controllers and observers for different processes.
- To enhance knowledge on stability analysis of multivariable processes.

MODULE I SYSTEM REPRESENTATION AND ANALYSIS 8

Open loop and closed loop control systems – Transfer Function – Mechanical, Electrical and Electromechanical Systems – Block diagram representation – Block diagram reduction – Signal flow graphs – Mason’s Gain formula – Characteristics Equation.

MODULE II TIME DOMAIN ANALYSIS 8

Transient and Steady State response – Test Signals – Time domain specifications – First and Second order system, Steady state error and error constants – P, PI, PID modes of feedback control – Tuning of PID Controller using MATLAB.

MODULE III FREQUENCY DOMAIN ANALYSIS 8

Frequency domain specifications – Relation between time and frequency domain parameters – Analysis based on bode plot and polar plot – Gain and phase margin – Nichols chart.

MODULE IV COMPENSATOR DESIGN 7

Compensator design using bode plots: Lag, Lead, Lead-Lag Compensator. Realization of Lag, lead and Lead-Lag networks.

MODULE V MODELING IN STATE SPACE 7

Introduction to State Space Approach – System representation in state variable form –Controllability and Observability–System analysis using state space approach in

MATLAB.

MODULE VI SYSTEM STABILITY 7

Stability analysis by locating roots in s plane – Routh Hurwitz criterion– Root locus construction and performance analysis – Stability analysis in frequency domain – Nyquist stability criterion- Case Study- Modelling and parameter analysis of a closed loop control system.

L – 45; T – 15; Total Hours –60

REFERENCES:

1. K. Ogata, 'Modern Control Engineering', 4th edition, Pearson Education, New Delhi, 2003.
2. I.J. Nagrath& M. Gopal, 'Control Systems Engineering', New Age InternationalPublishers, 2003.
3. Benjamin C Kuo, "Control Systems", Tata McGraw Hill, 2002
4. C.J.Chesmond.'Basic Control System Technology', Viva low priced student edition, 1998.
5. John S. Bay, "Fundamentals of Linear State Space Systems", McGraw-Hill 1999.
6. R.C.Dorf and R.H.Bishop, 'Modern Control Systems', Addison-Wesley, 1995 (MATLAB Reference).

OUTCOMES:

At the end of the course, the student will have knowledge and achieve skills on the following:

- Ability to analyze complex systems using mathematical models.
- Get the time response of first and second order systems analytically and interpret the response.
- Perform frequency response analysis of physical systems and interpret the response.
- Design appropriate compensator for the given system to meet the desired specifications
- Perform stability analyses of the system using conventional mathematical approach.
- Implement state space approach for the process and obtain the solution.

EEC3213 **EMBEDDED SYSTEMS LAB**

L	T	P	C
0	0	2	1

OBJECTIVES:

• Simple Assembly Language programming using 8086 and 8051 Instruction set.
• Framing and implementing of algorithms.
• Subroutines, nesting and interrupts need and usage.

LIST OF EXPERIMENTS

1. Programs on arithmetic operations: addition / division using 8085
2. Programs on logical operations: Largest / Descending using 8085
3. Introduction to Software Tools MikroC, PicKit2 programmer
4. Blinking LED and Square wave generation using PIC Microcontroller – MikroC
5. Using Push Button Switch with PIC Microcontroller
6. Interfacing Relay with PIC Microcontroller
7. Using Interrupt with PIC Microcontroller
8. Analog to Digital Conversion using in-built ADC Module
9. Interfacing DC Motor with PIC Microcontroller using L293D
10. Interfacing Matrix Keypad with PIC Microcontroller
11. Using Internal EEPROM of PIC Microcontroller
12. Interfacing Stepper Motor with PIC Microcontroller
13. Interfacing Real Time Clock (RTC) DS1307 with PIC Microcontroller
14. Using Analog Comparator in PIC Microcontroller
15. Generating PWM with PIC Microcontroller using CCP Module
16. PIC to PIC Communication using UART

TOTAL HOURS: 30

OUTCOMES:

At the end of the course the student is expected to possess knowledge and achieve skills on the following.

• Usage of arithmetic, logical branching and control instructions.
• Interfacing of peripheral devices and waveform generation.
• Design and implementation of simple projects using peripheral devices and processors and controllers.

EEC3214 CONTROL SYSTEMS LAB

L	T	P	C
0	0	2	1

OBJECTIVES:

- To provide a platform for understanding the basic concepts of linear control theory and its application to practical systems.

LIST OF EXPERIMENTS

1. Transfer function of separately excited DC Generator and determine the stability pole-zero map.
2. Transfer function of Armature controlled and field controlled DC Motor and dete the stability using pole-zero map.
3. State space model of a DC Servomotor.
4. State space model of an AC Servomotor.
5. Digital simulation of an Automatic cruise control to maintain a constant vehicle s despite external disturbances.
6. Time response analysis of a Type-1 system with the standard test inputs.
7. Stability analysis of a DC Motor speed control using Bode plot.
8. Stability analysis of a DC Motor position control using Root locus/Nyquist plot.
9. Lag, Lead and Lag-Lead compensator design.
10. Design of P, PI and PID controller for a second order system.
11. Study of synchro for angle detection in Radar.
12. Study of application of stepper motor in Robotics.

TOTAL HOURS: 30

OUTCOMES:

At the end of the course, the student will have knowledge and achieve skills on the following:

- Ability to determine the transfer function of D.C generator, D.C motor, D.C and A.C servomotors.
- Ability to simulate the response of I and II order systems using MATLAB.
- Capable to analyze the output of systems with different TYPES and Order.
- Capable to analyze the stability of different systems using Bode, Root locus, Nyquist plot etc
- Able to design lag, lead and lag-lead compensators.
- Capable to predict the performance of synchro, stepper motor etc.

SEMESTER VII

EEC4101	POWER SYSTEM PROTECTION AND SWITCHGEAR	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce students to power system protection and switchgear
- To discuss the causes of abnormal operating conditions (faults, lightning and switching surges) of the apparatus and system.
- To understand the characteristics and functions of relays and protection schemes.
- To understand the problems associated with circuit interruption by a circuit breaker.
- Ability to discuss understand and Re-striking.
- To develop an ability and skill to design the feasible protection systems needed for each main part of a power system in students.

MODULE I INTRODUCTION 6

Importance of Protective schemes for electrical apparatus and power system-Qualitative review of faults and fault currents – Methods of Neutral grounding - essential qualities of protection- CTs and PTs and their applications in protective schemes.

MODULE II PROTECTION AGAINST OVER VOLTAGES AND NEUTRALGROUNDING 7

Generation of Over Voltages in Power Systems - Protection against Lightning Over Voltages –Shielding – Nonmetallic shielding methods - Valve type and Zinc-Oxide Lighting Arresters – Impulse Ratio -Standard Impulse Test Wave - Volt-Time Characteristics - BIL - Insulation Coordination.

MODULE III OPERATING PRINCIPLES AND RELAY CHARACTERISTICS 8

Relay terminologies- definitions- Electromagnetic relays – over current, directional and non-directional, distance, negative sequence, differential and under frequency relays –relay co-ordination- Introduction to static relays.

MODULE IV APPARATUS PROTECTION 8

Main considerations in apparatus protection – transformer, generator and motor protection – protection of bus bars. Transmission line protection – zones of protection.

MODULE V THEORY OF CIRCUIT INTERRUPTION 8

Physics of arc phenomena and arc interruption – DC and AC circuit breaking– restriking voltage and recovery voltage – rate of rise of recovery voltage – resistance switching – current chopping – interruption of capacitive current.

MODULE VI CIRCUIT BREAKERS 8

Types of circuit breakers – air blast, air break, oil, SF6 and vacuum circuit breakers – comparative merits of different circuit breakers – testing of circuit breakers.

TOTAL HOURS – 45

REFERENCES:

1. Ravinranath.B and Chander.N, "PowerSystem Protection and Switchgear", New Age International (P) Publishers,1977 (2005 Reprint).
2. Chakrabarti.A.Soni.M.L Gupta, P.V. "A Text book on Power System Engineering", Dhanpat Co. Pvt. Ltd., 2008.
3. C.L.Wadhwa; "Electrical Power Systems", New Age International Pvt. Ltd., 2006.
4. Patra S.Basu S.K & Choudary.S, "Power System Protection", Oxford and IBH Publishing Co. Ltd.,1983.
5. Sunil S.Rao, "Switch Gear and Protection", Khanna Publishers, New Delhi, 1986.

OUTCOMES:

At the end of the course, the student is expected to

- gain knowledge on different Protective Equipment or Power Systems
- Know about various protective systems- how it works and where it works
- apply Oil Circuit Breaker, Air Blast circuit Breakers, SF6 Circuit Breaker in the appropriate places.
- identify Rotor, Stator Faults, inter turn faults and their protection.
- Analyze the fault level and accordingly design the protective devices in a power system for power frequency voltages and currents.
- Ability to design insulation co – ordination between protected equipment and protective devices so that major equipment are protected against surges.

EEC4102 DESIGN OF ELECTRICAL APPARATUS

L	T	P	C
3	1	0	4

OBJECTIVES:

- To know about the various types of materials used for designing an electrical apparatus
- To get knowledge about the magnetic equivalent circuit of electrical apparatus
- To understand and design the basic principles of DC and AC machine
- To know about the design of stator and rotor of induction machines.
- To understand the heating cooling system design of electrical apparatus
- To simulate and model BLDC motor

MODULE I INTRODUCTION AND MAGNETIC CIRCUITS 8

Major design considerations – Classification of Electrical Engineering materials – Calculation of total MMF – carter's co - efficient and gap contraction factor – Real and apparent flux density – problems – magnetic leakage calculation for parallel sided slot, tapered slot and circular slot.

MODULE II MAIN DIMENSIONS OF DC MACHINE 8

Introduction – Output equation – main dimensions – Design of armature – magnetic circuit calculations.

MODULE III FIELD AND COMMUTATOR DESIGN 6

Design : field – interpoles – commutator & brushes – efficiency.

MODULE IV TRANSFORMERS 7

Introduction- Power transformer and distribution transformer- Core, winding, tank, tapping, oil, relay– construction and design of single phase and three phase transformers – resistance and reactance from design data – cooling tank design.

MODULE V INDUCTION MOTORS 8

Introduction – Output equation – main dimensions – Design of slots – bar current – end ring current - resistance and reactance from design data – wound rotor design.

MODULE VI BRUSHLESS DC MOTOR 8

Brushless DC motor (BLDC): Introduction – Advances in BLDC motor drives –

Mathematical model – Characteristics analysis – Design of machine parameters – S-Function Simulation – Graphical simulation – Application design.

L – 45; T – 15; TOTAL HOURS – 60

REFERENCES:

1. K. G. Upadhyay, “Design of Electrical Machines”, New Age International, 2011.
2. Sawhney, A.K., 'A Course in Electrical Machine Design', Dhanpat Rai & Sons, New Delhi, 1987.
3. M.G.Say, ‘The Performance and Design of Alternating Current Machines’,CBS 3rd EDITION,2005.
4. A.E.Clayton and N.N.Hancock, ‘Performance and design of Direct current machines’ CBS 1st edition July 2004.
5. Chang Liang Xia,“ Permanent magnet Brushless DC motor drives and controls” John Wiley & Sons, April 2012.

OUTCOMES:

At the end of the course, the student is expected to

- design an electrical machine considering dynamic and thermal quantities.
- troubleshoot and rectify the design issues in any type of electrical apparatus.
- transform application demands to simple design specification.
- justify the given magnetic equivalent circuit design.
- design an efficient transformer.
- Simulate and model BLDC motor.

EEC4103	PLC & DCS	L	T	P	C
		3	0	2	4

OBJECTIVES:

- To provide fundamental knowledge about the PLC networks.
- To give an introductory knowledge about PLC and the programming languages.
- To give adequate knowledge about the applications of PLC and DCS.
- To give basic knowledge in the architecture and local control unit of distributed control system.
- To know how to design a DCS system and interfacing in a process industry
- To give adequate information in the interfaces used in DCS.

MODULE I PLC AND DCS 12

Evolution of PLCs – controller and hardware — PLC Architecture – PLC sizes and its application – PLC Vs. Computer – International Electrotechnical Commission (IEC) programming languages – Programming of PLC — relay logic – Ladder logic – Fundamentals of logic circuits – Programming: Timers and Counters.

Practical: Basic Programming and cascading – Timer and counter

MODULE II COMMUNICATION IN PLC 12

Plc Programming - Ladder logic , Functional block programming, sequential function chat, Instruction list, Communication networks for PLC — connecting PLC to computer

Practical: Development of Ladder program for simple on-off applications, Development of Ladder program for Timing and counting applications, Development of FBD in PLC.

MODULE III DISTRIBUTED CONTROL SYSTEMS 10

DCS – Various Architectures – Comparison – Local control unit – Process interfacing issues – Displace study of any one DCS available in market - case studies in DCS

Practical: Configuring Screens and Graphics (DCS), Tag Assignments to Field Devices in DCS, DCS based PID control for level loop.

MODULE IV INDUSTRIAL DATA COMMUNICATION 15

HART: Introduction — Evolution of signal standard — HART Communication protocol — Communication modes — HART networks — HART and OSI model— Field bus: Introduction— General field bus architecture — basic requirements of field bus standard — Field bus topology –Interoperability and Interchangeability - Profibus: Introduction – Profibus protocol stack – Profibus communication model – Communication objects – Foundation field bus versus Profibus – Introduction to Device net – Ethernet- 10Mbps- 100Mbps.

Practical: Study of HART communicator, Fieldbus.

MODULE V DATA NETWORK FUNDAMENTAL 10

Network hierarchy and switching – ISO/OSI Reference model – Data link control protocol: - HDLC - media access protocol: - Command / response, Token passing and CSMA/CD – TCP/ IP – Bridges – Routers – Gateways – Standard ETHERNET and ARCNET Configuration

Practical: Programming of HMI interfacing with PLC - Develop simulate programming using FBD in Delta V

MODULE VI PROCESS CONTROL SYSTEM 16

Logic gates – Boolean Conversions – Combination logic circuits – Decoder – Encoder – Flip flop – Annunciator – Math Instructions – Jump Instructions

Practical: Design of Level control system, temperature control system, pump sequence, Conveyor control, density-based traffic control system.

L – 45; P – 30; TOTAL HOURS – 75

REFERENCES:

1. G.K.Mc-Millan, "Process / Industrial Instrument and controls and handbook", McGraw Hill, New York, 1999.
2. Frank D Petrezeulla, "Programmable Controllers", 4th edition, Mc-Graw Hill, 2010
3. Hughes T, "Programmable Logic Controllers", ISA Press, 1989.
4. Michael P. Lucas, "Distributed Control System", Van Nastrand Reinhold Company, New York, 1986.

OUTCOMES:

At the end of the course, the student is expected to

- design all types of logic gates and sequences using PLC.
- design and execute ladder logic program for any industrial system.
- interface any type of PLC to achieve the required operation.
- write the sequence of operation for any industrial/process control plant.
- establish communication between PLC and DCS.
- design DCS based system for any plant.

PROGRAMME ELECTIVES

POWER SYSTEM

EECX01 POWER DISTRIBUTION SYSTEM

L	T	P	C
3	0	0	3

OBJECTIVES:

To impart knowledge on

- The importance of the design of distribution systems.
- Various components of the distribution systems.
- The methods of analysis of distribution systems.
- Protection of the distribution systems.
- Concepts of demand side management.

MODULE I INTRODUCTION TO DISTRIBUTION SYSTEMS 7

General - Introduction to distribution system, an overview of the role of computers in distribution system planning. Load modeling and characteristics: Definition of basic terms like demand factor, utilization factor, load factor, plant factor, diversity factor, coincidence factor, contribution factor and loss factor - Relationship between the load factor and loss factor - Classification of loads (Residential, Commercial, Agricultural and Industrial) and their characteristics

MODULE II DISTRIBUTION FEEDERS 7

Design consideration of Distribution feeders - voltage levels – different types of feeder loading.

MODULE III SUBSTATIONS AND GROUNDING SYSTEM 9

Types of substations - Design considerations of the secondary distribution system - Bus-bar arrangements - Substation bus schemes - Location of substations - Rating of a distribution substation - Service area with primary feeder - Resistance of grounding systems - Grounding grids - Design principles of substation grounding system.

MODULE IV DISTRIBUTION SYSTEM ANALYSIS 8

Voltage drop and power loss calculations - Derivation for volt-drop and power loss in lines – dc distribution – ac distribution –three phase balanced primary lines- Non-three-phase primary lines.

MODULE V PROTECTIVE DEVICES AND COORDINATION 8

Objectives of distribution system protection - Types of common faults and procedure for fault calculation. Protective devices - Principle of operation of fuses, circuit reclosers, line sectionalizer and circuit breakers. Coordination of protective devices - General coordination procedure

MODULE VI CONCEPTS AND METHODS OF DSM, LOAD CONTROL 6

Load control - Energy efficiency - Load management - DSM planning, design, marketing, impact assessment - Direct, distributed and local control – Assessment of impact on load shape.

TOTAL HOURS ; 45

REFERENCES:

1. Turan Gonen, “Electric Power Distribution System Engineering”, Mc.Graw-Hill Book Company, 1986.
2. A.S.Pabla, “Electric Power Distribution”, Tata Mc Graw-Hill Publishing Company, 5^{th} Edition, 2003.
3. V.Kamaraju, “Electrical Power Distribution Systems”, Tata Mc Graw Hill publication, 2009.
4. S.N. Singh, “Electric Power Generation, Transmission and Distribution”, Prentice Hall of India Pvt. Ltd, New Delhi, 2002.
5. Luces M.Fualkenberry, Walter Coffer, “Electrical Power Distribution and Transmission”, Pearson Education, 1996.
6. Hadi Saadat, “Power System Analysis”, Tata McGraw Hill Publishing Company, 2003
7. Gellings, C.W. and Chamberlin, J. H., “Demand-Side Management: Concepts & Methods”, Firmont Press, 1993.
8. Gellings, C.W. and Chamberlin, J. H., ‘Demand-Side Management Planning’, Firmont Press, 1993.
9. B.R.Gupta, ‘Power System Analysis and Design’, S.Chand, New Delhi, 2003.

OUTCOMES:

At the end of the course, the student will

- be attaining skills on various components of the distribution systems.
- be able to design distribution feeders
- have ability to implement grounding system in substations.
- have ability to perform analysis of voltage drop and power loss on feeders
- be able to carry out fault analysis and Co-ordination of protective devices in distribution systems.
- be able to do demand side management.

EECX02	POWER SYSTEM PLANNING AND RELIABILITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

To impart knowledge on:

- Load forecasting in power systems.
- Basic probability theory and concepts of reliability analysis.
- Factors influencing the reliability of generation systems, transmission systems and distribution systems.
- Expansion planning.

MODULE I LOAD FORECASTING 8

Objectives of forecasting - Load growth patterns and their importance in planning - Load forecasting based on discounted multiple regression technique – Procedure for Weather sensitive load forecasting - Determination of annual forecasting.

MODULE II INTRODUCTION TO RELIABILITY ANALYSIS 7

Review of probability distribution, binomial distribution and exponential distribution – Network modeling and evaluation of simple systems - Series and parallel systems - reliability evaluation using probability distributions – Frequency and duration techniques — MARKOV process - Recursive technique– Bathtub curve - Meantime to failure

MODULE III GENERATION SYSTEM RELIABILITY ANALYSIS 8

Probabilistic generation and load models - Determination of reliability of isolated systems - Procedure for determination of reliability of interconnected systems.

MODULE IV TRANSMISSION SYSTEM RELIABILITY ANALYSIS 7

Deterministic contingency analysis - Probabilistic load flow - Probabilistic transmission system reliability analysis - Determination of reliability indices like LOLP and expected value of demand not served isolated system.

MODULE V EXPANSION PLANNING 7

Basic concepts on expansion planning - A perspective: brief introduction to structure of power systems, growth of power system in India, present Indian power industry, GRID formation, concept of National GRID - Procedure followed to integrate transmission system planning, current practice in India - Capacitor placement problems in transmission systems and radial distribution systems.

MODULE VI DISTRIBUTION SYSTEM PLANNING AND RELIABILITY 8

Introduction, sub transmission lines and distribution substations - Design primary and secondary systems - Distribution system protection and coordination of protective devices. Distribution system reliability evaluation.

Total Hours –45

REFERENCES:

1. R.L .Sullivan, "Power System Planning", Heber Hill, 1987.
2. Roy Billington, “Power System Reliability Evaluation”, Gordan & Breach Scain Publishers, 1990.
3. A.S.Pabla, “Electric Power Distribution”, Tata Mc Graw-Hill Publishing Company, 5th edition, 2003.
4. Turen Gonen, “Electric Power Distribution System Engineering”, McGraw Hill, 1986.
5. Turen Gonen, “Electric Power Transmission System Engineering Analysis and Design”, McGraw Hill, 2nd Edition, 2010.
6. Eodrenyi, J., “Reliability Modelling in Electric Power System”, John Wiley, 1980.
7. B.R. Gupta, “Power Sytem Analysis and Design”, S.Chand, New Delhi, 2003.

OUTCOMES:

At the end of the course, the Students are expected to possess knowledge andachieve skills on following:

- Understand the importance of maintaining reliability of power system components
- Apply the probabilistic methods for evaluating the reliability of generation and transmission systems.
- Assess the different models of system components in reliability studies.
- Understanding some advanced concepts of power system planning.
- Familiarity with load forecasting techniques
- Expansion planning of power systems.

EECX03 POWER SYSTEM DYNAMICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge on dynamic modelling of a synchronous machine in detail.
- To describe the modelling of excitation and speed governing system in detail.
- To understand the fundamental concepts of stability of dynamic systems and its classification.
- To understand and enhance small signal stability problem of power systems.

MODULE I INTRODUCTION 8

Concepts and importance of stability in power system operation and design-Basic concepts and definition-Classification of power system stability-complexity of stability problem in large system-Need for reduced models-stability of interconnected systems.

MODULE II SYNCHRONOUS MACHINE MODELLING 8

Physical description-Park's transformation: flux linkage equations, voltage equation and torque equation-per unit conversion-normalizing the equation-equivalent circuit-flux linkage state space model with transient and sub transient inductances and time constants- Simplified models (one axis and constant flux linkage), steady state equations and pharsor equation.

MODULE III MODELLING OF EXCITATION AND SPEED GOVERNINGSYSTEMS 8

Excitation system requirements-Elements of Excitation System-Types of Excitation System-Typical excitation system configuration-block diagram and state space representation of IEEE type 1 excitation system-saturation function-stabilizing circuit. Function of speed governing systems-block diagram and state space representation of IEEE steam turbine and hydraulic governor.

MODULE IV TRANSIENT STABILITY 8

State equation for multimachine –transient stability simulation of multimachine power system with one axis machine model including excitation system and speed governing system using R-K method of fourth order (Gill's Technique), Power system stabilizer.

MODULE V SMALL SIGNAL STABILITY 8

System response to small disturbance –Linear model of the synchronous machine and load -modes of oscillation-effect of excitation on dynamic stability-approximation system representation-supplementary stabilizing signals-small signal performance measures.

MODULE VI ENHANCEMENT OF SMALL SIGNAL STABILITY ANDTRANSIENT STABILITY 5

Methods of enhancing transient stability –methods based on reduction of disturbance severity-methods by increasing synchronizing forces-methods of enhancing small signal stability-Power system stabilizers-delta-omega stabilizer.

Total Hours –45

REFERENCES:

1. P.Kundur, "Power System Stability and Control", Mc Graw-Hill ,1993.
2. P.M.Anderson and A.A Fouad, "Power System Control and stability", Lowa State university Press, Ames, Iowa,1978.
3. R.Ramanujam, "Power system dynamics, Analysis and simulation", Prentice Hall India Learning Pvt.Ltd., New Delhi, 2009.

OUTCOMES:

At the end of the course, the student is expected to possess knowledge and achieve skills on the following:

- Understanding of detailed modeling of the electrical and mechanical parts of a three phase synchronous machine, excitation system and turbine.
- Mathematically model the basic controllers, excitation and turbine governing systems for dynamics studies.
- Perform simple power system stability study on a small multi-machine power system model using commercial software AU POWER LAB, ETAP, CYME. Report and critically assess the results of the study.
- Analyze the methodology for small-signal stability and transient stability without controller.
- Assess power system stability for small disturbances and transient disturbances.
- Understand the enhancement of power system stability for both small signal and large signal.

EECX04 POWER SYSTEM TRANSIENTS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To identify and analyze the cause of surges and their propagation and their effect on power system components.
- To understand & distinguish between power frequency and surge voltages and currents and accordingly model the power system components.

MODULE I INTRODUCTION 8

Types of power system transients – modeling of lines for surges and power frequency over voltages – effect of transients & power system components – importance of study of transients in planning.

MODULE II LIGHTNING TRANSIENTS 8

Lightning phenomenon: charge formation in clouds, rate of charging of thunder clouds, mechanism of lightning strokes, characteristic of lightning strokes - protection against lightning over voltage by shielding and non shielding methods.

MODULE III SWITCHING TRANSIENTS 8

Circuit closing transients in RL and RLC circuits with sinusoidal excitation to simulate faults – circuit breaker restriking and recovery voltage – double frequency transients.

MODULE IV SWITCHING OVERVOLTAGES 8

Generation of system over voltages - current chopping – reclosing circuit breaker and compound transients – control of switching over voltages.

MODULE V TRAVELLING WAVES AND COMPUTATION OF TRANSIENTS 8

Wave equations and its solution- travelling voltage and current waves: velocity, attenuation and distortion-reflection, refraction of travelling waves – behaviour at line termination multiple reflections – Lattice diagram.

MODULE VI TRANSIENTS IN INTEGRATED POWER SYSTEM 5

Over voltage in integrated power system and its simulation and analysis using EMTP.

Total Hours –45

REFERENCES:

1. Allan Greenwood, “Electrical Transients in Power Systems”, Wiley Interscience, NewYork, 2nd edition,1991.
2. R.D. Begamudre, “Extra High Voltage AC Transmission Engineering”, Wiley Eastern Limited,1986.
3. Pritidra Choudary, “Electromagnetic Transients in Power System”, John Wiley and sons Inc,1996.

OUTCOMES:

At the end of the course, the student is expected to possess knowledge and skills on the following:

- Identify the occurrence of transient disturbance in the power system
- Analyse the lightning stroke current
- Calculate the stress on the insulator strings
- Design the protective schemes against transient disturbance
- Calculate the multiple reflections in power system due to travelling waves
- Analyse the power system using EMTP software

EECX05 **SMART POWER GRID**

	L	T	P	C
	3	0	0	3

OBJECTIVES:

- Introduce the fundamentals of smart grids.
- Introduce modeling of devices associated with smart grids.
- Introduce the different automation and networking standards.
- Introduce the concept of Wide area measuring systems and Phasor measurement units.(PMU)

MODULE I SMART GRID FUNDAMENTALS 9

Smart grid structure – Interactive grid – Micro grid – Distributed Resources modeling – communication infrastructure – sensing and Control devices – smart grid characteristics.

MODULE II COMPONENTS AND STANDARDS 9

Smart grid components – Metering – Virtual power plants-Benefits and cost elements – Pricing regulations – Networking Standards and integration – Analytics.

MODULE III AUTOMATION TECHNOLOGIES 9

Control centre systems – Data management principles – Smart Grid implementation standards and procedure – Advanced Metering Infrastructure – Outage management – Distribution and Substation automation.

MODULE IV WIDE AREA MEASUREMENT SYSTEMS AND PMU 6

Wide area measurement systems –Phasor Measurement Units-Optimal placement algorithm for PMUs. Smart grid experimentation plan for load forecasting.

MODULE V CASE STUDY I 6

Smart meters – Cloud computing and security issues -Forecasting – Coordination between cloud computing andSmart power grids – Development of power system modelsand control and communication software.

MODULE VI RECENT TRENDS IN SMART POWER GRIDS 6

Demand Response – concepts and models.Real time pricingmodels for practical applications-SCADA in smart grids.

Total Hours –45

REFERENCES:

1. Ali Keyhani :" Design of Smart Power Grid Renewable Energy Systems ", First Edition , John Wiley Inc., 2011
2. Tony Flick and Justin Morehouse : "Securing the Smart Grid –Next generation Power Grid security ", Elsevier Publications,2011.
3. Krzysztof Iniewski:Smart Grid Infrastructure and Networking , 1st Edition , 2012.
4. Stephen F Bush :Smart Grid Communication – Enabled Intelligencefor Electric Power Grid, Wiley IEEE .,2014
5. James Momoh : Smart Grids , Fundamentals of Design andAnalysis .,2014.
6. Mini . S. Thomas :Power System SCADA and Smart Grids.
7. Kenneth . C.Budka , Jayant G.Deshpande :Communication Networks for Smart Grids:Making Smart Grid Real , 2014

OUTCOMES:

At the end of the course the student is expected to

- design and implement smart Power Grid Power Systems
- apply the concept of demand response in Smart grids.
- apply smart grid concepts to real time applications.
- implement optimal location strategies of PMU in smart grids.
- coordinate the use of cloud computing application for smart grids.
- apply the concept of SCADA in smart grids.

EECX06 WIND ENERGY CONVERSION SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the demand for electrical power generation from the renewable wind energy and fundamentals of wind power.
- To study and understand about the wind turbine components, power generation machinery, control systems.

MODULE I INTRODUCTION 8

Historical development and current status of Wind Power-Generators and power electronics for wind turbines - Impacts of wind power-Wind speed estimation-Wind speed measurements-Rayleigh distribution-Maximum Power obtainable-Bertz limit-Power coefficient –Aerodynamics of wind rotor-Blade element theory-Aerodynamic Efficiency-Wind energy conversion system components.

MODULE II WIND TURBINE 8

Types of Wind Turbine-Rotor design considerations-Tip speed ratio-Blade Profile-Power Regulation-Yaw control –Pitch angle control-Stall Control-Schemes for maximum power extraction.

MODULE III FIXED SPEED AND VARIABLE SPEED SYSTEMS 8

Fixed speed and variable speed wind turbine- Need of variable speed systems-Power-wind speed characteristics-Generation schemes with fixed and variable speed turbines-Comparison of different schemes.

MODULE IV MODELING AND SIMULATION OF FIXED SPEED ANDVARIABLE SPEED WIND GENERATORS 8

Modeling of fixed speed Induction generator - axes transformation - flux linkage equations - voltage equations-state equations-modeling of variable speed DFIG for wind energy conversion systems-converter control system- transient stability simulation of fixed speed induction generator using EUROSTAG - Doubly Fed Induction Generator(DFIG) modeling - controller modelling - Modelling of DFIG in EUROSTAG - Transient stability simulation of power systems with induction generators using EUROSTAG.

MODULE V POWER ELECTRONICS IN WIND ENERGY CONVERSIONSYSTEM 8

Induction generator-Controlled firing angle scheme with AC and DC side Capacitor-Scalar method-flux vector scheme-Control scheme for synchronous generator with variable speed drive-Variable speed synchronous generator control with boost converter.

MODULE VI GRID CONNECTED SYSTEMS 5

Stand alone and grid connected WECS system-Grid connection Issues-Impacts of wind power on power system stability-wind plant reactive power capability and its requirements-voltage control and active power control - Storage technologies.

Total Hours –45

REFERENCES:

1. S.N.Bhadra,D.Kasthra,S.Banerjee, “Wind Electrical Systems,”Oxford Higher Eduction, 2005.
2. Thomas Ackermann,”Wind Power in Power system, ”Wiley 2012.
3. L.L.Freris "Wind Energy conversion Systems", Prentice Hall, 1990.
4. Jian Zhang, Adam Dysko, John O'Reilly, William E. Leithead," Modeling and performance of fixed-speed induction generators in power system oscillation stability studies", Electric Power System Research Vol. 78 (2008) 1416-1424.
5. Andre´s Feijoo, Jose Cidras, Camilo Carrillo, "A third order model for the doubly-fed induction machine", Electric Power Systems Research 56 (2000) 121-127.
6. Eurostag 4.3 Theory Manual Part I.
7. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.
8. E.W.Golding "The generation of Electricity by wind power", Redwood burn Ltd., Trowbridge, 1976. S.Heir "Grid Integration of WECS", Wiley 1998

OUTCOMES:

At the end of the course, the student will be able to:

- recognize the need of renewable energy technologies and their role in the world energy demand.
- identify and mathematically model the wind turbine components, calculate the available wind power, predict mechanical loads based on design, and discuss the generation of electrical power.
- to numerically simulate the wind turbine dynamic system behavior with integration of components, sensors, and control for given real time application.
- mathematically model and simulate the transient and steady state performance of the stand-alone and grid connected wind generators using EUROSTAG,

MATLAB, CYME packages.

- analyze the wind power integration issues and their mitigation techniques.
- identify the present and the future energy storage technologies used for standalone operation and grid connected operation .

EECX07	FLEXIBLE AC TRANSMISSION SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the need for reactive power compensation in AC transmission system.
- To become familiar with modeling and operation of thyristor and voltage source inverter-based FACTS controllers.
- To study the effect of FACTS controllers on AC transmission system.

MODULE I REACTIVE POWER CONTROL IN TRANSMISSIONSYSTEM 8

Reactive power - uncompensated transmission lines - load compensation - system compensation - lossless distributed parameter lines -symmetrical lines - midpoint conditions of a symmetrical line case study - passive compensation - shunt compensation -series compensation effect on power-transfer capacity.

MODULE II CONVENTIONAL FACTS DEVICES 8

Types, definitions and representation of various FACTS controllers - synchronous Condensers - saturated Reactor (SR) - thyristor-controlled reactor (TCR) - operating characteristics of a TCR- fixed Capacitor–thyristor-controlled reactor (FC–TCR)- thyristor-switched capacitor (TSC)- thyristor-switched capacitor–thyristor-controlled reactor (TSC–TCR).

MODULE III STATIC VAR COMPENSATOR 8

Voltage Control - V-I characteristics of the SVC - dynamic Characteristics-steady-State characteristic advantages of the slope in the SVC dynamic characteristic influence of the SVC on system voltage.

MODULE IV THYRISTOR-CONTROLLED SERIES CAPACITOR (TCSC) 8

Fixed-series compensation - need for variable series compensation-advantages of the TCSC - TCSC controller- operation of the TCSC - modes of TCSC operation - capability characteristics - single-module TCSC- multi - module TCSC - variable-reactance model of TCSC.

MODULE V EMERGING FACTS CONTROLLERS 8

STATCOM: principle of operation - V-I characteristic - SSSC: principle ofoperation - UPFC: principle of operation.

MODULE VI APPLICATIONS OF FACTS DEVICES 5

Increase in steady-state power-transfer capacity - enhancement of transient stability. - TCSC applications - applications of STATCOM, SSSC and UPFC.

Total Hours –45

REFERENCES:

1. Mohan Mathur.R., Rajiv. K. Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc 2000.
2. Narain G. Hingorani, "Understanding FACTS -Concepts and Technology of Flexible AC Transmission Systems", Standard Publishers Distributors, Delhi, 2001.
3. A.T. John, "Flexible A.C. Transmission Systems", Institution of Electrical and Electronic Engineers (IEEE), 1999.

OUTCOMES:

At the end of the course, the student is expected to

- Compute power transmission capability of a transmission system and apply reactive compensation methods for its improvement.
- Analyse the different conventional FACTS devices in the transmission line for compensation.
- Familiarise the operation of SVC and its characteristics.
- Choose appropriate mode TCSC and to model it.
- Analyse and utilize the emerging FACTS devices in the utility networks.
- Apply the techniques of FACTS controller design for enhancing power transfer, increasing stability, augmenting system damping, mitigating sub-synchronous resonances, preventing voltage instability, performing load compensation, etc.

EECX08	INDUSTRIAL POWER SYSTEM ANALYSIS AND DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide practical knowledge in the field of power system analysis and design for industrial applications.
- To introduce the fundamentals of smart grid and associated Information Technology services.
- To derive expressions for the computation of transmission line parameters.
- To understand the problems associated with circuit interruption by a circuit breaker.

MODULE I ELECTRICAL POWER SYSTEM BACKGROUND 7

Overview of power systems generation, transmission and distribution- utilityscale systems versus industrial power systems; utility restructuring and deregulation- smart grid.

MODULE II POWER SYSTEM STUDIES 9

Load flow – short circuits – protective coordination – arc flash hazard calculation – harmonic analysis – power system stability – simple calculation.

MODULE III TRANSMISSION LINE MODELING AND TRANSFORMER 8

Line configurations and physical parameters- lumped circuit equivalent models- applications- Transformer – types – transformer for non linear loads – instrument transformers.

MODULE IV FAULTS AND SYSTEM PROTECTION 7

Symmetrical components- symmetrical and unsymmetrical faults- protection devices.

MODULE V SWITCHGEAR CIRCUIT BREAKER- MOTOR CONTROL CENTRE 7

Switchgear: low voltage medium voltage – load interrupt switchgear – power fuse – medium and high voltage circuit breaker – SF6 gas insulated switchgear – low and medium voltage motor control centre.

MODULE VI APPLICATION & PROTECTION OF MEDIUM VOLTAGE MOTORS 7

Introduction overview – load characteristics – squirrel cage induction motor –wound rotor induction motor – synchronous motor – electric motor for variable frequency drives – motor controllers and starting methods.

TOTAL HOURS: 45

REFERENCES:

1. J Duncan Glover, "Power system analysis and design", 4th edition, Thompson, USA.
2. Arnold, C.P., Arrillaga, J. &Harker, B. J., "Computer Modelling of Electrical Power Systems", John Wiley & Sons, 1983.
3. Davies, T., "Protection of Industrial Power Systems", 2nd edition, 1998.
4 Shoaib khan, "Industrial Power Systems", CRC publication, 1997.
5. Elgerd, O. I., "Electric Energy Systems Theory", 2nd edition, McGraw-Hill, 1983.
6. Kusic, G., "Computer-Aided Power Systems Analysis", 2nd edition, CRC, 2008.
7. John J. Grainger and William D. Stevenson, Jr., "Power system analysis", McGraw-Hill, Inc,, 2000.
8. T. K. Nagsarkar and M.S.Sukhija, "Power system analysis", Oxford University press.
9. PrabhaKundur, "Power system stability and control", McGraw-Hill, Inc, 1999.

OUTCOMES:

At the end of the course, the student is expected to

- understand the operation of deregulated power system and smart grids
- perform power flow studies
- determine voltage regulation and efficiency for short, mediumand long lines.
- perform fault calculations.
- design circuit breaker ratings
- select an induction motor and synchronous motor for a particular industrial application

EECX09	**ELECTRIC ENERGY GENERATION, UTILIZATION AND CONSERVATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

To impart knowledge on

- Generation of electrical power by conventional and non-conventional methods.
- Electrical energy conservation, energy auditing and power quality.
- Principle and design of illumination systems and methods of heating and welding.
- Electric traction systems and their performance.
- Industrial applications of electric drives.

MODULE I CONVENTIONAL METHODS OF POWER GENERATION 6

Thermal, hydro and nuclear based power generation- Selection of site for power plants- schematic arrangement- merits and demerits of power plants.

MODULE II NON-CONVENTIONAL METHODS OF POWERGENERATION 6

Fuel cells-tidal waves-wind- geothermal -solar- bio mass - municipal waste. Co generation. Effect of distributed generation on power system operation.

MODULE III ECONOMIC ASPECTS OF GENERATION 8

Economic aspects of power generation - load and load duration curves - number and size of units - cost of electrical energy - tariff. Economics of power factor improvement - power capacitors - power quality. Importance of electrical energy conservation - methods - energy efficient equipments. Introduction to energy auditing.

MODULE IV ILLUMINATION 8

Importance of lighting - properties of good lighting scheme - laws of illumination - photometry - types of lamps - lighting calculations - basic design of illumination schemes for residential, commercial, street lighting, and sports ground - energy efficiency lamps.

MODULE V HEATING AND WELDING 8

Introduction - advantages of electric heating - modes of heat transfer - methods of electric heating -resistance heating - arc furnaces - induction heating - dielectric heating - electric welding - types -resistance welding - arc welding - power supply for arc welding - radiation welding.

MODULE VI ELECTRIC DRIVES AND TRACTION 9

Fundamentals of electric drive - choice of an electric motor - application of motors for particular services - traction motors - characteristic features of traction motor - systems of railway electrification -electric braking - train movement and energy consumption - traction motor control.

Total Hours –45

TEXT BOOKS:

1. Wadhwa, C.L. "Generation, Distribution and Utilization of Electrical Energy", New Age International Pvt. Ltd, 2003.
2. Gupta B.R., "Generation of Electrical Energy", Eurasia Publishing House (P) Ltd, New Delhi, 2003.

REFERENCES:

1. Partab.H, "Art and Science of Utilisation of Electrical Energy", Dhanpat Rai and Co, New Delhi, 2004.
2. Openshaw Taylor.E, "Utilization of Electrical Energy in SI Units", Orient Longman Pvt. Ltd, 2003.
3. Gupta.J.B, "Utilization of Electric Power and Electric Traction", S.K.Kataria and Sons, 2002
4. R.K.Rajput, Utilisation of Electric Power, Laxmi publications Private Limited.,2007

OUTCOMES:

At the end of the course the student will be able to

- understand the concepts conventional power generation systems
- implement small renewable based power generation systems
- find the number and size of units from load curve, compute tariff and power factor correction for practical system and carry out energy management and auditing.
- compute illumination and suggest lighting scheme for various application.
- understand practical implications of electric heating and welding
- select suitable motor for different applications including traction system.

EECX10	RESTRUCTURED POWER SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide the student a background on restructuring of power system which has taken place in many countries in the world including our country
- To provide insight on new trends in operation and control in deregulated power systems
- To highlight electric energy trading in the electricity market.
- To compare and calculate various pricing strategies in restructured environment.

MODULE I INTRODUCTION TO RESTRUCTURING 7

Restructuring Models: PoolCo Model, Bilateral Contracts Model, Hybrid Model-Independent System Operator (ISO): The Role of ISO - Power Exchange (PX): Market Clearing Price (MCP) - Market operations: Day-ahead and Hour-Ahead Markets, Elastic and Inelastic Markets - Market Power- Restructuring in Indian Power Sector.

MODULE II KEY ISSUES IN RESTRUCTURING 8

Transmission Pricing: Contract Path Method, The MW-Mile Method -Congestion Pricing: Congestion Pricing Methods, Management of Inter-Zonal/Intra Zonal Congestion: Solution procedure.

MODULE III ELECTRIC UTILITY MARKETS IN THE UNITED STATES 7

California Markets- New York Market: Market operations - PJM interconnection - Ercot ISO - New England ISO.

MODULE IV OASIS: OPEN ACCESS SAME-TIME INFORMATION SYSTEM 8

Structure of OASIS: Functionality and Architecture of OASIS-Transfer Capability on OASIS: Definitions, Transfer Capability Issues, ATC Calculation, TTC Calculation, TRM Calculation, CBM Calculation - Transmission Services - Methodologies to Calculate ATC.

MODULE V ELECTRIC ENERGY TRADING 7

Essence of Electric Energy Trading - Energy Trading Framework: The Qualifying factors - Derivative Instruments of Energy Trading: Forward Contracts, Futures Contracts, Options, Swaps, Applications of Derivatives in Electric Energy Trading.

MODULE VI SPECIAL COMPUTATIONAL TECHNIQUES 8

Formulation of D.C. Optimal Power Flow (DCOPF) model for assessment of Available Transfer Capability (ATC), assessment of Simultaneous ATC (SATC) and Congestion Management.

Total Hours –45

REFERENCES:

1.Mohammad Shahidehpour and Muwaffaq Almoush, “Restructured Electrical Power systems: Operation, Trading and Volatility”, Marcel Dekkar, Inc., 2001.
2 G.Zaccour, “Deregulation of Electric Utilities”, Kluwer Academic Publishers,1998.
3 M.Ilic, F. Galiana and L.Fink, "Power Systems Restructuring : Engineering and Economics", Kluwer Academic Publishers, 2000.
4 Editor: Loi Lei Lai, "Power System Restructuring and Deregulation: Trading, Performance and Information Technology", John Wiley and sons Ltd, 2001
5.K.Bhattacharya, M.H.J.Bollen and J.E.Daader, "Operation of Restructured Power Systems", Kluwer Academic Publishers, 2001.
6 J.H.Chow,F.F.Wu and J.A.Momoh, "Applied Mathematics for restructured electric power systems: Optimization, Control and Computation Intelligence", Springer 2004.
7 F.C.Schweppe, M.C.Caramanis, R.D.Tabors and R.E.Bohn, "Spot Pricing of Electricity", Kluwer Academic Publishers, 2002.

OUTCOMES:

At the end of the course, the student is expected to possess knowledge and achieve skills on the following:

- understand the various process of restructuring.
- perform the various steps of electricity trading operation such as market clearing and settlement for an exchange.
- Explain the operation of different electricity markets in United States.
- Compute transmission pricing and perform congestion Use and interpret the real time information available in an OASIS.
- Perform the various steps of trading such as forecasting of energy requirement and billing of supply offers / demand bids for GENCOS / DISCOS
- Compute the ATC and perform congestion management in restructured power systems.

EECX11	SOLAR ENERGY TECHNOLOGY	L	T	P	C
		1	0	0	1

OBJECTIVES:

The primary objectives of the course are to deliver knowledge at fundamental and advanced levels in the following topics:

- Solar energy technologies and their design principles
- Sources of energy consumption in buildings.
- Solar thermal and photovoltaic (PV) technologies for application in buildings.

MODULE **15**

- Solar Energy – Need, types- Physics of Solar Energy Energy Policies
- Solar PV Technologies- olar Cells & types - Balance of System
- Design of PV System - Types of PV System - Design of Off-Grid PV System - Design of On-Grid PV System
- Solar Power Plant - Grid Tie Plants - Off grid Plants - Hybrid Plants - Maintenance of plant

Total Hours : 15

REFERENCES:

1. Arno Smets , Klaus Jager , Olindo Isabella , Rene van Swaaij, “Solar Energy: The physics and engineering of photovoltaic conversion, technologies and systems”, UIT, Cambridge, 2016. ISBN: 1906860327, 9781906860325

2. H Garg & J Prakash, “Solar Energy : Fundamentals and Applications”, McGraw Hill Education, 2017.

3. Solanki C.S, “Solar Photovoltaics - Fundamentals, Technologies and Applications”, PHI, 2015.

OUTCOMES:

After studying this course, the student should be able to:

- explain the principles that underlie the ability of various natural phenomena to deliver solar energy.
- outline the technologies that are used to harness the power of solar energy

EECX12	MICRO-GRID PROTECTION	L	T	P	C
		3	0	0	3

OBJECTIVES:

To familiarize the students with

- The concepts of microgrid, its types, modes of operation and importance.
- Control aspects of microgrid
- Various microgrid pilots and microgrid components

MODULE I INTRODUCTION 8

Microgrid basic concepts – architecture - operational conditions, Microgrid: merits and demerits - functionalities and variables in microgrid - issues in microgrid. Types of microgrid (LV microgrid, MV microgrid - DC microgrid, AC microgrid, hybrid) - Microgrid as part of smarter grid.

MODULE II DISTRIBUTED ENERGY RESOURCES AND STORAGE DEVICES 8

Distributed Energy Resources: solar – wind – CHP – MCHP – Microturbine - Diesel generators –geo thermal. Storage devices-Batteries - fuel cells - super capacitors.

MODULE III MICRO-GRID PROTECTION AND CONTROL 8

Requirements of protection - issues in protection (LOM, Blinding of protection, unwanted islanding, lack of selectivity) - challenges in protection scheme -design of digital relays: under/over voltage relay- over current relay- differential relay – directional over current relay.

Modes of operation: grid connected mode - islanded mode - transition between grid connected mode and islanded mode. primary control strategy - secondary control strategy- Control of distribution generation - demand side management - Opportunities and risk of different market players.

MODULE IV CONTROLLERS FOR MICROGRID 7

Three phase converter - Three phase Voltage source Inverter (VSI) – Boost Converter – PWM Techniques - P-Q Control -Structure of the VSI PQ Controller - Power Voltage (PV) Control Scheme - Frequency (V/f) Control Scheme -generation Control Based on Droop Concept - adaptive droop control, Phase locked loop for synchronisation.

MODULE V COMMUNICATION FOR MICROGRIDS 7

Communication lines in power system: PLC - Microwave – fiber optic links - PMU basic concepts- International Electrotechnical Commission (IEC) 61850, 61850-7-420, 61850-8. Renewable Microgrid controller RMC 600. Review / Comparison on simulation packages used for Microgrid Protection

MODULE VI MICROGRID COMPONENTS 7

Microgrid pilots: KERI – CERTS - Intelligent Electronic Devices (IED) - Microgrid Management system (MMS) - Static Transfer switch (STS) - RTU/ gateway - Smart metering –Sensing Devices.

Total Hours –45

REFERENCES:

1. Jukka Ihamäki, "Integration of microgrids into electricity distribution networks" Master's Thesis in Lappeenranta University of Technology, 2012, pages-105
2. Amirhossein Hajimiragha, "Generation Control in Small Isolated Power Systems" ,Master of Science Thesis -Royal Institute of Technology, Department of Electrical EngineeringStockholm 2005.
3. Juan Carlos V´asquez Quintero, "Decentralized Control Techniques Applied to Electric Power Distributed Generation in Microgrids dissertation submitted for the degree of European Doctor of Philosophy, June 10, 2009.
4. Stanley H.Horowitz and Arun G. Phadke, " Power System Relaying third edition, John Wiley & sons
5. Renewable Microgrid controller RMC 600 – ABB Brochure
6. Taha Selim Ustun, Cagil Ozansoy and Aladin Zayegh, " Fault current coefficient and time delay assignment for microgrid protection system with central protection unit" IEEE Transaction (accepted for publication in future issue of the journal-DOI-10.1109/TPWRS.2012.2214489
7. Taha Selim Ustun, Cagil Ozansoy and Aladin Zayegh, " Modelling of a centralized Microgrid Protection system and Distributed Energy Resources according to IEC 61850-7-420" IEEE Transaction on power systems, vol 27, No.3, pp 1560-1567, 2012.
8. M. Amin Zamani, Amirnaser Yazdani, and Tarlochan S. , "A Communication-Assisted Protection Strategy for Inverter-Based Medium-Voltage Microgrids", IEEE Transactions on Smart Grid, Vol. 3, No. 4,pp.2088-2099, 2012
9. Eric Sorotomme, S.S. Venkata, Joydeep Mitra, "Microgrid protection using communication assisted digital relays" IEEE transaction on power delivery, vol.25, No.4, pp.2789-2796, 2010

OUTCOMES:

The students will be able to

- Know the operation of Distributed Energy Resources and Storage Devices and its integration issues
- Know the significance of microgrid and its types.
- Know various control strategies of microgrid.
- Realize various issues involved in microgrid protection.
- Incorporate communication techniques and standards for microgrid protection.
- Have an idea of various microgrid components.

EECX13 ELECTRIC VEHICLE TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

• To introduce the concept of Electric Vehicles.

• To familiarize the basic energy transfer processes that govern existing and proposed methods of power generation for Electric Vehicles.

• To familiarize with the traditional and non-traditional sources for Electric Vehicles in terms of energy content, accessibility, required processing steps and projected remaining reserves.

MODULE I INTRODUCTION 6

A Brief History - Types of Electric Vehicle in use today: Battery electric vehicles - The IC engine/electric hybrid vehicle - Fuelled electric vehicles – Electric vehicles using supply lines - Solar powered vehicles - Electric vehicles which use flywheels or super capacitors – Environmental impact.

MODULE II BATTERIES 8

Battery Parameters - Lead Acid Batteries - Nickel-based Batteries – Sodium based Batteries - Lithium Batteries - Metal Air Batteries - Battery Charging - Choice of Battery - Use of Batteries in Hybrid - Vehicles - Battery Modelling.

MODULE III FUEL CELLS 8

Hydrogen Fuel Cells - Fuel Cell Thermodynamics - Connecting Cells in Series - Water Management in the PEM Fuel Cell - Thermal Management of the PEM Fuel Cell - A Complete Fuel Cell System - Hydrogen Supply – Fuel Reforming - Hydrogen Storage.

MODULE IV ULTRA CAPACITOR AND REGENERATIVE BRAKING 8

Ultra Capacitor :Features, Basic Principle, Performance – Ultra capacitor technology – Ultrahigh Speed Flywheels: Operation & Principles - Power Capacity of Flywheel Systems - Flywheel Technologies - Hybridization of Energy Storages - Energy Consumption in Braking - Braking Power and Energy on Front and Rear Wheels - Brake System of EVs and HEVs - Antilock Brake System.

MODULE V ELECTRIC VEHICLE MODELLING AND ANCILLARY SYSTEMS 7

Tractive Effort - Modelling Vehicle Acceleration - Modelling Electric Vehicle Range - Aerodynamic Considerations - Transmission Efficiency – Electric Vehicle Chassis and Body Design - Heating and Cooling Systems - Design of the Controls - Power Steering - Choice of Tyres - Wing Mirrors, Aerials and Luggage Racks - Electric Vehicle Recharging and Refuelling Systems.

MODULE VI DESIGN OF HYBRID ELECTRIC DRIVE TRAIN 8

Series Hybrid Electric Drive Train Design: Operating patterns - control strategies - sizing of major components - power rating of traction motor - power rating of engine/generator - design of PPS .

Parallel Hybrid Electric Drive Train Design: Control strategies - design of engine power capacity - design of electric motor drive capacity - transmission design - energy storage design.

TOTAL HOURS: 45

REFERENCES:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained”, John Wiley & Sons Ltd, 2003.
2. Iqbal Husain, “Electric and Hybrid vehicles”,Design Fundamentals, CRC Press,2003.
3. M. Ehsani, Y. Gao, S. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel CellVehicles” , CRC Press, 2005.

OUTCOMES:

At the end of the course, the student is expected to possess knowledge and achieve skills on the following:

- Identify and quantify the important energy transfer for Batteries and fuel cell schemes.
- Identify the opportunities and challenges of advances in Electric Vehicles.
- Choose a suitable drive scheme for developing an electric hybrid vehicle depending on Resources
- Design and develop basic schemes of electric vehicles and hybrid electric vehicles.
- Choose proper energy storage systems for vehicle applications

- Identify the current industry activities by car makers, electricity utilities, parts, suppliers batteries), including joint ventures, product announcements and pilot projects.
- design Electric Vehicles to meet desired needs within realistic constraints such as economic, environmental, manufacturability, and sustainability.

EECX14	POWER SYSTEM SIMULATION SOFTWARE	L	T	P	C
		0	0	2	1

OBJECTIVES:

To expose the students to various proprietary and open source software for simulation of power systems.

COURSE DESCRIPTION:

Study of both proprietary and open source software for simulation of power systems:

PROPRIETARY SOFTWARE

- ETAP
- CYME
- PSCAD
- EUROSTAG

OPEN SOURCE SOFTWARE

- UWPFLOW
- PSAT
- InterPSS
- DCOPFJ
- OpenDSS
- MatDyn
- minpower
- Dome
- GridLAB-D
- OpenPMU

Assessment I: A presentation on the proprietary software available in the department and the latest open source software.

Assessment II: Comparative study by simulating the same problem over multiple software.

Semester End: Solving a given power system problem using any one of the software.

Total Hours: 30

OUTCOMES:

At the end of the course, the student will be able to

- Get knowledge on various proprietary and open source software for simulation of power system.

- Perform load flow studies and ontingency analysis
- Solve various faults on power system elements using fault analysis techniques.
- Perform transient and small signal stability study.
- Perform load frequency dynamics of single area and two area power systems.
- Implement optimal scheduling using economic dispatch programme.

EECX15 WIDE AREA MEASUREMENT SYSTEMS

L	T	P	C
2	0	0	2

OBJECTIVES:

To understand the operating principle of wide area measurement systems and performance of phasor measurement units.

MODULE I MATHEMATICAL BACKGROUND 8

Phasor representation of sinusoids - Fourier series and Fourier transform and DFT Phasor representation - Phasor Estimation of Nominal Frequency Signals - Formulas for updating phasors - Nonrecursive updates - Recursive updates - Frequency Estimation

MODULE II SYNCHRO PHASOR MEASUREMENTS 10

Need of Synchro phasor Measurements, Phasor Measurement Unit: Architecture, Functions, Optimal Placement of PMUs, phasor data concentrators and associated communication system. Visualization tools to enhance visibility and control within transmission system, PMU measurements and sampling rates State Estimation & observability by using PMU, phasor data use for real time operation, frequency stability monitoring and trending, power oscillation, voltage monitoring and trending. Alarming and setting system operating limits. Dynamic line rating and congestion management, outage restoration. Application of PMU for wide area monitoring and control.

MODULE III WIDE AREA MEASUREMENT SYSTEM 6

Architecture, Components of WAMS, GUI (Graphical User Interface), Applications: Voltage Stability Assessment, Frequency stability Assessment, Power Oscillation Assessment, Communication needs of WAMS, WAMPAC (Wide Area Monitoring Protection & Control), RAS (Remedial Action Scheme). Standards: IEEE 1344, IEEE C37.118 (2005), IEEE Standard C37.111-1999 (COMTRADE), IEC61850 GOOSE

MODULE IV PERFORMANCE OF A GENERIC PMU 6

The global positioning system - Hierarchy for phasor measurement systems, - Functional requirements of PMUs - Transient Response of Phasor Measurement Units - of instrument transformers, filters, during electromagnetic transients – Transient response during power swings

Total Hours- 30

REFERENCES:

1. A.G. Phadke, J.S. Thorp, 'Synchronized Phasor Measurements and Their Applications', Springer Publications, 2008

2. Joseph Euzebe Tate "Event detection and visualization based on phasor measurement units for improved situational awareness", UMI Dissertation Publishing.

3. Fahd Hashiesh, M. M. Mansour , Hossam E. Mostafa Fahd Hashiesh , M. M. Mansour , Hossam E. Mostafa ,"Wide Area Monitoring, Protection and Control: The Gateway to Smart Grids",

4. Dr. Arun G. Phadke, Dr. James S. Thorp,."Computer Relaying for Power Systems", Wiley Publication, Second Edition.

5. Krzysztof Iniewski "SMART GRID Infrastructure & Networking", Tata McGraw Hill.

OUTCOMES:

Upon finishing the course, students are expected to,

- Model the phasor measurement system mathematically.
- Define and demonstrate the concept of Wide area measurement systems
- Use the wide area measurement systems for assessing power system oscillations and stability.
- Analyze the performance of a generic phasor measurement unit.

EECX16 ENERGY AUDITING

L	T	P	C
2	0	0	2

OBJECTIVES:

- To introduce the general concepts and methodologies of energy auditing.
- To understand the procedures and techniques involved in energy auditing
- To systematically explore the possibilities of energy saving.
- To expose the students to different instruments involved in energy auditing.

MODULE I GENERAL ASPECTS, METHODOLOGY AND APPROACH 9

General Philosophy and need of Energy Audit and Management. Definition and Objective of Energy Management, General Principles of Energy Management - Energy Audit: Need, Types - Understanding Energy Costs, Bench marking, Energy performance, Matching energy usage to requirements, maximizing system efficiency, Optimizing the input energy requirements, Fuel and Energy substitution.

MODULE II PROCEDURES AND TECHNIQUES 8

Data gathering: Level of responsibilities, energy sources, control of energy and uses of energy get Facts, figures and impression about energy /fuel and system operations, Past and Present operating data, Special tests, Questionnaire for data gathering. Analytical Techniques: Incremental cost concept, mass and energy balancing techniques, inventory of Energy inputs and rejections, Heat transfer calculations, Evaluation of Electric load characteristics, process and energy system simulation.

MODULE III EVALUATION OF SAVING OPPORTUNITIES 7

Determining the savings in Rs, Noneconomic factors, Conservation opportunities, estimating cost of implementation. Energy Audit Reporting: The plant energy study report- Importance, contents, effective organization, report writing and presentation - Identification of losses, Improvements. Energy Balance sheet

MODULE IV ENERGY AUDIT INSTRUMENTS 6

Basic measurements – Electrical measurements, Light, Pressure, Temperature and heat flux, Velocity and Flow rate, Vibrations, etc. Instruments Used in Energy systems: Load and power factor measuring equipments, Wattmeter, flue gas analysis, Temperature and thermal loss measurements, air quality analysis

Total Hours- 30

REFERENCES:

W.R.Murphy, G.Mckay ‘Energy Management’ Butterworths
2. C.B.Smith‘Energy Management Principles’, Pergamon Press
3. I.G.C.Dryden‘Efficient Use of Energy’, Butterworth Scientific
4. A.V.Desai‘Energy Economics’, Wieley Eastern
5. D.A. Reay ‘Industrial Energy Conservation’, Pergammon Press
6. W.C. Turner ‘Energy Management Handbook, John Wiley and Sons, AWiley Interscience Publication
7. L.C. Witte, P.S. Schmidt, D.R. Brown ‘Industrial Energy Management andUtilization’, Hemisphere Publication, Washington
8. ‘Industrial Energy Conservation Manuals’, MIT Press, Mass, 1982
9. Patrick/Patrick/Fardo ‘Energy Conservation guide book’, Prentice Hall
10. Handbook on Energy efficiency
11. ASHRAEE Energy Use (4 Volumes)
12. CIBSI Guide –Users Manual (U.K.)
13. CRC Handbook of Energy Efficiency – CRC Press.

OUTCOMES:

At the end of the course, the students will be able to

- Demonstrate the importance of energy auditing.
- Use the right technique and procedure for energy auditing.
- Explore the possibilities of reducing the losses and saving the energy systematically.
- Use appropriate instruments in the process of energy auditing.

POWER ELECTRONICS & DRIVES

EECX21 SPECIAL ELECTRICAL MACHINES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge on the constructional features and operating principles of various types of special electrical machines.
- To review the fundamental concept of stepper motor and high-speed application.
- To impart knowledge on principle of operation, control and performance of Synchronous Reluctance, SRM and linear induction motor.
- To expose the students to the principle of operation, emf and Torque speed characteristics of PM brushless and PM synchronous motors.

MODULE I STEPPER MOTORS 6

Constructional features, Principle of operation, Permanent magnet stepper motor, Variable reluctance motor, Hybrid motor, Single and multistack configurations, Torque equations, Modes of excitations, Characteristics, Drive circuits, Control of stepping motors.

MODULE II HIGH-SPEED OPERATION OF STEPPER MOTORS 8

Pull-out torque/speed, characteristics of Hybrid stepper motors, calculation of pull-out torque, pull-out torque/speed characteristics for the VR stepper-motors, calculation of the pull-out torque.

MODULE III SWITCHED RELUCTANCE MOTORS 8

Constructional features – Principle of operation – Torque prediction –Power controllers – Non-linear analysis – Microprocessor based control – Characteristics.

MODULE IV LINEAR INDUCTION AND SYNCHRONOUS MOTORS 8

Development of a Double-sided LIM from Rotary type IM- Schematic of LIM drive for electric traction, Development of one-sided LIM, Equivalent circuit of LIM, Linear Synchronous motor.

MODULE V PERMANENT MAGNET BRUSHLESS D.C. MOTORS AND SYNCHRONOUS MOTORS 8

Permanent magnet brushless D.C. Motors, Permanent magnet synchronous motors and axial flux machine: Principle of operation – EMF and torque equations – Phasor diagram – Power controllers - Torque speed characteristics.

MODULE VI MODELLING OF MACHINES 8

Mathematical model of switched reluctance motor, PMBLDC motor, PM synchronous Motor, axial flux motor.

Total Hours – 45

REFERENCES:

1. Miller, T. J. E., “Brushless Permanent Magnet and Reluctance Motor Drives”, Clarendon Press, 1989.
2. Taylor E.O., “The Performance and Design of AC Commutator Motors”, Sir Issac Pitmanand Sons, 1998.
3. T. Kenjo, S. Nagamori, “Permanent Magnet and Brushless DC Motors”, Clarendon Press, London, 1988.
4. Kenjo T., “Stepping Motors and their Microprocessor Controls”, Clarendon Press, 1984.
5. Murphy J.M.D., “Power Electronics Control of AC Drives”, Pergamon Press, 1988.
6. Naser A. and Boldea L., “Linear Electric Motors: Theory Design and Practical Applications”, Prentice Hall of India, 1987.
7. T.J.E. Miller, 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press, Oxford, 1989.
8. M. Gopal, 'Digital Control and State Variable Methods', Tata McGraw-Hill,1997

OUTCOMES:

At the end of the course, the student is expected to

- explore the performance and applications of stepping motors.
- design control ciruit for switched reluctance motors.
- analyze the performance synchronous reluctance machine
- select the suitable machines for real time applications to maximize the torque output.
- design motor for traction applications
- model any type of motor

EECX22 CAD FOR ELECTRICAL APPARATUS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge on using electromagnetic field theory in understanding the modeling concepts of Electrical Apparatus.
- To Provide Basic Electromagnetic Field Equations And The Problem Formulation For CAD Applications.
- Applying Maxwell's equation to model Electrical Apparatus.
- Providing numerical solutions for the analysis of Electrical Apparatus, using finite element approach.

MODULE I INTRODUCTION 5

Conventional design methodology – limitation -need for field analysis-based design - computer aided design aspects – Advantages.

MODULE II ELECTROMAGNETICS AND ELECTROSTATICS 5

Basic field equations – calculation of field distribution – flux linkages – voltage induced – storage energy in electric field and magnetic field inductance – capacitance - Laplace and Poisson equation.

MODULE III CAD PACKAGES 8

Recent developments – preprocessing – modeling – boundary conditions – material characteristics – problem formulation – solution – post processing.

MODULE IV FINITE ELEMENT ANALYSIS 9

Mathematical formulation – differential and integral equation-FDM-discretisation – shape functions – stiffness matrix – solution techniques – post processing.

MODULE V FUNDAMENTAL DESIGN PROBLEMS 8

Design of actuator – solenoid –Inductance and force calculation– transformer with EMF equation.

MODULE VI DESIGN PROBLEMS IN MOTORS 10

Induction motor - switched reluctance motor – stepper motor – P.M. machines-Torque calculation.

TOTAL HOURS - 45

REFERENCES:

1. Sheppard J. Salon, “Finite Element Analysis of Electrical Machines”, Springer Edition, 2009.
2. Nicola Bianchi, “Electrical Machines Analysis Using Finite Elements”, Taylor & Francis group, 2009.
3. P.P. Silvester and Ferrari, “Finite Element for Electrical Engineers”, Cambridge University Press, 1984.
4. D.A. Lowther and P.P. Silvester, “Computer Aided Design in Magnetics”, Springer Verlag, Newyork, 1986.
5. M.V.K. Chari and P.P. Silvester, “Finite Elements in Electric and Magnetic Field Problems”, John Wiley, 1980.

OUTCOMES:

At the end of the course, the students are expected to possess knowledge and achieve skills on following:

- To implement the importance of CAD to applications.
- To model electromagnetic field equation and problem formulation for CAD application.
- Apply theoretical concepts in designing of Electrical Apparatus.
- To design actuators, solenoid, transformer and AC Machines using MAGNET software.
- Model any Electrical Apparatus.
- Apply FEM for the designing of differential eqaution.

EECX23 SOFTWARE FOR CIRCUIT SIMULATION

L	T	P	C
2	0	2	3

OBJECTIVES:

- To gain hands-on experience to simulate, verify, examine, and design electrical, mechanical and electronic circuits using electrical software such as PSPICE, MATLAB, MagNet and Lab View
- To possess the intuitive analysis skill to forecast / illustrate the circuit simulation results.

PREREQUISITES: Computer basics, Network Theory, Electronic Devices and Basic Electrical Machines

MODULE I PSPICE 8

Introduction – PSpice overview – DC circuit Analysis –AC circuit analysis –Transient and the time domain analysis – Fourier Series and Harmonic components – Modelling of devices like BJT, FET and MOSFET as amplifiers and oscillators and their analysis.

MODULE II MATLAB 7

Introduction - function description – Data types – Tool boxes – Graphical Display- Import and Export of data - programs for numerical solutions of equations.

MODULE III MAGNET 8

Introduction - 2D mesh adaption tools - 2D boundary conditions – Modelling and predicting the performance of any electromagnetic or electromechanical device such as Electric Motors / Generators and Transformers.

MODULE IV LABVIEW 7

Introduction – Lab view concepts - Environment basics – Graphical programming basics – for and while loops – Arrays and clusters – Graphs and Charts – Structures - Debugging tools.

LABORATORY PRACTICE

1. Forward Characteristics of Diode using PSPICE
2. Resonant frequency analysis of series RLC circuit using PSPICE
3. Transient Analysis of RC circuit using PSPICE
4. Import and Export data in MATLAB
5. Solution of numerical equations by Newton Raphson method using MATLAB

6. Numerical integration by Trapezoidal method using MATLAB
7. Performance analysis of Electric motors using MAGNET
8. Performance analysis of Transformer using MAGNET
9. Create a VI to display the numbers 1 to 10 in a Numeric Indicator using a While Loop in LabVIEW
10. Import and Export data in LabVIEW

L-30; P-30; Total Hours -60

REFERENCES:

1. Paul Tobin Morgan, “Pspice for Circuit Theory and Electronic Devices”, Claypool publishers, 2007.
2. Amos Gilat, “MATLAB: An Introduction with Applications”, Wiley Publication,2012.
3. “MagNet Version 6.23 user guide” by Infolytica Corporation, 2007.
4. Gary W. Johnson , Richard Jennings, “Labview Graphical Programming”, McGraw Hill Education, 2017.
5. Rajagopalan V., Marcell Dekker, “Computer aided analysis of power electronic
6. systems”, 1987.
7. John Keown, “Microsim Pspice and Circuit analysis”, Prentice Hall Inc, 1998.
8. “Matlab / Simulink manual”, MathWork, 2010.
9. Robert H., “Learning with Labview 2009”, Bishop prentice Hall, 2009.

OUTCOMES:

At the end of the course, the student is expected to possess knowledge and achieve skills on the following:

- Modelling and simulation of electrical and electronic circuits and evaluate their performance.
- Write MATLAB codes for various mathematical evaluations of systems.
- Model and predict the performance of any electromagnetic or electromechanical devices.
- Create graphical programs and GUI for specific operations in systems.

EECX24 ELECTROMAGNETIC FIELD COMPUTATION AND MODELLING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge on the mathematical modelling of physical systems for analysis.
- To make the students analyse the system based on controllability and observability methods.
- To Introduce design techniques for effective control.
  To provide concept for analysing the stability of a system.

MODULE I INTRODUCTION 9

Review of basic field theory – electric and magnetic fields – Maxwell's equations– Laplace, Poisson and Helmoltz equations – principle of energy conversion – force/torque calculation – Electro thermal formulation.

MODULE II SOLUTION OF FIELD EQUATIONS I 8

Limitations of the conventional design procedure, need for the field analysis based design, problem definition, solution by analytical methods-direct integration method – variable separable method – method of images, solution by numerical methods- Finite Difference Method.

MODULE III SOLUTION OF FIELD EQUATIONS II 9

Finite element method (FEM) – Differential / integral functions – Variational method – Energy minimization – Discretisation – Shape functions –Stiffness matrix –1D and 2D planar and axial symmetry problem.

MODULE IV FIELD COMPUTATION FOR BASIC CONFIGURATIONS 7

Computation of electric and magnetic field intensities– Capacitance and Inductance – Force, Torque, Energy for basic configurations

MODULE V BASIC EXERCISES IN FEA PACKAGES 6

Modeling – Pre-processing – A vector and flux plot calculations – deriving point quantities in Post-processing.

MODULE VI DESIGN APPLICATIONS 6

Insulators- Bushings – Cylindrical magnetic actuators – Transformers – Rotating machines.

Total Hours – 45

REFERENCES:

1. K.J.Binns, P.J.Lawrenson, C.W Trowbridge, "The analytical and numerical solution of Electric and magnetic fields", John Wiley & Sons, 1993.
2. Nathan Ida, Joao P.A.Bastos, "Electromagnetics and calculation of fields", Springer-Verlage, 1992.
3. Nicola Biyanchi, "Electrical Machine analysis using Finite Elements", Taylor and Francis Group, CRC Publishers, 2005.
4. S.J Salon, "Finite Element Analysis of Electrical Machines." Kluwer Academic Publishers, London distributed by TBH Publishers, India, 2007.
5. User manuals of MAGNET, MAXWELL & ANSYS software.
6. Silvester and Ferrari, "Finite Elements for Electrical Engineers" Cambridge University press, 1983.

OUTCOMES:

At the end of the course, the student is expected to possess knowledge and achieve skills on the following:

- Model the physical systems in terms of mathematical model for easier analysis.
- Analyse the system controllability and observability.
- Ability to model electric systems in finite element analysis scenario.
- Ability to calculate any electrical or magnetic parameter from the analysis and co-relate it.
- Design and develop modal control technique for systems.
- Analyse the systems stability using Lyapunov's theory.

EECX25 SOLID STATE AC AND DC DRIVES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To study and understand the operation of electrical drives - D.C. motor drives, Induction motor drives, Synchronous motor drives.
- To analyze the closed-loop control of both DC and AC drives.
- To understand the differences between induction motor drives and synchronous motor drives.

MODULE I ELECTRIC MOTOR CHARACTERISTICS 7

Characteristics of DC motors - Induction motors - Synchronous motors - Constant torque and constant HP operations – Four quadrant operations – Rating of motors - Selection of drives.

MODULE II CONVERTER FED DC DRIVES 8

Single phase semi and full converter fed drives – three phase semi and full converter fed drives – continuous and discontinuous modes – closed loop converter fed drives.

MODULE III CHOPPER FED DC DRIVES 7

Operation of Class A, B, C, D, E chopper fed DC drives - four quadrant operations – closed loop chopper fed drives.

MODULE IV STATOR CONTROLLED INDUCTION MOTOR DRIVES 7

AC voltage controller fed induction motor drive – VSI and CSI fed drives – closed loop stator-controlled induction motor drives - Braking methods for induction motors.

MODULE V ROTOR CONTROLLED INDUCTION MOTOR DRIVES 8

Rotor resistance control – slip power recovery scheme - Scherbius drive - sub synchronous operation, Kramers drive – super synchronous operation – closed loop rotor-controlled drives.

MODULE VI SYNCHRONOUS MOTOR DRIVES 8

Operation of wound field cylindrical and salient pole synchronous motor for constant voltage and constant frequency source – brushless excitation – closed loop self controlled synchronous motor drives.

Total Hours – 45

REFERENCES:

1. Gopal K.Dubey, "Power semiconductor controlled drives", Prentice Hall international, 1989.
2. Vedam subramanyan, "Thyristor Control of Electrical Drives", Tata McGraw-Hill Co.Ltd., 1988.
3. Murphy, J.M.D and Turnbull.F.G., "Thyristor control of AC Motors", Pergamon Press, 1988.
4. B.K. Bose, "Power Electronics and AC Drives", Prentice Hall Onglewood cliffs, New Jersey, 1986.
5. S.B. Dewan, Gordon R. Slemon and A. Straughen, "Power Semiconductor Drives", John Wiley Pub., 1996.

OUTCOMES:

At the end of the course the student will be able to

- Apply suitable motor for different applications
- Apply suitable power electronic controller for electric drives.
- Design and analyze converter fed DC drive.
- Design and analyze chopper fed AC drive.
- Apply power electronic controllers for the speed control of induction motor drives.
- Apply power electronic controllers for the speed control of synchronous motor drives.

EECX26 CONVERTERS, APPLICATIONS AND DESIGN

L	T	P	C
3	0	0	3

OBJECTIVES:

- To get an overview of different types of power semi-conductor devices and their switching characteristics.
- To understand the operation, characteristics and performance parameters ofcontrolled rectifiers.
- To design & implement real time industrial application of Power Electronicequipments.
- To know the practical application for power electronics converters in conditioning the power supply.

MODULE I PROTECTION OF POWER ELECTRONIC DEVICES 7

SCR – Triac – MOSFET - IGBT - Protection Circuits - Snubber Circuits –Ratings - safe operating Area - Heat sink Design.

MODULE II DESIGN OF CONTROLLED CONVERTERS 8

Gate pulse generating circuits - conventional methods, gate pulse generationusing microcontroller, gate drive circuits - Pulse Transformers - Opto Triacs - Synchronisation Circuits - fully controlled fed DC motor - Open loop, closedloop.

MODULE III DC-DC CONVERTERS 7

Half Bridge and Full Bridge Driver ICs for MOSFET and IGBT - Phase shiftedseries Resonant Converters - ZCS – ZVS – DC to DC Converter for ElectricVehicle.

MODULE IV PHASE CONTROLLERS 8

Photosensors - Temperature sensors - Micro controller Programming for phaseangle control - Implementation of phase controller for illuminating lights &Electric furnace control using micro controller -Maximum power point trackers Grid connected inverter - Implementation of converters for solar panel.

MODULE V SWITCHING POWER SUPPLIES 8

Design of PWM inverters - SPPWM inverters - Design and implementation of UPS and SMPS - Harmonic analysis of inverters using Harmonic Analyser.

MODULE VI CASE STUDY 7

Mini Project Model – Hardware Fabrication – converter – DC to DC Converter DC Drives.

Total Hours – 45

REFERENCES:

1. M.H. Rashid, “Power Electronics Handbook”, Elsevier Press, Micro C Manual, 2003.
2. Nihal Kularatna, “Power Electronics Design Handbook”, “Low-PowerComponents and Applications”, 1999.
3. Keith H. Sueker, “Power Electronics Design - A Practitioner’s Guide”, 1998.
4. “International Rectifiers”, Application note Catalogue.

OUTCOMES:

At the end of the course, the student is expected to possess

- Practical exposure in DC-DC converter and control.
- Knowledge in power control devices.
- Experience to selection of converter for various application.
- Design controllers for drives.
- Fabricate hardware for project models.
- Design and implement SMPS and UPS.

EECX27	**POWER ELECTRONICS APPLICATION TO RENEWABLE ENERGY SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To provide basic understanding of the emerging power electronics technologies to Renewable systems.
- To enable students to design power electronics circuit that can control active and reactive power flow in grids.
- To integrate theory and practical knowledge of power system protection.

MODULE I OVERVIEW OF ENERGY CONVERSION AND RENEWABLE ENERGY SYSTEMS 7

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems -Block diagram.

MODULE II ELECTRICAL ENERGY CONVERSION SYSTEMS 8

Review of reference theory fundamentals - principle of operation and analysis: IG, PMSG, SCIG and DFIG - different conversion schemes - fixed and variable speed operation - drive selection - power control - braking systems - grid integration issues.

MODULE III POWER CONVERSION IN RENEWABLE SYSTEMS 8

Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters - Inverters for high power applications: Multi-level Inverters, Analysis of their performance, Selection of inverter, Battery sizing, Array sizing, harmonics, Interaction with power grid.

MODULE IV ANALYSIS OF WIND ENERGY SYSTEMS 8

Stand alone operation of fixed and variable speed wind energy conversion systems - electrical design - power collection systems – earthing - electrical protection - reactive VAR issues - compensators -remote monitoring and control - economic aspects.

MODULE V ANALYSIS OF PV SYSTEMS 8

Technical and non-technical considerations - system size and module choice - mounting systems and building integration- power conditioning system - lightning protection - earthing - metering Stand-alone systems: Modules-Batteries - charge controllers -sizing of PV arrays – applications.

MODULE VI HYBRID RENEWABLE ENERGY SYSTEMS 6

Need for Hybrid Systems- Range and type of Hybrid systems- micro wind systems and solar system- Grid integrated PMSG and SCIG Based WECS - Case studies.

Total Hours –45

REFERENCES:

1. Rashid M. H, "Power electronics Hand book", Academic press, 2001.
2. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4. Gray, L. Johnson, "Wind energy system", Prentice Hall Inc, 1995.
5. B.H.Khan, “Non-conventional Energy sources”, Tata McGraw-hill Publishing Company, New Delhi.

OUTCOMES:

At the end of the course, the student will be able to

- understand different renewable energy resources : Solar, Wind, Ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.
- develop RE systems considering sustainable development.
- Possess knowledge on the advancements in designing of power electronics equipments related to renewable energy sources.
- Identify power electronics topologies for used in controlling active and reactive power in a RES.
- understand Grid Connection Issues in the RES plant.
- Identify and integrate and justify the techniques to be used in the planning and operation of grid control with renewable energy sources

EECX28	**EMBEDDED CONTROL OF ELECTRIC DRIVES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To make the student into a competent and independent practitioner in the field of embedded systems.
- To provide an In-depth study both of microcontroller design, and of the Power Electronic Converters and Electric Drives to which the microcontroller must interface.
- Study and application of a Real Time Operating System using programming in C.

MODULE I PIC16F8XX- MICROCONTROLLERS 8

Function - I/O Ports – Timers - CCP Modules - Serial Communication Modules - Analog Modules - EEPROM.

MODULE II MICROCONTROLLER C 8

Mikro C Compiler reference - mikro C Libraries: ADC, PWM, Keypad, LCD, Trigonometric Libraries –Preprocessor - Statements.

MODULE III ALGORITHM AND PROGRAMMING IN MIKROC 8

Source codes in Mikro C: ADC and PWM – Unipolar SPWM – Phase Angle Control with Zero Crossing Detection- LCD with Key Pad - Speed Measurement.

MODULE IV ISOLATORS AND SENSORS 10

High Speed Opto-Couplers – Zero Crossing Detectors - Optically Isolated High Voltage and High Current sensing circuits –Optical Encoders – Tachogenerators.

MODULE V CLOSED LOOP CONTROL OF ELECTRIC DRIVES 6

Closed Loop Control - Hardware and Software Implementation: DC Motor control using PWM based DC-DC converters and Controlled Rectifiers – AC Motor Control Using TRIAC Phase Controller, SPWM inverter fed single and three phase induction motors.

MODULE VI MICRO C BUILDING APPLICATIONS 5

Micro C IDE - Code Editor- Code Explorer – Debugger – Error Window – Statistics – Integrated Tools - Building applications - Projects – Source Files - Search Paths –

Managing Source Files – Compilation - Output Files – Assembly View – Error Messages - Burning Software - Overview of Microbar - ICSP port

.

Total Hours – 45

REFERENCES:

1. John Main, "PIC Microcontroller C", 2007.
2. "Mikro C- Compiler for PIC Microchip controllers", Mikro Electronika.
3. Martin P. Bates, "Programming 8-bit PIC Microcontrollers in C: With Interactive Hardware Simulation", 2006.
4. Tim Wilmshurst, "Designing Embedded Systems with PIC Microcontrollers-Principles and applications", Newnes, 2007.
5. Martin P. Bates, "PIC Microcontrollers–An Introduction", Newnes, 2011.

OUTCOMES:

At the end of the course, the student will have:

- A thorough understanding on PIC Microcontroller and its modules.
- Able to provide details of hardware and software development of modern embedded systems.
- The ability to form algorithm and execute programming in mikro C.
- The capability to design power electronics equipments related to renewable energy sources.
- The ability to simulate closed loop Control of Electric Drives.
- The capability to apply micro c compiler for real time operating systems.

EECX29	**POWER QUALITY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To acquire knowledge on factors affecting Power Quality.
- To analyze power quality problems.
- To mitigate power quality issues in electrical network.

MODULE I POWER QUALITY TERMS AND DEFINITIONS 8

Introduction – transients - short duration/long duration voltage variations -voltage imbalance - waveform distortion - voltage fluctuations – power frequency variation. Power Quality Problems - Poor load power factor – loads containing harmonics - notching in load voltage -DC offset in loads – unbalanced loads - disturbance in supply voltage.

MODULE II VOLTAGE SAGS AND INTERRUPTIONS 8

Sources of sags and interruptions - end user issues - Ferro resonant transformer - on-line UPS - hybrid UPS - motor generator set, SMES etc. -motor starting sags - utility system fault clearing issues.

Transient over Voltage - Sources of transient over voltages - principles of over voltage protection - devices for over voltage protection - utility capacitor switching transients - utility lightning protection - load-switching transient problems.

MODULE III LONG DURATION VOLTAGE VARIATIONS 8

Devices for voltage regulation - Utility voltage regulator applications – capacitors for voltage regulation- end-user capacitor application - regulating Utility voltage with dispersed sources.

Quality and Reliability of Power Supply - Reliability of power supply – reliability measurements consumer interruption cost - distribution automation – substation grounding - energy auditing.

MODULE IV HARMONICS 7

Voltage and current harmonics distortions - harmonics of single-phase power supplies - three phase power converters - arcing devices - storable devices -effects of harmonics distortion - system response characteristics – locating sources of harmonics, peripherals for controlling harmonics - devices for filtering harmonics.

MODULE V WIRING AND GROUNDING 7

Harmonics study procedure - symmetrical components - modeling harmonics sources - harmonic filter design - telecommunication interferences – Reason for grounding - typical wiring and grounding problems and their solutions.

MODULE VI POWER QUALITY MONITORING AND CUSTOM POWER DEVICES 7

Power quality related standards - standard test waveform and detailed power quality monitoring - power quality measurement equipments. Custom Power Devices: Utility customer interface - network reconfiguring device load compensation using shunt compensators - voltage regulation using shunt compensators - dynamic voltage restorer - unified power quality conditioner - Computer tools for harmonic analysis.

Total Hours – 45

REFERENCES:

1. Roger C.Dugan, Mark F. Mc Granhgan, Surya Santoso," Electrical Power System Quality", Mc Graw hill, 2nd Edition, 2001.
2. Arindam Ghosh and Gerard Ledwich, "Power Quality Enhancement using custom power devices", Kulwer academic publisher, 2004.
3. C.L Wadhwa, "Generation and Distribution utilization of electrical Energy", New Age International.
4. C. Sankarm, "Power Quality" CRC Press USA, 2000.
5. Barry W. Kennedy, "Power Quality Primer "McGraw Hill, 2000.
6. Wilson E. Kazibwe, Van Nostrand Reinhold, "Electrical power quality controls techniques".

OUTCOMES:

At the end of the course, the student is expected to possess knowledge and achieve skills on the following:

- Understand the power quality issues and its importance.
- Evaluate the characteristics of power quality disturbances.
- Analyse the sources of power quality issues.
- Understand the importance of computer tools and equipments to measure power quality disturbance
- Identify the techniques to mitigate power quality disturbances.
- Know the importance of grounding to improve power quality.

EECX33 IoT FOR ELECTRICAL ENGINEERS

L	T	P	C
3	0	0	3

OBJECTIVES:

- The objective of this course is to introduce IoT in Electrical and Electronics Engineering
- Introduces CLOUD PLATFORMS and PROTOCOLS.
- To provide practical experience with IoT and microcontroller systems
- Demonstrates the use of the IoT.

MODULE I INTRODUCTION TO INTERNET OF THINGS (IoT) 4

Introduction - Overview of the Architecture of Internet of Thing- Overview of the top-level components: the device, gateway and cloud - IOT enabling technologies.

MODULE II IOT COMPONENTS 5

Device platforms : Raspberry Pi - Arduino controller – Overview of Device platforms and interfacing - USB – GPIO - Inter-Integrated Circuit serial bus Serial Peripheral Interface Bus, Universal Asynchronous Receiver/Transmitter (UART) -Sensors: Temperature and Humidity, Moisture, light, Voltage , Current, IR, PIR and Hall sensors.

MODULE III COMMUNICATION PROTOCOLS FOR IoT 6

Basics of the MQTT, HTTP, CoAP Protocols –installing the Arduino MQTT Libraries - testing MQTT.

MODULE IV OVERVIEW OF CLOUD PLATFORMS 10

Overview of Cloud platforms - AWS IoT Platform -Microsoft Azure IoT Hub - IBM Watson/Bluemix cloud IoT Platform - Google Cloud Platform - SAP Cloud Platform - General Electric’s Predix cloud - Node-RED programming tool - Arduino Ethernet Shield, GSM module, Wi-Fi module and NodeMCU.

MODULE V INTERFACING CLOUD PLATFORM WITH HARDWARE 12

LM 35 Temperature sensor and calibration – interfacing LM 35 with Arduino – Interfacing Ethernet shield with Arduino – sending data from arduino to cloud platform – monitoring temperature in the cloud.

MODULE VI APPLICATION OF IOT IN SMART GRID 8

Case Study: Advanced metering infrastructure (AMI) – remote control operation of energy consuming devices – virtual power plants and smart metering.

Total Hours – 45

REFERENCES:

1. Peter Waher "Learning Internet of Things" Copyright © 2015 Packt Publishing
2. Pradeeka Seneviratne, "Internet of Things with Arduino Blueprints", Published by Packt Publishing Ltd. UK. © 2015
3. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems Dr. Ovidiu Vermesan,Dr. Peter Friess *Published by* River Publishers Denmark © 2013.
4. John Soldatos "Building Blocks for IoT Analytics Internet-of-Things Analytics" ©2017 River Publishers, Denmark
5. Martin P. Bates,"Programming 8-bit PIC Microcontrollers in C: With Interactive Hardware Simulation.
6. Michael Margolis "Arduino Cookbook" O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472.@ March 2011.

OUTCOMES:

At the end of the course, the student is expected to possess knowledge and achieve skills on the following:

- Work on different projects making use of the IoT.
- Implement sensor interfaces in various Cloud systems by using various interfacing techniques.
- Enable the student to design IoT based monitoring to interact with real-world systems
- Design and develop Arduino microcontroller and NodeMCU based automation systems.
- Develop and demonstrate how to accomplish a given task using IoT with Arduino microcontroller.
- Demonstrate a working knowledge of the necessary steps and methods used to interface a IoT system to devices such as relays, meters, motor controls and sensors, etc.

HIGH VOLTAGE ENGINEERING

EECX36	HIGH VOLTAGE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide fundamental knowledge on effects of overvoltges in power sytems
- To understand breakdown mechanisms in gaseous, liquids
- To perceive breakdown mechanisms in solid and composite dielectrics.
- To understand the generation of high voltages and currents.
- To study different measurement techniques for high voltages and currents.
- To analyze various high voltage testing methods.

MODULE I OVER VOLTAGE PHENOMENON AND INSULATION COORDINATION 8

Natural causes for over voltages – Lightning phenomenon, Overvoltage due to switching surges, system faults and other abnormal conditions, Principles of Insulation Coordination on High voltage and Extra High Voltage power systems.

MODULE II BREAKDOWN IN GASEOUS AND LIQUID DIELECTRICS 7

Gases as insulating media, collision process, Ionization process, Townsend’s criteria of breakdown in gases, Paschen’s law - Streamer theory-Breakdown in non uniform fields and corona discharges. Liquid as Insulator, pure and commercial liquids, breakdown in pure and commercial liquids.

MODULE III BREAKDOWN IN SOLID DIELECTRICS 8

Intrinsic breakdown, electromechanical breakdown, thermal breakdown, breakdown of solid dielectrics in practice, Breakdown in composite dielectrics, Solid dielectrics used in practice.

MODULE IV GENERATION OF HIGH VOLTAGES AND CURRENTS 8

Generation of High Direct Current Voltages, Generation of High alternating voltages, Generation of Impulse Voltages, Generation of Impulse currents, Triggering and control of impulse generators.

MODULE V MEASUREMENT OF HIGH VOLTAGES AND CURRENTS 7

Measurement of High DC, AC and impulse voltages, Measurement of High DC, AC and impulse currents, Digital techniques in high voltage measurements.

MODULE VI HIGH VOLTAGE TESTING 7

High voltage testing of Transformers, Insulators and bushings, cables, Isolators and circuit breakers, surge Arresters- Radio Interference measurements.

TOTAL HOURS – 45

REFERENCES:

1. C.L.Wadhwa, “High Voltage Engineering”, by New Age Internationals (P) Limited, 1997.
2. Ravindra Arora, Wolfgang Mosch, “High Voltage Insulation Engineering”, by New Age International (P) Limited, 1995.
3. M.S.Naidu and V. Kamaraju - High Voltage Engineering”, by – TMH Publications, 3rd Edition, 2000.
4. E.Kuffel, W.S.Zaengl, J.Kuffel, “High Voltage Engineering”, Fundamentals by Elsevier, 2nd Edition, 1999.

OUTCOMES:

At the end of the course, the student will be able to

- understand the causes of abnormal operating conditions (faults, lightning and switching surges) in power systems and the principles of insulation coordination in high voltage and extra high voltage systems.
- gain knowledge of the various breakdown mechanisms in, liquid and gaseous dielectrics
- analyze the fundamental behaviour and breakdown mechanisms in solid and composite dielectrics.
- generate high AC,DC and impulse voltages and currents.
- gain knowledge on measurement of high AC, DC and impulse voltages and impulse currents.
- select appropriate type of test for each high voltage power apparatus.

EECX37	**BIO-ELECTRICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To teach the students, some of the basic concepts of bio-electrics through pulsed power principles.
- To impart a detailed knowledge on pulsed power systems.
- To study about various applications of electroporation
- To gain a detailed knowledge on electroporation
- To study about equipments used for electroporation
- Applications of electroporation

MODULE I BIO-ELECTRICITY 8

Introduction – Diffusion – Comparison of gravity and diffusion – Membrane potential – membrane capacitance – Ion selectivity – Channel density – Channel conductance – Channel number, channel conductance and membrane potential – Channel conductance and random switch – Probability – Membrane potential revisited – Diffusion potential – More realistic view of cell potential – Channel opening probability – Channels in membranes – Classes of selective holes – Total membrane conductance and potential.

MODULE II PULSED SYSTEMS: DESIGN PRINCIPLES 7

Lumped parameter pulsed systems - Principle schemes for pulse generation – Voltage multiplication and transformation. Pulse generation using long lines - Generation of nanosecond pulses – voltage multiplication in line based generators – pulse systems with segmented and non uniform lines.

MODULE III APPLICATIONS OF PULSED POWER AND PLASMAS TO BIO-SYSTEMS AND LIVING ORGANSISMS 8

Pulsed power source using magnetic compression system – discharge plasma by pulsed power – action of pulsed power and discharge plasma to bio-systems.

MODULE IV ELECTROPORATION 7

Introduction to Electroporation – Electroporation and cellular physiology – the cell in the electric field.

MODULE V EQUIPMENT FOR ELECTROPORATION

Pulse generator – Applicator – Electrode – Electrochemotherapy – Gene Electrotransfer – DNA Vaccination – Irreversible Electroporation.

MODULE VI APPLICATIONS OF ELECTROPORATION 7

Case Study.

TOTAL HOURS – 45

REFERENCES:

1. Louis J. Defelice, "Electrical Properties of Cells: Patch Clamp for Biologists", Plenum press, 1997.
2. Eberhard Neumann, Arthur.E.Sowers, Carol A. Jordan, "Electroporation and Electrofusion in cell biology", Plenum press, New York, 1989.
3. Gennadii Andreevich Mesiats, "Pulsed power", Springer, 2005.
4. Yoshinobu Kawai, Hideo Ikegami, Noriyoshi Sato, Akihisa Matsuda, Kiichiro Uchino, Masayuki Kuzuya, Akira Mizuno, "Industrial Plasma Technology", 2007.
5. Stephen T.Lee, Julie Gehl, Edward W.Lee, "Clinical aspects of Electroporation", Springer, 2011.

OUTCOMES:

At the end of the course, the student is expected to possess knowledge and achieve skills on the following:

- Pulsed power principles and bio-electricity.
- Illustrate the design principles of pulse forming networks
- Appraise the pulse and plasma transmission to bio-systems and living organisms
- Understand the concept of electroporation and its application in cellular physiology
- Identify and apply an appropriate equipment for electroporation technique
- Electroporation and applications of electroporation through conducting of case studies

EECX38	EHVAC AND HVDC TRANSMISSION ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide an in depth understanding of the different aspects of Extra High Voltage AC and HVDC transmission system analysis and design.
- To acquire knowledge about the various parameters of EHV lines
- To study about the various EHVAC transmission schemes
- To acquire knowledge about the various EHV testing methods and techniques.
- Compare EHVAC and HVDC systems and suggest appropriate transmission systems based on requirement and constraints
- Understand about the overvoltage and its effects on power system. Complete analysis of harmonics and basis of protection for HVDC systems

MODULE I INTRODUCTION 8

Need of EHV transmission-standard transmission voltages-comparison of EHVAC and HVDC transmission systems and their applications & limitations-surface voltage gradients in conductor- distribution of voltage gradients on sub-conductors- mechanical considerations of transmission lines-modern trends in EHVAC and HVDC transmission.

MODULE II PARAMETERS OF EHV LINES 8

Resistance of conductors- bundle conductors-inductance of EHV Line configurations line capacitance-sequence inductance and capacitance- line parameters for modes of propagation- resistance and Inductance of ground returns.

MODULE III EHVAC TRANSMISSION 7

Corona loss formulas- corona current- audible noise – generation and characteristics corona pulses their generation and properties- radio interference (RI) effects- over voltage due to switching- ferroresonance-reduction of switching surges on EHV system.

MODULE IV EXTRA HIGH VOLTAGE TESTING AND DESIGN OF EHV LINES 7

Characteristics and generation of impulse voltage -generation of high AC and DC voltages- measurement of high voltages by sphere gaps and potential dividers- Consideration for Design of EHV Lines: Design factors under steady state limits- EHV line insulation design based upon transient over voltages- Effects of pollution on performance of EHV lines.

MODULE V HVDC TRANSMISSION 7

Types of DC links- converter station-choice of converter configuration and pulse number- effect of source inductance on operation of converters- Principle of DC link control- converter controls characteristics- firing angle control- current and excitation angle control- power control-starting and stopping of DC link.

MODULE VI CONTROL AND PROTECTION OF HVDC LINE 8

Converter faults- protection against over currents and over voltages-smoothing reactors-generation of harmonics- AC and DC filters- Multi Terminal DC systems (MTDC): Types, control- protection and applications-control of HVDC system desired features of control - control characteristics

TOTAL HOURS –45

REFERENCES:

1. Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering” Revised Second Edition, John Wiley.
2. K.R. Padiyar, “HVDC Power Transmission System”, Second revised Edition, New Age Int. 2012
3. S. Rao, “EHVAC and HVDC Transmission Engineering Practice”, Khanna Publishers, 2000.
4. Arrillaga J “High Voltage Direct current Transmission” 2nd Edition (London) Peter Peregrinus, IEEE.
5. Hingorani HG and Gyugyi L “Understanding FACTS-concepts and Technology of Flexible AC Transmissions Systems” New York, IEEE Press, 2010.
6. Padiyar K R “FACTS controllers in Power Transmission and distribution” New Delhi, New Age Int. publishers.
7. Clayton R.Paul, “Analysis of multi-conductor transmission lines”, Wiley publication, 2000.

OUTCOMES:

At the end of the course, the student will be able to

- compute the surface voltage gradient for bundled conductors.
- compute the line parameters for EHVAC transmission lines.
- explain the issues, such as corona, radio interference and switching surges, in

EHVAC systems.

- design an EHVAC transmission system for the given requirement and explain the methods of testing EHVAC systems.
- explain the operation of converters in HVDC transmission systems.
- analyze a HVDC systems for faults and identify suitable methods to control and protect it.

EECX39 HIGH VOLTAGE DIRECT CURRENT TRANSMISSION

L	T	P	C
3	0	0	3

OBJECTIVES:

- Understand the evolution of HVDC conversion and transmission
- To develop the skills in the area of HVDC power transmission with the analysis of HVDC converters, harmonics and design of filters.
- To understand about the various control schemes associated with HVDC systems
- To analyze AC/DC system interactions and know the operation and control of various MTDC systems.
- To acquire knowledge about the power flow analysis in HVDC systems
- To study about different applications of HVDC systems.

MODULE I INTRODUCTION TO TRANSMISSION SYSTEMS 8

Introduction – Evolution of HVDC Transmission systems – Comparison of HVAC and HVDC transmission systems – Types of HVDC transmission systems – Components of HVDC transmission systems.

MODULE II ANALYSIS OF HVDC CONVERTERS AND HVDC SYSTEM 8

Analysis of simple rectifier circuits – Bridge Rectifier analysis – Analysis of HVDC Converter: Different modes of converter operation - Output voltage waveforms and DC voltage in rectification - Output voltage waveforms and DC in inverter operation - thyristor voltages - Equivalent electrical circuit.

MODULE III HVDC SYSTEM CONTROL 8

HVDC System control features – Control modes - Control schemes – Control comparisons.

MODULE IV MULTITERMINAL DC SYSTEMS 10

Converter mal-operations – Commutation failure – starting and shutting down the converter Bridge – Converter Protection - Smoothing reactor and DC lines – Reactive power requirements – Harmonic Analysis – Filter Design

MODULE V POWER FLOW ANALYSIS IN AC/DC SYSTEMS 6

Component Models for the Analysis of AC and DC Systems - Power flow analysis of AC-DC systems - Transient stability analysis - Dynamic stability analysis.

MODULE VI APPLICATIONS OF HVDC SYSTEMS 5

Multiterminal HVDC system - Advances in HVDC transmission - HVDC system application in wind power generation.

TOTAL HOURS – 45

REFERENCES:

1. KR Padiyar, “HVDC Power Transmission Systems”, Willey Eastern Limited, Second edition, 2001.
2. J Arrillaga, “High Voltage Direct Current Transmission”, Peter Peregrinus Ltd, UK, 1999.
3. EW Kimbark, “Direct Current Transmission”, Wiley-Interscience, New York, 2000.
4. SN Singh, “Electric Power Generation, “Transmission and Distribution”, PHI, New Delhi 2nd edition, 2008.
5. P. Kundur, “Power System Stability and Control”, McGraw-Hill, 1993.
6. Additional reading - Research Papers.
7. Erich Uhlmann, “Power Transmission by Direct Current”, BS Publications, 2004.
8. V.K.Sood, HVDC and FACTS controllers – “Applications of Static Converters in Power System”, Kluwer Academic Publishers, 2004.

OUTCOMES:

At the end of the course, the student is expected to possess knowledge and skills on the following:

- Ability to identify and design the various components of HVDC system.
- Ability to analyse the HVDC converters for different modes of operation.
- Ability to design the different control schemes for HVDC system.
- Ability to design the protection schemes for converters and filters to overcome harmonics in multi terminal HVDC system operations
- Ability to perform power flow analysis ,transient stability and dynamic stability analysis in HVDC systems
- Ability to implement the HVDC system for different applications.

EECX40	**ELECTROMAGNETIC INTERFERENCE AND ELECTROMAGNETIC COMPATIBILITY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

This course conveys essential facts on:

- Different electromagnetic Interference problems occurring in Intersystem and their possible mitigation techniques in Electronic design.
- EMI Sources, EMI problems and their solution methods in PCB level / Subsystem and system level design.
- Characteristics and design of electromagnetic compatibility
- Methods of coupling, grounding, filtering, shielding and coating
- Explain the digital logic noise and ground noise
- Standard and laboratory techniques for EMC standards

MODULE I BASIC CONCEPTS 6

Definition of EMI and EMC with examples - Classification of EMI/EMC - CE, RE, CS, RS Modules of parameters - Sources of EMI - EMI coupling modes - CM and DM, ESD phenomena and effects - Transient phenomena and suppression.

MODULE II EMI MEASUREMENTS 8

Basic principles of RE, CE, RS and CS measurements - EMI measuring instruments- Antennas, LISN, Feed through capacitor, current probe, EMC analyzer and detection technique - Open area site - shielded anechoic chamber - TEM cell.

MODULE III EMC STANDARD AND REGULATIONS 8

National and Intentional standardizing organizations- FCC, CISPR, ANSI, DOD, IEC, CENEEC, FCC CE and RE standards - CISPR, CE and RE Standards - IEC/EN, CS standards - Frequency assignment - spectrum conversation.

MODULE IV EMI CONTROL METHODS AND FIXES 8

Shielding – Grounding – Bonding – Filtering - EMI gasket - Isolation transformer - Opto isolator.

MODULE V GROUNDING FOR THE EMI CONTROL 8

Characteristics of grounding systems: Impedance characteristics - Antenna characteristics – Ground, related interference - Circuit, Equipment, and System grounding: Single-point grounding scheme - Multipoint grounding Scheme - Selection of a grounding Scheme - Ground system confgurations - EMI control devices and techniques.

MODULE VI EMC DESIGN AND INTERCONNECTION TECHNIQUES 7

Cable routing and connection - Component selection and mounting - PCB design - Trace routing - Impedance control – decoupling - Zoning and grounding.

TOTAL HOURS – 45

REFERENCES:

1. Prasad Kodali.V, “Engineering Electromagnetic Compatibility”, S.Chand& Co, New Delhi, 2000.
2. Clayton R.Paul, “Introduction to Electromagnetic compatibility”, John Wiley & Sons, 1992.
3. Keiser, “Principles of Electromagnetic Compatibility”, Artech House, 3rd Edition, 1994.
4. Donwhite Consultant Incorporate, “Handbook of EMI / EMC - Vol I”, 1985.

OUTCOMES:

At the end of the course, the student is expected to possess knowledge and achieve skills on the following:

- Ability to understand Electromagnetic Interference problems and their mitigation techniques and grounding systems for EMI control.
- Real-world EMC design constraints and make appropriate tradeoffs to achieve the most cost-effective design that meets all requirements.
- Designing electronic systems that function without errors or problems related to electromagnetic compatibility
- To design systems with Electromagnetic compatibility and to diagnose and solve basic electromagnetic compatibility problems
- To able to design systems to mitigate the effects of Electromagnetic Interference.
- Knowledge and awareness on EMC design and interconnection techniques.

EECX41 OUTDOOR INSULATORS

L	T	P	C
3	0	0	3

OBJECTIVES:

The course aims at giving a comprehensive knowledge on

- Outdoor Insulators, which are mainly, used for transmission and distribution systems.
- Exposure to a range of insulation materials and composites used in HV insulation systems and their electrical properties.
- Learn a comprehensive range of testing and measurement techniques to characterise insulation materials.
- Acquire knowledge on design and manufacture of insulators.
- Acquire knowledge on partial discharges, condition monitoring and insulation quality assessment.
- Selection, design and maintainence of insulation system according to IEC standards.

MODULE I INTRODUCTION 7

Overview – Important Definitions – Types of Outdoor Insulators – Uses of Outdoor Insulators – Stresses Encountered in Service – Electrical Performance– Mechanical Performance – Role of Insulators on Overall Power System Reliability – Shapes of Outdoor Insulators – Mechanical and Electrical Ratings of Insulators – Comparison of Porcelain, Glass and Composite Insulators – Life Expectancy.

MODULE II NONCERAMIC INSULATOR TECHNOLOGY 7

Introduction - Materials for Weathersheds / Housings – Shed Design – Insulator Core – Hardware – Establishing Equivalency to Porcelain/Glass – Manufacturing Changes and Quality Control (QC) – Un-standardization/ Propagation - Live-line Maintenance Handling, Cleaning and Packaging - Brittle Fracture – Water Drop Corona – Aging and Longevity – Grading Control Rings.

MODULE III DESIGN AND MANUFACTURE OF INSULATORS 8

Porcelain Insulators – Manufacture of Porcelain Insulators – The Porcelain Suspension Insulator – Porcelain Pin-type Insulators – Porcelain Multicone Insulators – Porcelain Long-rod and Post Insulators – Porcelain Insulators Glazes - Porcelain Insulator Hardware – Porcelain Insulator Cement – The Porcelain Dielectric.

Nonceramic Insulators - Nonceramic Suspension Insulator – Line Post Insulator –

Hollow Core Insulator – Manufacture of Nonceramic Insulators – The Composite Dielectric – Voltage Stress Control.

MODULE IV TESTING STANDARDS FOR INSULATORS 8

Need for Standards – Standards Producing Organizations – Insulator Standards– Classification of Porcelain / Glass Insulator Tests – Brief Description and Philosophy of Various Tests for Cap and Pin Porcelain/Glass Insulators – Summary of Standards for Porcelain/Glass Insulators – Standards of Nonceramic (Composite) Insulators – Classification of Tests, Philosophy and Brief Description – Standards for Nonceramic Insulators.

MODULE V DETECTION OF DEFECTIVE INSULATORS 7

Detecting defective porcelain insulators – principles involved – electrical methods – thermography - Detecting defective non ceramic insulators – detection prior to installation – detecting degraded insulator during service.

MODULE VI SELECTION AND MAINTENANCE OF INSULATORS 8

Introduction – Cost and Weight – National Electricity Safety Code (NESC) – Basic Lightning Impulse Insulation Level (BIL) – Contamination Performance– Experience with Silicone Rubber Insulators in Salt Areas – Compaction – Grading Rings for Nonceramic Insulators - Maintenance of Insulators - Maintenance Inspection – Hotline washing – equivalent salt deposit.

TOTAL HOURS – 45

REFERENCES:

1. Ravi S. Gorur, Edward A. Cherney and Jeffrey T. Burnham, “Outdoor Insulators”, Ravi S. Gorur. Inc., 1999.
2. J.S.T. Looms, “Insulators for High Voltages”, Peter Peregrinus Ltd., 1988.
3. A.O. Austin, “Porcelain Insulators”, Ohio Brass Company, 1980.
4. IEC 1109, “Composite Insulators for AC overhead lines with a Nominal Voltage Greater than 1000V, Definition, Test Methods and Acceptance Criteria”, 1992.
5. EPRI, “Transmission Lines Reference Book – 345kV and above”, 1982.
6. ANSI C 29.1, “Electrical Power Insulator – Test Methods”, 1992.

OUTCOMES:

Upon completing the Course, the student will be able to do the following:

- Become familiar with different stresses encountered in the service of the insulator as well as the types and performance of Insulators.

- Able to connect the current area of research in insulators including non-ceramic insulators.
- Design and manufacturing process of insulators can be understood.
- Ability to understand the various testing standards of insulating materials
- Ability to perform quality check of insulating materials.
- The testing standards, selection and maintenance of insulators will also be made aware.

EECX44	HIGH VOLTAGE TESTING TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

To acquire knowledge on,

- basics of condition monitoring of high voltage equipment.
- pre-testing procedures by statistical evaluation methods.
- different types of testing and measurement techniques.

MODULE I INTRODUCTION 6

Objectives of high voltage testing, classification of testing methods- self restoration and non-self restoration systems-standards and specifications measurement techniques, Diagnostic testing online measurement, standard test cells.

MODULE II STATISTICAL EVALUTION OF MEASURED RESULTS 8

Determination of probability values, Distribution function of a measured quantity, confidence limits of the mean values of disruptive discharges - 'Up and Down' method for determining the 50% disruptive discharge voltage, multi stress ageing, life data analysis.

MODULE III TESTING TECHNIQUES FOR ELECTRICAL EQUIPMENT 8

Testing of insulators, bushings, air break switches, isolators, circuit breakers, power transformers, voltage transformers, current transformers, surge diverters, cable - testing methodology-recording of oscillograms - interpretation of test results.

MODULE IV NON-DESTRUCTIVE INSULATION TEST TECHNIQUES 8

Dynamic properties of dielectrics-dielectric loss and capacitance measurement-partial discharge measurements-basic partial discharge (PD) circuit - PD currents-PD quantities -Digital PD instruments and measurements, acoustic emission technique and UHF Techniques for PD identification, Corona and RIV measurements on line hardware.

MODULE V POLLUTION TESTS AND DESIGN OF HIGH VOLTAGE LAB 8

Artificial Pollution tests- salt-fog method, solid layer method, Dimensions of High voltage laboratory, equipment- fencing, earthing and shielding, circuits for high voltage experiments.

MODULE VI APPLICATION OF HIGH VOLTAGE ENGINEERING IN INDUSTRY 9

Introduction – Electrostatic applications – Electrostatic precipitation, separation, painting coating, spraying, imaging, printing – Transport of materials – Sandpaper Manufacture – Smoke particle detector – Electrostatic spinning, pumping, propulsion – Ozone generation – Biomedical applications.

TOTAL HOURS – 45

REFERENCES:

1. Dieter Kind, Kurt Feser, "High voltage test techniques", SBA Electrical Engineering Series, New Delhi,1999.
2. Naidu M.S. and Kamaraju V., "High voltage Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2004.
3. Kuffel, E., Zaengl, W.S. and Kuffel J., "High Voltage Engineering Fundamentals", Elsvier India P Ltd, 2005
4. Gallagher, T.J., and Pearmain A., "High Voltage Measurements, Testing and Design", John Willey & Sons, New York, 1983.
5. IS, IEC and IEEE standards for "Dielectric Testing of High Voltage Apparatus" W.Nelson, Applied Life Data Analysis, John Wiley and Sons, New York, 1982.
6. W.Kennedy, "Recommended Dielectric Tests and Test Procedures for Converter Transformer and Smoothing Reactors", IEEE Transactions on Power Delivery, Vol.1, No.3, pp 161-166, 1986.
7. IEC - 60270, "HV Test technique - Partial Discharge Mechanism", 3rd Edition December 2000.
8. M.D Judd, Liyang, Ian BB Hunter, "P.D Monitoring of Power Transformers using UHF Sensors" Vol.21, No.2, pp5-14, 2004.
9. M.D Judd, Liyang, Ian BB Hunter "P.D Monitoring of Power Transformers using UHF Sensors Part II, Vol.21, No.3, pp 5-13, 2004.

OUTCOMES:

At the end of the course the student will be able to

- coordinate the various standards for testing of HV equipments
- evaluate the results by using statistical tools.
- Familiarize with different testing techniques.
- identify an appropriate non destructive testing technique for high voltage applications

- demonstrate the pollution performance tests on high voltage equipments
- select, apply and perform testing on various high voltage electrical equipment using appropriate testing technique

EECX45	PULSED ELECTRIC FIELD AND FOOD PRESERVATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To acquire skills in the area of food preservation using pulsed electric field treatment.
- To study about different inactivation techniques used in pulsed electric field.

MODULE I FUNDAMENTALS OF PULSED ELECTRIC FIELD 7

Introduction- Methods of Applying Electricity – High Intensity PEF Processing System – Basics of High Intensity PEF – Energy Requirements – Applications of PEF in Food Preservation – Disadvantages of PEF.

MODULE II DESIGN OF PEF PROCESSING EQUIPMENT 8

Introduction – High Voltage Pulsers – Switches – Treatment Chambers – Cooling system – Typical Measurements in PEF system – Packaging and Storaging.

MODULE III MICROBIAL INACTIVATION IN ELECTRIC FIELDS 7

Introduction – Transmembrane Potential – Electromechanical Compression and instability – Osmotic Balance – Viscoelastic Model – Hydrophobic and Hydrophilic pores - Theories based on conformational changes – Electric Field induced structural changes.

MODULE IV PEF INDUCED BIOLOGICAL CHANGES 8

Introduction – Electropermeabilization – Electrofusion – Disruption and Biological Alteration – Electrical and Thermal Gradients induced by PEF on microbial cell membranes – Main factors in Microbial inactivation.

MODULE V PEF INACTIVATION OF VEGETATIVE CELLS SPORES AND ENZYMES IN FOODS AND FOOD PROCESSING BY PEF 7

Introduction – Microbial Inactivation – Inactivation of yeasts - E.Coli - S.Aureus– Lactobacillus – Bacillus – Salmonella – Pseuomonas - Inactivation of other microorganisms - Spore Inactivation – Standardization of inactivation assessment - Enzyme inactivation.

MODULE VI FOOD PROCESSING BY PEF 8

Microbial Analysis – Chemical and Physical Analysis – Sensory evaluation and Shelf life studies - Quality and Shelf Life Evaluation of PEF products – Processing of Apple Juice, Orange Juice, Milk, Eggs and Green Pea Soup - Processing of Brine solutions and water in cooling systems.

Total Hours – 45

REFERENCES:

1. Gustavo V. Barbosa Canovas, M. Marcela gongora nieto, Usha R. Pothakamury, Barry G. Swanson, “Preservation of Foods with Pulsed Electric Fields”, Academic Press, 1999.
2. Javier Raso, Volker Heinz, “Pulsed electric field technology for the food industry, Fundamentals and applications”, Springer Science and Business Media, 2006.
3. Huub L. M. Lelieveld, S. L. H. Notermans, S. W. H. De Haan, “Food preservation by pulsed electric fields from research to application”, Wood head publishing limited, 2007.

OUTCOMES:

At the end of the course, the student is expected to possess knowledge and achieve skills on the following:

- Understand and analyze the PEF concept in different applications.
- Ability to study about the design of PEF processing equipments
- Ability to understand the various microbial inactivation techniques in electric feilds
- Ability to analyse electrical and thermal Gradients induced by PEF
- Study different inactivation techniques used in pulsed electric field.
- Ability to perform microbial, chemical and physical analysis for food processing by PEF

COMPUTER SCIENCE & INFORMATION TECHNOLOGY

ITCX81	DATABASE MANAGEMENT SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

To enable the students to

- Describe essential features of database management systems and its use.
- Be familiar to identify about the procedural and non-procedural language.
- Mastering the design principles of databases, as well as in the normalization approach.
- Provide the description of physical file structures and access methods.
- Be familiar with the basic concepts of transaction processing and concurrency control.
- Master in the advanced topics and current trends.

Prerequisite: Knowledge on Programming, Data structures and Algorithm.

MODULE I INTRODUCTORY CONCEPTS 7

General Introduction to database-Traditional file system and database-Database system three tier architecture- various components of database- Data models- Modeling using ER model.

MODULE II RELATIONAL ALGEBRA AND SQL LANGUAGE 8

Unary Operations: Select and Project-Relational Set operations -Binary Relational operators.SQL: Data definition Language in SQL-Basic constraints in SQL- Basic Queries in SQL- Joins and Aggregate functions.

MODULE III DATABASE DESIGN AND DATA STORAGE 8

Functional dependencies- Normal forms up to BCNF- Dependency preserving and Lossless decomposition. Storage File organization: Memory Hierarchies-Secondary Storage devices -Magnetic tape storage device. Files - Operations on files.

MODULE IV INDEXING AND TRANSACTION PROCESSING 8

Indexing -Different type of index - B tree and B+ trees: Insertion and Deletion.

Introduction to transaction processing: Need for Concurrency and recovery-Transaction states- ACID properties- Schedules based on Serializability. Characterizing schedules based on Recoverability: Recoverable-Non-recoverable schedules.

MODULE V CONCURRENCY AND RECOVERY TECHNIQUES 8

Concurrency control techniques: Locking, Basic Two-phase locking (2PL) protocol, Timestamp-ordering based protocol, Deadlock. Database recovery techniques: Immediate update, deferred update, Shadow paging, and Checkpoint.

MODULE VI ENHANCED DATA MODEL FOR SPECIFIC APPLICATIONS 6

Overview of object-oriented concepts- Temporal Databases-Introduction to multimedia and spatial databases- Distributed databases and issues-Types of distributed database systems-XML documents and XML Querying-Data mining concepts.

Total Hours – 45

TEXT BOOK:

1. Elmasri, R., & Navathe, S. B. “Fundamentals of database systems” (7th Edition) Pearson Education, 2017.
2. Silberschatz, A., Korth, H. F., & Sudarshan, “Database system concepts” McGraw-Hill. ,(International Edition) (6th ed.). New York, 2011.

REFERENCES:

1. Raghu Ramakrishnan, “Database Management System”, 3rd Edition, Tata McGraw-Hill Publishing Company, 2003.
2. Peter Rob and Corlos Coronel- “Database System, Design, Implementation and Management”, 5th edition, 2003.
3. C J Date, “An Introduction to Database System”, 8th Edition, 2004.

OUTCOMES:

On successful completion of the course, the students will be able to

- Summarize the vital concepts and architecture associated with DBMS
- Describe relational database using SQL.
- Apply normalization techniques in database design.
- Understand database file organization and indexing.
- Use the transaction processing and concurrency control for application software.
- Apply the knowledge in current trends of database system.

ITCX82	COMPUTER NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To enable the students to

- know the computer networking basics and the functions of different layers in OSI Model and TCP-IP Model.
- acquire the knowledge about the different error detection and correction methods and how the data flow is controlled in data communication.
- learn the internetworking protocols and how to apply the sub netting scheme to efficiently use the IP addresses by reducing the wastage of addresses.
- be conversant with the various transmission control protocols and congestion control mechanisms.
- be familiar with various application layer protocols.
- learn about cryptographic techniques and algorithms for network security.

Prerequisite: Computer Fundamentals

MODULE 1 DATA COMMUNICATIONS 8

Components - Direction of Data flow - networks - Components and Categories- types of Connections - Topologies -Protocols and Standards - OSI and TCP-IP Model- Transmission Media – Twisted Pair Cable - Coaxial Cable – Optical Fiber Cable - Line Coding .

MODULE 2 DATA LINK LAYER 8

Error detection and correction - Parity - CRC - Hamming code - Flow and Error control - stop and wait - go back-N ARQ - selective repeat ARQ- sliding window - HDLC - LAN - Ethernet IEEE 802.3 - IEEE 802.11 - Bridges.

MODULE 3 NETWOK LAYER 8

Internetworks - Packet Switching and Datagram approach – IPv4 and IPv6 - IP addressing methods - Sub netting – Routers - Routing - Distance Vector Routing - Link State Routing.

MODULE 4 TRANSPORT LAYER 7

Process to Process delivery – Port Addressing - Multiplexing - Demultiplexing - Sockets - User Datagram Protocol (UDP) - Transmission Control Protocol (TCP) - Congestion Control - Quality of services (QOS).

MODULE 5 APPLICATION LAYER **7**

Domain Name System – Simple Message Transfer Protocol – Post Office Protocol – Internet Message Access Protocol - File Transfer Protocol – Hyper Text Transfer Protocol – World Wide Web.

MODULE 6 CRYPTOGRAPHY **7**

Introduction – Symmetric Key Cryptography – Traditional ciphers – Simple Modern Ciphers – Modern Round Ciphers – Mode of operation – Asymmetric Key Cryptography – RSA Algorithm.

Total Hours - 45

TEXT BOOK:

1. Behrouz A. Forouzan, "Data Communication and Networking", 4th Edition, Tata McGraw- Hill, 2017.

REFERENCES:

1. James F. Kurose and Keith W. Ross, "Computer Networking: A Top-Down Approach Featuring the Internet", Fifth Edition, Pearson Education, 2017.

2. Andrew S. Tanenbaum, David.J.Wetherall "Computer Networks", Fifth Edition, Pearson Education, 2013.

3. William Stallings, "Data and Computer Communication", Tenth Edition, Pearson Education, 2017.

4. Paul Goransson,Chuck Black, and Timothy Culver **"**Software Defined Networks: A Comprehensive Approach" Second Edition, Pearson Education, 2016.

OUTCOMES:

On successful completion of the course, the students will be able to

- discuss the terminology and concepts of the OSI reference model & TCP-IP model and the various technologies & standards related networks.
- apply the error detection & correction methods and compare various flow control mechanisms in data communication.

- design and apply appropriate sub netting scheme upon analyzing the requirements of the organization networking structure.
- illustrate the role of various transmission control protocols , how congestion in the networks can be controlled .
- explain the various services provided by network and the protocols related with each service.
- apply cryptographic techniques and algorithms for network security.

ITCX83 **JAVA PROGRAMMING**

L	T	P	C
2	0	2	3

OBJECTIVES:

To enable the students to

- understand the basic concepts of object oriented programming using java.
- acquire knowledge and skills for developing Graphical User Interface (GUI) using java.
- understand java database connectivity for web and enterprise application development.

MODULE I JAVA FUNDAMENTALS **7**

Introduction to java- Features - Java virtual machine - Byte code interpretation - Programming structures- Data types - variable-expressions- operators-arrays-,strings-input -output and control structures.

MODULE II OBJECTS AND CLASSES **8**

Introduction to object oriented programming-Classes -objects-constructors-static fields-static methods-packages- inheritance-polymorphism-abstract class-reflection-interface and inner class.

MODULE III EXCEPTION HANDLING AND IO STREAMS **7**

Exception handling fundamentals-types- Try -catch- finally – throws - java's built-in exceptions-IO basics-byte streams-character streams-reading and writing files- Java Thread model - Thread Life cycle - thread class-runnable interface-thread creation.

MODULE IV GUI AND DATABASE PROGRAMMING **8**

Swing components – JApplet, JButton, JFrame -Event handling -Actions-Mouse events-Layout managers- Design of JDBC-JDBC configuration -sql query execution-results set -row sets -transactions.

Total : 30 Hours

LIST OF EXPERIMENTS

1. Java program using control statements,loop statements and decision making.
2. Java program for string handling
3. Java program to demonstrate inheritance and polymorphism.
4. Implementing Exception handling using java program,
5. Java programs to implement thread using thred class and runnable interface.

6. Java programs for database connectivity using JDBC-ODBC connectivity.
7. Java programs for layout manager.
8. Java program using swing GUI components and applets.

Practical: 30 Hours

Total Hours – 60

TEXT BOOK:

1. Cay S. Horstmann and Gary Cornell, “Core Java: Volume I – Fundamentals”, 9th Edition, Prentice Hall, 2013.
2. Cay S. Horstmann and Gary Cornell, “Core Java: Volume II–Advanced features”, 9th Edition, Prentice Hall, 2013.

REFERENCES:

1. Herbert Schildt, "Java: The Complete Reference", 9th Edition, Oracle Press,2017.
2. K. Arnold and J. Gosling, “The JAVA programming language”, 4th Edition, Addison Wesley Professional,2005.

OUTCOMES:

At the end of the course completion, the student is able to :

- Express the basic concepts of java programming.
- Apply the knowledge of objects, classes, streams, multi-threading and GUI for developing java application.
- Develop small scale customised applications using java.

ITCX85	CLOUD COMPUTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn about cloud computing basics.
- To know the various technologies available for cloud platforms.
- To understand the cloud storage service and standards to access cloud service providers.
- To learn virtualization technology over various open source cloud tools to monitor the cloud performance.
- To understand security and challenges in cloud.

MODULE I CLOUD COMPUTING BASICS 8

Cloud Computing Overview- Cloud Components – Infrastructure – Services-Applications- Storage – Database services- Intranets and Cloud- Components-Hypervisor applications- Cloud providers- Amazon, Google, Microsoft- Benefits and Limitations of Cloud.

MODULE II CLOUD COMPUTING TECHNOLOGY 7

Hardware and Infrastructure – Thick and thin clients –Security–Network- Services-Accessing the cloud – Cloud Platforms– Web Applications – Web API"s – Web Browsers – Google App Engine.

MODULE III CLOUD STORAGE 8

Storage as a Service – Cloud Storage Providers – Amazon S3- Nirvanix- Google Big Table Data store- Standards- Application- Client- Infrastructure-Service-Google File System.

MODULE IV VIRTUALIZATION TECHNOLOGY 7

Virtualization Technology - Overview - Virtual Machines Provisioning and Manageability - Virtual Machine Migration Services - VM Provisioning and Migration in Action - VM Life Cycle and VM Monitoring - Amazon Elastic Compute Cloud.

MODULE V DEVELOPING APPLICATIONS 7

Google- Payment- Force.com and Google- Google Gears- Microsoft- Live Services-Microsoft SQL services- Microsoft Share point services- Dynamic CRM Services-Development- Google App Engine-Salesforce.com- Microsoft Windows Azure.

MODULE VI SECURITY MANAGEMENT 8

Cloud Security Fundamentals- Security requirements- Security Management in cloud- Availability management – Access control- Vulnerability management- Patch management-Configuration Management- Security Management functions for Cloud Delivery models-security responsibilities for customers of public cloud services- Case Study example for IaaS, PaaS, SaaS.

Total Hours - 45

TEXT BOOKS:

1. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, "Cloud Computing: A Practical Approach", McGraw-Hill, 2010.
2. Tim Malhar, S.Kumaraswammy, S.Latif, "Cloud Security & Privacy", SPD, O"REILLY 2009.
3. Rajkumar Buyya, James Broberg, Andrzej Goscinski, "Cloud Computing Principles and Paradigms", John Wiley & Sons, Inc Publications, 2011

REFERENCES:

1. Kai Hwang, Fox and Dongarra, Morgan Kaufmann, "Distributed and Cloud Computing", 1st Edition, Elseiver, 2012.
2. Scott Granneman, "Google Apps Deciphered: Compute in the cloud to streamline your desktop", Pearson Education, 2009.
3. Thomas Erl , Ricardo Puttini , Zaigham Mahmood, "Cloud Computing: Concepts, Technology & Architecture", Prentice –Hall, 2013

OUTCOMES:

- Discuss the core concepts of cloud computing paradigm.
- Analyze services, systems, platforms, frameworks to support cloud computing.
- Illustrate the concepts of cloud storage system services.
- Assess virtualization technology services in open source cloud computing environment.
- Can deploy the applications developed in cloud.
- Identify cloud security issues to demonstrate real time applications.

ITCX86 **OPERATING SYTEMS**

L	T	P	C
3	0	0	3

OBJECTIVES:

To enable the students to

- Understand the overview of computer system and the operating system, the concepts of process, memory, and I/O management.
- summarize the various approaches for solving the problem of mutual exclusion in an operating system.
- compare and contrast the various CPU scheduling algorithms.
- elaborate conditions that lead to deadlock.
- enrich knowledge in memory hierarchy and cost-performance trade-offs.

Prerequisite: Programming concepts

MODULE 1 OPERATING SYSTEM TYPES **7**

Introduction - Mainframe systems - Desktop Systems - Multiprocessor Systems- Distributed Systems - Clustered Systems - Real Time Systems – Handheld Systems - Hardware Protection - System Components - Operating System Services - System Calls.

MODULE 2 PROCESS SCHEDULING **8**

Process Concept - Process Scheduling - Operations on Processes - Cooperating Processes - Inter-process Communication - CPU Scheduling - Basic Concepts - Scheduling Criteria - Scheduling Algorithms

MODULE 3 PROCESS SYNCHRONIZATION **7**

The Critical-Section Problem - Synchronization Hardware - Semaphores - Classic problems of Synchronization – Monitors- Threads.

MODULE 4 DEADLOCKS **7**

System Model - Deadlock Characterization - Methods for handling Deadlocks - Deadlock Prevention - Deadlock avoidance - Deadlock detection – Recovery from Deadlocks.

MODULE 5 MEMORY MANAGEMENT **8**

Swapping - Contiguous Memory allocation - Paging - Segmentation - Virtual Memory - Demand Paging - Page Replacement.

MODULE 6 FILE SYSTEM & DISK MANAGEMENT **8**

File Concept - Access Methods - Directory Structure - Protection - File System Structure - File System Implementation - Directory Implementation - Allocation Methods - Disk

Structure - Disk Scheduling.

Total Hours – 45

TEXT BOOK:

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, "Operating System Concepts", 9 th Edition, John Wiley & Sons (ASIA) Pvt. Ltd, 2012.

REFERENCES:

1. Harvey M. Deitel, "Operating Systems", 2nd Edition, Pearson Education Pvt Ltd, 2004.
2. Andrew S. Tanenbaum, "Modern Operating Systems", Prentice Hall of India Pvt Ltd, 2014.
3. William Stallings, "Operating System", 5 th Edition, Prentice Hall of India, 2006
4. Dhamdhere D M, "Operating Systems", Tata Mc Graw Hill, New Delhi, 2012.
5. Pramod Chandra P. Bhatt, "An Introduction to Operating Systems, Concepts and Practice", PHI, 2014.

OUTCOMES:

On successful completion of the course, the students will be able to

- discuss the different types of systems and operating system services.
- implement the various scheduling techniques and evaluate their performance.
- analyze the issues in process synchronization and implement multithreaded programs using synchronization tools.
- analyze and manage deadlocks in multi process environment.
- discuss the concepts of primary and virtual memory management.
- elaborate the concepts of file and disk management.

ITCX87 **INTERNET OF THINGS**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce the basics of Internet of things.
- Utilize IoT features and create applications based on IoT middleware and protocols.
- To discuss the features of cloud of things.
- Outline the embedded prototyping and apply the use of IoT devices in IoT Technology.
- To explain real world IoT design with API techniques

MODULE I INTRODUCTION 8

IoT Functional Requirements –Motivation – IoT Architecture (IoT-A) – Ubiquitous IoT Applications – Vertical IoT Applications - Four Pillars of IoT – M2M (Internet of Devices) – RFID (Internet of Objects) – WSN (Internet of Transducers) – SCADA (Internet of Controllers) DNA of IoT – DCM – Device – Things that Talk – Connect – Via Pervasive Networks – Manage – To Create New Business Value Middleware for IoT: Overview – Communication middleware for IoT.

MODULE II MIDDLEWARE & PROTOCOLS FOR IOT 8

Overview of Middleware – Communication Middleware for IoT – MTC/M2M – SCADA – RFID – WSN – Protocol Standardization for IoT – M2M and WSN Protocols - SCADA and RFID Protocols - – Issues with IoT Standardization - – Unified Data Standards - Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus – KNX – ZigBee.

MODULE III CLOUD OF THINGS 8

Cloud Computing – Cloud Middleware – Cloud Standards – Cloud Providers and Systems - Mobile Cloud Computing - Cloud of Things Architecture – Deployment Models – Vertical Applications – Essential Features – Technological Pillars – Layers of IoT Systems

MODULE IV DESIGN PRINCIPLES OF CONNECTED DEVICES 7

Technology for design – Privacy in storing data – Internet principles for connected devices-Prototypes and production – Changing embedded platform – Open source versus closed source.

MODULE V PROTOTYPING EMBEDDED DEVICES 7

Prototyping embedded devices – Electronics- Sensors – Actuators – Arduino – Raspberry PI – Beagle Bone Black – Electric Imp.

MODULE VI PROTOTYPING ONLINE COMPONENTS AND EMBEDDED CODING 7

Sketch – Iterate and Explore – Preparation of physical prototype – Getting started with API – Writing New API – Other Protocols – Techniques for Writing Embedded code – Libraries and Debugging.

Total Hours : 45

1.

TEXT BOOKS:

1. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press, 2012.
2. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things – Key applications and Protocols”, Wiley, 2012.

REFERENCE BOOKS:

1. Adrian McEwen & Hakim Cassimally, “Designing internet of things”, Jhon Wiley and Sons, 2014.
2. Dieter Uckelmann; Mark Harrison; Florian Michahelles-(Eds.), “Architecting the Internet of Things” Springer, 2011.

OUTCOMES:

Upon Completion of course the students will be able to :

- Identify and analyze the new models for market strategic interaction
- Analyze various middleware and protocols for IoT
- Analyze Cloud of things with features and applications
- Design the principles of connected devices
- Identify the prototyping with various embedded devices
- Analyze and design different prototypes for embedded devices and API techniques

ITCX88 PYTHON PROGRAMMING

L	T	P	C
2	0	2	3

OBJECTIVES:

- To understand the fundamentals of python programming.
- To develop python programs with conditional loops.
- To define and declare functions and call them.
- To explore file input and output operations.
- To develop simple data structures using python.
- To study OOPS concepts using python programming

Pre requisites: Computer Fundamentals, Programming in ‘C’ or C++.

MODULE I PYTHON BASICS 8

Overview and fundamentals of python, executing simple programs, exploring python variables, operators and comprehend python blocks.

MODULE II DATA TYPES AND PROGRAM FLOW CONTROLS 7

Basic data types, numeric data types, string and string operations, list data types and slicing, tuples and its types, conditional blocks, control statements, looping statements, break statements, for loop, while loop using strings and dictionaries.

MODULE III FUNCTIONS , PACKAGES AND MODULES 8

Organize functions using python code, import libraries and methods internally and externally, usage of external packages, powerful functions in python, understanding packages.

MODULE IV BULIDING BLOCKS OF PYTHON – METHODS 7

String and dictionary manipulations, list manipulation using in build methods, programming using string, list and inbuilt functions. Exception handling and programs.

THEORY: 30 Hours

LABORATORY PRACTICE:

1. Implementation of simple python program by installing and exploring python IDE.
2. Programs to implement basic data types, tuples, strings, numeric data types and list data types.
3. Implement control statements and conditional blocks.
4. Implement looping statements – for, while and do-while.

5. Implement strings and dictionaries.
6. Programming using functions in python
7. Programming powerful functions in python.
8. Import basic packages and libraries and execute programs
9. Build methods using list and basic data structures.
10. Implement exception handling using python programs

PRACTICAL: 30 Hours

Total Hours – 60

TEXT BOOKS

1. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012.
2. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.

REFERENCES

1. John V Guttag, "Introduction to Computation and Programming Using Python'', Revised and expanded Edition, MIT Press , 2013.
2. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012.
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
4. Timothy A. Budd, "Exploring Python", Mc-Graw Hill Education (India) Private Ltd., 2015.

OUTCOMES:

Upon Completion of course the students will be able to:

- write and execute python programs
- develop simple python programs to solve problems.
- explore libraries in python and molder programs to functions
- develop data structures based on python programs

ELECTRONICS, COMMUNICATION, INSTRUMENTATION AND CONTROL

ECCX81	IMAGE PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Describe and explain basic principles of digital image processing;
- Design and implement algorithms that perform basic image processing
- Design and implement algorithms for advanced image analysis
- Assess the performance of image processing algorithms and systems

MODULE I DIGITAL IMAGE FUNDAMENTALS 8

Components of Image Processing System, Elements of Visual Perception, MTF of VisualSystem, Image Sensing and Acquisition, Image formation model, Image Sampling &Quantization Spatial and Gray Level Resolution, Basic Relationships between Pixels.Statistical parameters, Measures and their significance, Mean, standard deviation, variance, SNR, PSNR.

MODULE II IMAGE ENHANCEMENT 7

Enhancement in Spatial Domain: basic gray level transformations, histogram processing, equalization, Arithmetic and logical operations between images, Basics of spatial filtering, smoothening and sharpening spatial filters. Image Enhancement in frequency Domain: smoothening and sharpening frequency domain filters. Fundamental of color imageprocessing: color models, RGB, CMY, YIQ, HIS. Pseudo Color Image processing: Intensityfiltering, gray level to color transformation, Basics of full color image processing.

MODULE III IMAGE TRANSFORMS 7

2D-DFT, FFT, DCT, the KL Transform, Walsh/Hadamard Transform, Haar Transform.

MODULE IV IMAGE CODING AND COMPRESSION 7

Image Coding Fundamentals, Image Compression Model, fundamentals-redundancy: coding, interpixel, psychovisual, fidelity criteria, elements of information theory. Error FreeCompression - variable length, bit plane, Lossless Predictive, Lossy Compression- LossyPredictive. Fundamentals of JPEG, MPEG, fractals.

MODULE V IMAGE ANALYSIS 7

Edge detection, spatial feature and boundary extraction, boundary representation by chain codes and B splines, Hough Transform. Morphological Image Processing: Dilation, Erosion, Opening, Closing on Binary Images, Segmentation: Point, line. Edge detection, Boundary detection and Thersholding.

MODULE VI IMAGE RESTORATION AND IMAGE PROCESSING APPLICATIONS 9

Image Degradation Model, Noise Models, and Restoration in Presence of Noise in spatial Domain, Linear Filtering, Applications: Character Recognition, Fingerprint Recognition, Remote Sensing. Applications using different Imaging modalities such as acoustic Imaging, Medical imaging, electron microscopy etc.

Total Hours – 45

TEXT BOOKS:

1. Gonzalez and Woods, "Digital Image Processing", Pearson Education, 2009.
2. Arthur Weeks Jr., "Fundamentals of Digital Image Processing", PHI, 2006.

REFERENCES:

1. A. K. Jain, "Fundamentals of Digital Image Processing"; PHI, 2006
2. Pratt William, "Digital Image Processing", John Wiley & Sons, 2007.

OUTCOMES:

At the completion of the course, students will be able to

- Explain the fundamental concepts of digital image processing.
- Recognize & apply various image enhancement techniques.
- Apply various transforms for image processing.
- Identify and use appropriate image compression techniques.
- Apply various techniques for image analysis and restoration.
- Apply suitable image processing techniques in different applications.

ECCX82	**VLSI DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

This course teaches:

- Basic concepts of HDL.
- Verilog language and its syntax constructs.
- Programmable Logic Devices and FPGAs
- MOS devices theory
- CMOS based combinational and sequential circuits

MODULE I REVIEW OF BASIC DIGITAL SYSTEMS 7

Boolean algebra, Building blocks of combinational logic design-Adders, multiplexer, encoder, decoder, comparator, Latches & flip-flops, counters, shift registers, State diagram,State Reduction and State Assignments.

MODULE II LOGIC DESIGN USING VERILOG HDL 8

Overview of Digital Design with Verilog HDL, Levels of Design Description, Concurrency,Hierarchical Modeling Concepts, Modules and Ports, Component instantiation Data flow and RTL, structural, gate level, switch level modeling and Behavioral Modeling.

MODULE III LANGUAGE CONSTRUCTS OF VERILOG HDL 7

Identifiers- gate primitives, gate delays, operators, timing controls, procedural assignments, conditional statements Variable types, arrays and tables, Tasks and functions, Test bench.

MODULE IV BUILDING BLOCKS OF DIGITAL VLSI SYSTEMS 8

HDL Design -Data Path Operations-Addition/Subtraction, Parity Generators, Comparators, Zero/One Detectors, Binary Counters, ALUs, Multiplication, Shifters, Memory Elements, Control-FSM, Control Logic Implementation. Programmable logic elements and AND-OR arrays, FPGAs and CPLD, programming methods.

MODULE V TRANSISTOR THEORY 7

Introduction to MOS Transistors-NMOS & PMOS Characteristics, Current Equations, Complementary CMOS Inverter-DC Characteristics, Static Load MOS Inverters, Differential Inverter, Tri State Inverter, BiCMOS logic.

MODULE VI BASICS OF DIGITAL CMOS DESIGN 8

NMOS & PMOS Logic Gate, CMOS Logic Gate, Basic layout design of simple gate-stick diagram, CMOS Logic Structures-full adder, multiplexers, pass transistor circuits, Transmission Gate, Dynamic CMOS circuit techniques

Total Hours – 45

REFERENCES:

1. M.Morris Mano "Digital Design", 3rd Edition, Prentice Hall of India Pvt. Ltd New Delhi 2003
2. Michael D. Ciletti"Advanced Digital Design with the Verilog HDL" (2nd Edition) Hardcover – January 31, 2010
3. J.Bhasker: Verilog HDL primer, BS publication, 2001.
4. J. P. Uyemura, "Introduction to VLSI Circuits and System", Wiley, 2002
5. Neil Weste and K. Eshragian, "Principles of CMOS VLSI Design: A System Perspective," 2nd edition, Pearson Education (Asia) Pvt.Ltd., 2000
6. Douglas A Pucknell& Kamran Eshragian, "Basic VLSI Design" PHI 3rd Edition (original edition – 1994)

OUTCOMES:

At the end of the course the students will be able to

- Create basic Register Transfer Level (RTL) models for combinational circuits &
- Sequential circuits using Verilog HDL.
- Create basic behavioral models for combinational circuits & Sequential circuits using
- Verilog HDL.
- Describe the usage of Programmable Logic Devices and FPGAs.
- Describe MOS devices theory and inverter circuit DC characteristics
- Design the basic digital building blocks using MOS circuit.
- Apply VLSI design concepts based on the requirements to conduct experiments or projects.

ECCX83	**INTEGRATED CIRCUITS AND SYSTEM DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To introduce the students to active and passive components available in CMOS and their parasitic elements of first order transistor modelling for initial manual design and the limits of applicability.
- To teach the student behaviour and design of basic analogue and digital circuit primitives, including quantitative treatment of matching.
- To introduce the students to switched capacitor techniques and continuous time filters.

MODULE I BASIC SEMICONDUCTOR PHYSICS 7

Quantum mechanical concepts and atomic states – Solid state structure – Intrinsic, Extrinsic and compensated semiconductors – Lattice vibrations – Electron and hole mobilities and drift velocities.

MODULE II DEVICES 7

Diode - CMOS – Wire models – CMOS inverter - Static behavior, Dynamic Behavior, Power, Energy.

MODULE III DIGITAL SYSTEMS 7

DTL IC – HTL IC – TTL IC – ECL IC – Basic digital circuits – Special Purpose gates – Flip flops – Clock and waveform generators.

MODULE IV SEQUENTIAL AND COMBINATIONAL LOGIC DESIGN 8

Ripple Adder, Look Ahead Carry Generator, Binary Parallel Adder, n-Bit Parallel Subtractor, Priority Encoder, Design considerations of the above combinational logic circuits with relevant Digital ICs. MSI Registers - Shift Registers - Modes of Operation of Shift Registers, Ring Counter, Johnson Counter -Basic sequential logic Design steps - Design considerations of the above sequential logic circuits with relevant Digital ICs.

MODULE V ANALOGUE INTEGRATED CIRCUIT DESIGN 8

CMOS amplifier basics – Current and Voltage sources – CMOS operational amplifiers – Data conversion circuits.

MODULE VI SYSTEM DESIGN EXAMPLES 8

Frequency counter – DACs and ADCs – Filter design - Filter response, Low pass RC active filter, Bandpass RC active filter, Switched C filter – Combinational logic design.

Total Hours – 45

REFERENCES:

1. Michael Shur, “Physics of Semiconductor Devices”, Prentice Hall, 2004.
2. B.S. Sonde, “Introduction to system design”, New Age International, 2003.
3. Razavi B., “Design of Analog CMOS Integrated Circuits”, McGraw Hill, 1998.
4. John F. Wakerly, “Digital Design Principles & Practices”, PHI Publications, 3rd Edition, 2005.
5. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, “Digital Integrated Circuits-A Design Perspective Pearson Education”, 2005.
6. Alan B. Marcovitz, “Introduction to Logic Design”, TMH, 2nd Edition, 2005.
7. Mano, “Digital Logic and Computer Design”, Pearson Education, 2000.

OUTCOMES:

At the end of the course, the student is expected to posses knowledge and achieve skills on the following:

- The student has a thorough understanding of the characteristic and design aspects of IC circuits.
- The student will be able to build simple digital and analogue ICs.

ECCX84	**COMMUNICATION SYSTEM SECURITY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

• To familiarize the students with the issues and technologies involved in designing a communication network system that is robust against attack.

• Students will gain an understanding of the various ways in which a network can be attacked and the tradeoffs in protecting it.

MODULE I NETWORK FUNDAMENTALS AND PHYSICAL LAYER 7

Introduction to Networks - definition of layers – services - interface and protocols - OSI reference model - layers and duties - TCP/IP reference model – layers and duties - Physical layer - general description – characteristics - signaling media types – topologies - examples physical layer (RS232C, ISDN, ATM, SONET).

MODULE II INTRODUCTION ON SECURITY 7

Security Goals, Types of Attacks - Passive attack, active attack, attacks on confidentiality, attacks on Integrity and availability - Security services and mechanisms, Techniques – Cryptography - Steganography - Revision on Mathematics for Cryptography.

MODULE III SYMMETRIC & ASYMMETRIC KEY ALGORITHMS 7

Substitution Ciphers - Transposition Ciphers - Stream and Block Ciphers - Data Encryption Standards (DES) - Advanced Encryption Standard (AES) - RC4 - principle of asymmetric key algorithms - RSA Cryptosystem.

MODULE IV INTEGRITY, AUTHENTICATION AND KEY MANAGEMENT 8

Message Integrity - Hash functions – SHA - Digital signatures - Digital signature standards - Authentication Entity Authentication – Biometrics - Key management Techniques.

MODULE V NETWORK SECURITY, FIREWALLS AND WEB SECURITY 8

Introduction on Firewalls - Types of Firewalls - Firewall Configuration and Limitation of Firewall - IP Security Overview - IP security Architecture - authentication Header - Security payload - security associations - Key Management - Web security requirement - secure sockets layer - transport layer security - secure electronic transaction - dual signature.

MODULE VI WIRELESS NETWORK SECURITY 8

Security Attack issues specific to Wireless systems - Worm hole – Tunneling - DoS.WEP for Wi-Fi network - Security for 4G networks - Secure Ad hoc Network - Secure Sensor Network.

Total Hours – 45

REFERENCES:

1. Behrouz.A. Forouzan, “Data Communication and Networking”, 4th Edition, Tata McGraw Hill, 2007.
2. John C. Bellamy, “Digital Telephony”, 3rd Edition, John Wiley 2006.
3. Nichols and Lekkas, “Wireless Security – Models, Threats, and Solutions,” McGraw-Hill, 2002.
4. Behrouz A. Fourcuzan, “Cryptography and Network security”, Tata McGraw- Hill, 2008.
5. William Stallings, "Cryptography and Network security- principles and practice", 2nd Edition, Prentice Hall of India, New Delhi, 2002.
6. Atul Kahate,” Cryptography and Network security”, 2nd Edition, Tata McGraw Hill, 2008.
7. R.K. Nichols and P.C. Lekkas, “Wireless Security”, 2000.

OUTCOMES:

At the end of the course, the student is expected to posses knowledge and achieve skills on the following:

• Students will gain an appreciation of the need to develop an understanding of underlying system applications and potential security issues early in the design process.

ECCX85	EMBEDDED HARDWARE & SOFTWARE SYSTEM DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

• The objective of this course is to present to the student the computation devices, peripherals and networks associated with an embedded system.

• The students are introduced to embedded - C used in the design of a modern-day embedded system.

MODULE I ARCHITECTURE OF EMBEDDED SYSTEMS 7

Categories of Embedded Systems - Specifications of Embedded systems -Resent trends in Embedded Systems - Hardware Architecture - Software Architecture - Communication software - Process of generation of executable image-development/testing tools.

MODULE II HARDWARE FUNDAMENTALS 7

Buses – DMA – interrupts – Built-ins on the microprocessor – Conventions used on schematics – Microprocessor Architectures – Software Architectures – RTOS Architectures – Selecting and Architecture. PIC microcontroller - Architecture of PIC 16c6x/7x – FSR - Reset action – Oscillatory connection - Memory organization - Instructions - Addressing modes - I/O ports – Interrupts – Timers – ADC - Assembly language programming.

MODULE III RTOS 7

Tasks and Task states – Semaphores – Shared data – Message queues, Mail boxes and pipes – Memory management – Interrupt routines – Encapsulating semaphore and queues – Hard Real-time scheduling – Power saving.

MODULE IV PROGRAMMING EMBEDDED SYSTEMS 8

Embedded Program – Role of Infinite loop – Compiling, Linking and locating – downloading and debugging – Emulators and simulators processor – External peripherals – Memory testing – Flash Memory.

MODULE V OPERATING SYSTEM 8

Embedded operating system – Real time characteristics – Selection process – Flashing the LED – serial ports – Zilog 85230 serial controlled code efficiency – Code size – Reducing memory usage.

MODULE VI EMBEDDED SOFTWARE DEVELOPMENT TOOLS 8

Host and target machines – Linkers / Locators for Embedded Software – Debugging techniques – Instruction set simulators Laboratory tools – Practical example – Source code.

Total Hours – 45

REFERENCES:

1. David E.Simon, “An Embedded Software Primer”, Pearson Education, 2003.
2. Michael Bass, “Programming Embedded Systems in C and C++”, Oreilly, 2003.
3. K.V.K.K.Prasad, “Embedded /Real-Time Systems-Concepts, Design and Programming”, Dream tech, Wiley, 2003.
4. Ajay V Deshmukh, “Microcontroller Theory and Applications”, Tata McGraw Hill, 2005.
5. Raj Kamal, “Embedded Systems Architecture Programming and Design”, 2nd Edition, TMH, 2008.
6. David E Simon, “An Embedded Software Primer”, Pearson Education, 2003.
7. Daniel 5.W Lewis, “Fundamentals of Embedded Software”, Pearson Education, 2001.
8. Peatman, “Designing with PIC Micro Controller”, Pearson, 2003.

OUTCOMES:

At the end of the course, the student is expected to posses knowledge and achieve skills on the following:

• Provide a knowledge foundation which will enable students to pursue subsequent courses in real-time embedded systems software and computer design.

ECCX86 DIGITAL SIGNAL PROCESSORS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge on the architectural details and instruction set of TMS320F2812 processor.
- To provide practical experience with Digital Signal Processors.
- To Introduce Code Composer Studio IDE for C 2000 Processors.
- To implement DSP Processor in real time Digital Motor Control application.

MODULE I ARCHITECTURE OF F2812 6

TMS320F2812 Architecture - The F2812 CPU-F2812 Math Units-Data Memory Access -Internal Bus Structure- Atomic Arithmetic Logic Unit (ALU) –Instruction Pipeline - Memory Map - Code Security Module - Interrupt Response- Operating Modes - Reset Behaviour.

MODULE II PROGRAM DEVELOPMENT TOOLS 8

Code Composer Studio IDE - The Software Flow - Code Composer Studio – Basics - Lab Hardware Setup - Code Composer Studio – Step by Step procedure - Createa project - Setup Build Options Linker Command File - Download code into DSP - beginner's project - Objective Procedure - Open Files, Create Project File- C28xFlash Programming - C28x Start-up Sequences -C28x Flash Memory SectorsFlash Flash Configuration Registers - Flash Programming Procedure .

MODULE III DIGITAL I/O 7

Data Memory Mapped Peripherals - The Peripheral Frames - Unit Digital I/O Registers Module - Watchdog Timer - System Control and Status Register - Low Power Mode – Digital Input / Output programmes.

MODULE IV INTERRUPT SYSTEM 8

C28x Core Interrupt Lines - The C28x RESET - Reset Bootloader - Interrupt Sources - Maskable Interrupt Processing - Peripheral Interrupt Expansion - C28x CPU Timers - Serial Peripheral Interface (SPI) Data Transfer - SPI Registers - SPI communication.

MODULE V C28X EVENT MANAGER AND C28X ANALOGUE DIGITAL CONVERTER 8

Event Manager Block Diagram - General Purpose Timer Timer Operating Modes -

Interrupt Sources - GP Timer Registers - GP Timer Interrupts - Event ManagerCompare Units Capture Units - Quadrature Encoder Pulse Unit (QEP).- Generate a PWM sine wave -.ADC Module Overview - ADC in Cascaded Mode -ADC in Dual Sequencer Mode - ADC Register Block .

MODULE VI DIGITAL MOTOR CONTROL APPLICATIONS 8

C28x IQ – Math Library - IQ – Math Library Functions - IQ- Math Application- FOC - C28x FIR – Filter - Texas Instruments C28x Filter Library - C28x Digital Motor Control - Field Orientated Control (FOC) Core Math Operations - PARK Transform - CLARKE Transform - Texas Instruments Digital Motor Control Library Modules. FOC for PMSM - Hardware Laboratory Setup - PMSM control project – Build levels.

Total Hours – 45

REFERENCES:

1. Code Composer Studio User’s Guide Literature Number: SPRU328 February 2000, Copyright © 1999-2000, Texas Instruments Incorporated.
2. TMS320F2810, TMS320F2811, TMS320F2812, TMS320C2810, TMS320C2811, TMS320C2812 Digital Signal Processors Data Manual,Copyright © 2001–2012, Texas instrument Incorporated.
3. TMS320F2812 DIGITAL SIGNAL PROCESSOR IMPLEMENTATIONTUTORIAL – Texas instruments.
4. B. B. Venkatramani & M.Bhaskar, “Digital Signal Procesors architecture, Programming and applications, Tata McGraw Hill 2002.
5. TMS320F/C24/X DSP controllers, Refernce guide literature No : SPRU160c, June 1994.

OUTCOMES:

At the end of the course, the student is expected to possess knowledge and achieve skills on the following:

- Programming Knowledge in DSP and its real time application.
- To configure DSPBIOS to handle hardware interrupts (HWI)
- Implementing Digital Motor Control Library Modules.
- Computing steps necessary to build a control scheme for Field Oriented Control (FOC).
- Board level operations of the Digital Signal Processors (DSP)based on the Texas Instruments TMS320F2812 Processor.

EICX81	**BIO INSTRUMENTATION AND SIGNAL ANALYSIS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To provide an acquaintance of the physiology of the brain, heart and lungs.
- To introduce the student to the biosensors, electrodes and amplifiers.
- To introduce the typical measurement and devices of bio-electric origin.
- To provide the latest ideas on devices of imaging techniques and monitoring and awareness of electrical safety of medical equipments.
- To bring out the importance of bio-signal analysis and diagnosis.

MODULE I ANATOMY AND PHYSIOLOGY 7

Basic components of a biomedical system, Cell and its structure – Action and resting – Potential propagation of action potential – Sodium pump – Nervous system – Nerve cell – Synapse – Cardio pulmonary system – Physiology of heart and lungs – Circulation and respiration.

MODULE II TRANSDUCERS AND AMPLIFIERS 7

Transducers – Different types – Piezo-electric, ultrasonic, resistive, capacitive, inductive transducers – Selection criteria. Electrodes – Micro, needle and surface electrodes – Amplifiers – Preamplifiers, differential amplifiers, chopper amplifiers – Isolation amplifier- ECG isolation amplifiers.

MODULE III ELECTRO – PHYSIOLOGICAL MEASUREMENTS 7

ECG – EEG – EMG – ERG – Lead systems and recording methods – Typical waveforms.

MODULE IV MEDICAL IMAGING AND PMS 7

X-ray machine - Radio graphic and fluoroscopic techniques – Computer tomography – MRI – Ultrasonography – types of biotelemetry systems and patient monitoring systems (PMS) – Electrical safety.

MODULE V BIO SIGNAL ANALYSIS 8

Objectives of biomedical signal analysis – Fundamental of Biosignals – classification of biosignals - Difficulties encountered in biomedical signal acquisition and analysis – Filtering for removal of artifacts – biosignal processing algorithms – time domain alaysis and frequency domain analysis – Computer aided diagnosis.

MODULE VI CASE STUDY 9

Problem statement: Connect up to 8/16 ECG input leads with ECG system or get available ECG data. Use automated analysis features for HRV, to classify heartbeats, identify arrhythmias, and perform ECG averaging and report.

Total Hours – 45

REFERENCES:

1. R.S.Khandpur, “Hand Book of Bio-Medical instrumentation’, 12th reprint, Tata McGraw Hill Publishing Co Ltd., 2008.
2. J.Webster, “Medical Instrumentation – Application and Design”, 4th Edition, John Wiley & Sons, 2009.
3. M.Arumugam, “Bio-Medical Instrumentation”, Anuradha Agencies, 2006.
4. L.A. Geddes and L.E.Baker, “Principles of Applied Bio-Medical Instrumentation”, John Wiley & Sons, 1975.
5. Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, “Bio-Medical Instrumentation and Measurements”, 2nd Edition, Pearson Education, 2008.
6. Rangaraj M. Rangayan, “Biomedical signal analysis”, John Wiley and sons (ASIA) Pvt Ltd., 2009.

OUTCOMES:

At the end of the course, the student is expected to posses knowledge and achieve skills on the following:

- Students will have an exposure of the physiology of the brain , heart and lungs.
- Students will be well equipped to choose the proper electrodes and required amplifiers for specific bioapplication.
- They will be able to analyze typical waveforms of bio potentials.

EICX82	SENSORS FOR BIO-MEDICAL APPLICATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the student to the various principles, technologies, methods and applications of biosensors and bioinstrumentation.
- To link engineering principles to understanding of bio systems in sensors and bioelectronics.
- To bring out the important and modern methods of sensor techniques.
- To provide the student with detail methods and procedures used in the design, fabrication and application of biosensors and bio electronic devices.

MODULE I INTRODUCTION TO BIOSENSORS 8

Introduction to biosensors - Types of bio sensors – Bio transducers – Different types - active and passive transducer – factors influencing and selection criteria of transducers for physiological parameters - Transducer for biomedical application.

MODULE II BIO RESISTIVE SENSORS 7

Resistive Transducers – Strain Gauge - types, construction, selection materials, Gauge factor, Bridge circuit and calibration - Strain Gauge type Blood pressure transducers - Thermistor used for cardiac output measurement - nasal airflow measurement - Photoelectric type resistive transducer.

MODULE III NON CONTACT TYPE BIOSENSORS 7

Non contact type infrared thermometry; Optical pyrometer – Electrochemical Biosensors – Electrochemical principles - Glucose biosensors – piezo electricsensors – ultrasonic sensors.

MODULE IV BIO ELECTRODES AND AMPLIFIERS 8

Electrodes – Micro needle and surface electrodes – Amplifiers – Preamplifiers, differential amplifiers, and chopper amplifiers – Isolation amplifier – ECG isolation amplifiers.

MODULE V BIO-CHEMICAL SENSORS AND NON ELECTRICAL MEASUREMENT 8

pH - pO2 - pCO2 – Electrophoresis – photometer - Auto analyzer - Blood flow sensors – phonocardiogram - respiratory measurement – pulse - Blood cell counters.

MODULE VI CASE STUDY 7

To analyse a diabetic patient using glucose biosensors – to analyse an asthmapatient using respiratory sensors – selection of temperature, pressure andflow sensors for biomedical application.

Total Hours – 45

REFERENCES:

1. R.S. Khandpar, "Hand Book of Biomedical Instrumentation and measurement", McGraw Hill publishing Co., 2009.
2. Aston, "Principles of Biomedical Instrumentation and measurements", McGraw Hill publishing Co., 2007.
3. Arumugam, "Biomedical Instrumentation", Anuradha Agencies Publishers, 2008.
4. John G. Webster, "Medical Instrumentation application and design", 3rd Edition, Wiley, 1997.
5. E.A.H.Hall, "Biosensors", Advanced Reference Series, Engineering, Prentice Hall, New Jersey, 1991.

OUTCOMES:

At the end of the course, the student is expected to posses knowledge and achieve skills on the following:

- On bio sensing and transducing techniques, design and construct biosensors instrumentation.
- Possess knowledge of detailed methods and procedures used in the design, fabrication and application of biosensors and bio electronic devices.
- To apply the above techniques for biomedical applications.

EICX83	**INTELLIGENT CONTROL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

• This course will obtain a basic understanding of artificial neural networks, fuzzy logic control and intelligent technique.

• Students will know how these techniques are applied to engineering problems, including control systems.

MODULE I INTRODUCTION TO INTELLIGENT CONTROL 7

Introduction and motivation - Approaches to intelligent control – Architecture for intelligent control - Symbolic reasoning system - rule-based systems – the AI approach - Knowledge representation - Expert systems.

MODULE II MATHEMATICAL MODELING 7

Concept of Artificial Neural Networks and its basic mathematical model -McCulloch-Pitts neuron model - simple perceptron - Adaline and Madaline -Feed-forward Multilayer Perceptron - Learning and Training the neural network- Data Processing - Scaling, Fourier transformation - principal-component analysis and wavelet transformations.

MODULE III NEURAL NETWORKS 7

Networks: Hopfield network - Self-organizing network and recurrent network- Neural Net based controller. Case studies: Identification and control of linearand nonlinear dynamic systems using Matlab - Neural Network toolbox.

MODULE IV INTRODUCTION TO FUZZY LOGIC 8

Introduction to crisp sets and fuzzy sets - basic fuzzy set operation and approximate reasoning - Introduction to fuzzy logic modeling and control –Fuzzification - inference and defuzzification - Fuzzy knowledge and rule bases- Fuzzy modeling and control schemes for nonlinear systems - Fuzzy logic control for nonlinear time-delay system - Implementation of fuzzy logic controller using Matlab fuzzy - logic toolbox.

MODULE V FUZZY LOGIC SYSTEM 8

Fuzzy logic system: Basic concepts of Fuzzy logic approaches – classic alsets & Fuzzy sets - linguistic variables - membership functions - basic operation- Fuzzy relations - numbers and arithmetic & logical operations - different de-Fuzzification techniques - Fuzzy rule based model & model based controllers- PID controllers, and application of Fuzzy controllers.

MODULE VI GENETIC ALGORITHM 8

Genetic Algorithm: Basic concept of Genetic algorithm and detail algorithmic steps - adjustment of free parameters - Solution of typical control problems using genetic algorithm.

Total Hours –45

REFERENCES:

1. Freeman, “Neural network: Algorithms Applications and ProgrammingTechniques”, 2005.
2. Goldberg, “Genetic Algorithm in Search, Optimization, and Machine Learning”, Addison Wesley Publishing Company Inc., 1989.
3. Millon W.T., Sutton R.S., and Webrose P.J., “Neural Networks for control”, MIT Press, 1992.
4. MATLAB Neural Network Tool Box Manual.
5. MATLAB Fuzzy Logic Tool Box Manual.
6. R. Eberhart, P.Simpson and R. Dobbins, “Computional Intelligence” PC Tools,2004.
7. Laurence Fausett, “Fundamentals of Neural Networks”, Prentice Hall,Englewood cliffs, N.J., Professional, Boston, 1996.
8. Jacek M.Zurada, “Introduction to Artificial Neural Systems”, Jaico PublishingHouse, 1997.
9. Timothy J.Ross, “Fuzzy Logic with Engineering Applications”, McGraw Hill Inc., 1997.

OUTCOMES:

At the end of the course, the student is expected to posses knowledge and achieve skills on the following:

• Students will be able to design control systems using fuzzy logic and artificial neural networks.

• Students will understand the advantages and disadvantages of these methods relative to other control methods.

• Students will be aware of current research trends and issues.

EICX84	ADVANCED CONTROL SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide a basic understanding of state space analysis of the system.
- To impart knowledge state space model for discrete systems.
- To provide knowledge about the nonlinear control systems.

MODULE I STATE SPACE ANALYSIS OF SYSTEMS 7

Classical Vs modern control theory ,concept of state, state space and state variables, state model for typical linear sytems, construction of state model using differential equations, state variable diagram and block diagram representation of state models, state space model for electrical circuits,mechanical systems, electro-mechanical system-DC motors, solution of time in variant state equation, state transition matrix from cayleigh -hamilton theorem,solution of linear time varying state equation. Simulation of state space model of electrical circuits, mechanical systems, electro-mechanical system-DCmotors using control system toolbox.

MODULE II TRANSFORMATION IN STATE SPACE MODEL 7

State space model from transfer functions - decomposition methods, state model for a multi input muti output system from block diagrams, similarity transformation, non uniqueness of state space model, transfer from statespace model, different canonical models like phase variable form ,observable canonical model, diagonal canonical model, Jordan canonical model, state variable description of discrete time systems.

MODULE III STATE FEEDBACK AND OBSERVER DESIGN 8

State and output controllability of systems - criterion for controllability of continuous and discrete time systems, observability of systems, criterion for observabilty of a system, significance of controllability and observability ,state feedback controller design using pole placement for plant represented in phase variable form, determination of feedback gain using ackerman’s formula,design of full state and reduced order observers. State feedback and observer design using control system toolbox.

MODULE IV STATE SPACE ANALYSIS OF DISCRETE TIME CONTROL SYSTEM 7

Discrete time systems - analogies with continuous time systems - Z-transforms (review), mathematical models for LTI discrete time systems. State model of linear discrete-time systems, state models from linear difference equations/system functions, derivation of system function from state model, solution of state equations-state transition matrix, controllability and observability conditions.

MODULE V NONLINEAR CONTROL SYSTEMS 8

Introduction to nonlinearities and non linear phenomenon, nonlinear system behavior. Methods of linearization, Phase Plane Analysis: Concepts of Phase Plane Analysis: Phase Portraits; Singular Points; Symmetry in Phase PlanePortraits, Methods of Constructing Phase Portraits: Analytical method, the method of Isoclines, Determining time form Phase Portraits, Phase Plane Analysis of linear systems, Phase Plane Analysis of nonlinear systems, limit cycles and existence of limit cycle

MODULE VI DESCRIBING FUNCTION METHOD 8

Describing function fundamentals: An example of describing functions; Computing describing functions, Derivations of describing functions of common online arities, Describing function analysis of nonlinear systems.

Total Hours – 45

REFERENCES:

1. Benjamin C. Kuo, “Digital Control Systems”, Oxford University Press, 2002.
2. George J. Thaler, “Automatic Control Systems”, Jaico Publishers, 2004.
3. I.J. Nagrath and M. Gopal, “Control Systems Engineering”, New Age International Publishers, 2003.
4. Raymond T. Stefani & Co., “Design of Feed back Control systems”, Oxford University, 2002.
5. William L. Luyben and Michael L. Luyben, “Essentials of Process Control”, McGraw Hill International Editions, Chemical Engineering Series, 1997.

OUTCOMES:

At the end of the course, the students will be able to,

- derive mathematical models in terms of state space of the system.
- design and analyse discrete systems using state space techniques.
- apply describing functions for nonlinear systems.

EICX85	**POWER PLANT INSTRUMENTATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

To provide an overview of different methods of Power generation, with a particular emphasis on thermal power generation.

- To get knowledge about the various measurements involved in power generation plants.
- To provide knowledge about the different types of analysers used for analysis.
- To impart knowledge about the different types of controls and control loops.
- To familiarize the student with the methods of monitoring different parameters like speed, vibration of turbines and their control.

MODULE I OVERVIEW OF POWER GENERATION 7

Brief survey of methods of power generation – Hydro, thermal, nuclear, solar and wind power – importance of instrumentation in power generation – Thermal power plants – Block diagram – Details of boiler processes – P & I diagram of boiler – Cogeneration.

MODULE II MEASUREMENTS IN POWER PLANTS 8

Measurements – Flow of feed water, fuel, air and steam with correction factor for temperature – Steam pressure and steam temperature – Drum level measurement – Smoke density measurement – Dust monitor.

MODULE III ANALYSERS IN POWER PLANTS 8

Flue gas oxygen analyser – Analysis of impurities in feed water and steam – Dissolved oxygen analyser – Chromatography – pH meter – Fuel analyser – Pollution monitoring instruments, conductivity meter; Silica Analyser.

MODULE IV CONTROL LOOPS IN BOILER & PROTECTION 8

Combustion control - Air fuel ratio control – Furnace draft control – Drum level control – Main steam and reheat steam temperature control – Super heater control – Air temperature – Deaerator Control – Distributed control system in power plants – Interlocks in boiler operation.

MODULE V TURBINE MONITORING 7

Speed, vibration, shell temperature monitoring and control – Lubricant oil temperature control – Cooling system.

MODULE VI TURBINE CONTROL & PROTECTION 7

Steam pressure control, L.P.Heater, H.P. Heater, Condenser Hotwell Control, Interlocks In turbine operation.

Total Hours – 45

REFERENCES:

1. Sam G.Dukelow, “The Control of Boilers”, Instrument Society of America, 1991.
2. P.K.Nag, “Power Plant Engineering”, Tata McGraw Hill, 2001.
3. “Modern Power Station Practice” Vol. 6, Instrumentation controls and Testing, Pergaman Press.
4. S.M.Elonka and A.L.Kohal, “Standard Boiler Operations”, Tata McGraw Hill, New Delhi, 1994.
5. R.K.Jain, “Mechanical and Industrial Measurements”, Khanna Publishers, New Delhi, 1995. 3. E.Al. Wakil, “Power Plant Engineering”, Tata McGraw Hill, 1984.

OUTCOMES:

At the end of the course, the student will be able to

- apply effectively the different methods of Power Generation in operation and maintenance of power generation in a core industry.
- monitor and analyze different parameters like speed, vibration of turbines and their control.
- control the power plant using control loops effectively.

EICX86	**INSTRUMENTATION AND CONTROL IN PETROCHEMICAL INDUSTRIES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To familiarize the students with raw material pertaining to making of petroleum process.
- To get knowledge about various operations.
- To expose to measurement, automation and control system in respect of petrochemical industry.
- To provide an overview of computer application in petrochemical industry.

MODULE I PETROLEUM PROCESSING 8

Petroleum exploration – recovery techniques – oil – gas separation processing wet gases – refining of crude oil.

MODULE II UNIT OPERATIONS IN PETROLEUM INDUSTRY 8

Thermal cracking – catalytic cracking – catalytic reforming – polymerisation – alkylation – isomerization – production of ethylene, acetylene and propylene from petroleum.

MODULE III CHEMICALS FROM PETROLEUM PRODUCTS 8

Chemical from petroleum – methane derivatives – acetylene derivatives – acetylene derivatives – ethylene derivatives – propylene derivatives – other products.

MODULE IV MEASUREMENTS IN PETROCHEMICAL INDUSTRY 6

Parameters to be measured in refinery and petrochemical industry – selection and maintenance of measuring instruments – intrinsic safety of instruments.

MODULE V CONTROL LOOPS IN PETROCHEMICAL INDUSTRY 10

Process control in refinery and petrochemical industry – control of distillation column – control of catalytic crackers and pyrolysis unit – automatic control of polyethylene production – control of vinyl chloride and PVC production.

MODULE VI CASE STUDY 5

Unique problem solving in petrochemical industries

Total Hours – 45

REFERENCES:

1. Waddams A.L, “Chemical from petroleum”, Butter and Janner Ltd., 1968
2. Balchan.J.G. and Mumme K.I., “Process Control Structures and Applications”, Van Nostrand Reinhold Company, New York, 1988.
3.Austin G.T.Shreeves, “Chemical Process Industries”, McGraw Hill International student edition, Singapore, 1985.
4. Liptak B.G., “Instrumentation in Process Industries”, Chilton Book Company, 1994.

OUTCOMES:

At the end of the course, the student will be able to

- implement the concept of different measurement techniques and control systems in Petrochemical Industry.
- implement the methods of computer control in petrochemical industry.

Physics Elective Courses

(To be offered in II Semester)

PHCX 01	**FUNDAMENTALS OF ENGINEERING MATERIALS**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

OBJECTIVES:

- To help students to acquire the properties and applications of conducting and semiconducting materials.
- To familiarize students with basic ideas about the properties of dielectric and magnetic materials and their applications.
- To familiarize students with basic knowledge of nanomaterials and its electrical, electronic, mechanical and magnetic properties.
- To enable the students to correlate theoretical principles with practical applications.

MODULE I CONDUCTING AND SEMICONDUCTING MATERIALS 7

Conductors: properties, Fermi distribution function, Fermi energy in metals- density of states- conducting polymers-properties-applications, semiconductors: intrinsic and extrinsic semiconductors-carrier concentration, conductivity and energy band gap, semiconducting polymers- properties- applications.

MODULE II DIELECTRIC MATERIALS 8

Polarization- dielectric constant – electronic, ionic, orientational and space charge polarization – frequency and temperature dependence of polarisation – Internal field - Clausius Mosotti relation - dielectric loss – dielectric breakdown – applications of dielectric materials (capacitors and transformers) – Pyroelectricity, Piezoelectricity, ferroelectricity and applications in Ferroelectric Random Access Memory (FeRAM) - multiferroic materials and its applications.

MODULE III MAGNETIC MATERIALS 7

Origin of magnetism-magnetic moment, susceptibility, permeability – Bohr magneton – Dia, Para and Ferro magnetism –Spontaneous magnetization- Domain theory – Hysteresis – soft and hard magnetic materials – antiferromagnetic materials – Ferrites and its application - Giant Magneto-resistance effect (GMR) - Magnetic resonance imaging(MRI).

MODULE IV NANOMATERIALS 8

Properties of nanomaterials – size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties – quantum confinement – classification of nanomaterials – quantum well, quantum wire, quantum dot - nanoporous materials - carbon nanotubes, graphene - nanocomposites – applications of nano materials.

PRACTICALS

1. Determination of energy band gap of a semiconductor.
2. Determination of resistivity of metals by four point probe method.
3. Determination of dielectric constant of dielectric material.
4. Determination of time constant of a capacitor using RC circuit.
5. Determination of paramagnetic susceptibility of given liquid.
6. Determination of hysteresis loss in a transformer using BH curve.
7. Analysis of size effect on the absorption spectrum of nanomaterials.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. William D. Callister, “Material Science and Engineering”, Wiley Publications, 2006.
2. Raghavan, V., “Materials Science and Engineering”, 5th edition, Printice Hall of India Pvt Ltd. New Delhi, 2004.
3. Wahab. M.A, “Solid State Physics: Structure and Properties of Materials”, Narosa Publishing House Pvt. Ltd., New Delhi , 2nd Edition, 2010.
4. Pillai, S.O., “Solid State Physics”, New Age International, New Delhi, 2005.
5. Charles P. Poole and Frank J. Owens, ”Introduction to nanotechnology”, Wiley (India), 2009.
6. Pradeep. T., “Textbook of Nanoscience and Nanotechnology”, McGraw Hill Education (India) Private Limited, New York, 2012.

OUTCOMES:

On completion of this course, the student will be able to

- apply the concepts of conducting and semiconducting materials for solid state devices.
- comprehend the significance of properties of dielectric magnetic materials and derive these properties from synthesized materials.
- differentiate between the properties of the nanomaterials compared to bulk materials.
- complement the knowledge acquired in the theory class and correlate the results for applications.

PHCX 02 **HEAT AND THERMODYNAMICS**

L	T	P	C
2	0	2	3

OBJECTIVES:

- To familiarize students with basic concepts of heat.
- To help students acquire the fundamentals of heat conduction and radiation.
- To enable students acquaint with the basics of thermodynamic concepts.
- To make students understand the fundamentals of heat based experiments.

MODULE I CONCEPTS OF HEAT 10

Definition of temperature, thermal and thermodynamic equilibrium - relationship between temperature and kinetic energy - definition of solid, liquid, gas - Introduction to phase transitions, critical and triple points- definition of heat capacity, mechanical equivalent of heat -Joule's calorimeter- latent heat- microscopic model of ideal gas - equation of state, internal energy, equipartition theorem- equation of state for non-ideal gases.

MODULE II CONDUCTION AND RADIATION 7

Thermal conductivity – rectilinear flow of heat – thermal conductivity of a good conductor – Forbe's method – thermal conductivity of a bad conductor – Lee's disc method – conduction of heat through compound media - radiation – Planck's law of blackbody radiation – Wien's law – Stefan's law – Newton's law of cooling from Stefan's law – Solar constant – Pyrometry.

MODULE III FUNDAMENTALS OF THERMODYNAMICS 8

Thermodynamic equilibrium – zeroth law of thermodynamics – first law of thermodynamics – Reversible and irreversible processes – second law of thermodynamics - Heat engine – Carnot's engine – Carnot's theorem – Internal combustion engines – petrol and diesel engines (qualitative) – Entropy and available energy – temperature – entropy diagram for Carnot's cycle - Third Law of thermodynamics (qualitative).

PRACTICALS

1. Determination of mechanical equivalent of heat by Joule's calorimeter.
2. Relation between temperature of a body and time by plotting a cooling curve- Newton's law of cooling.
3. Determination of specific heat capacity of liquid by cooling.
4. Determination of thermal conductivity of a good conductor-Forbe's method
5. Determination of thermal conductivity of a bad conductor-Lee's disc method

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Mathur. D.S, “Heat & Thermodynamics”, S.Chand & Co., 2009.
2. Brijlal & Subramaniam, “Heat and Thermodynamics”, S.Chand & Co, Delhi, 2010.
3. Gupta. A.B and Roy. H, “Thermal Physics”, Books and Allied Ltd., 2002.
4. Sharma. J.K and Sarkar. K.K, “Thermodynamics and statistical Physics”, Himalaya Publishing House, 1988.

OUTCOMES:

On completion of this course, the student will be able to

- understand the concepts of heat and its properties.
- comprehend the ideas governing the conduction and radiation processes.
- apply the knowledge of laws of thermodynamics in thermodynamic systems.

perform heat based experiments and determine its various properties.

PHCX 03 INTRODUCTION TO NANOSCIENCE AND TECHNOLOGY

L	T	P	C
2	0	2	3

OBJECTIVES:

- To acquire basic knowledge about the nanomaterials and applications.
- To learn about the synthesis and imaging techniques of nanomaterials.
- To gain the basic concepts of fabrication techniques.
- To enable the students to correlate theoretical principles with practical applications.

MODULE I NANOMATERIALS AND APPLICATIONS 10

Properties of nanomaterials – size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties – quantum confinement – classification of nanomaterials – quantum well, quantum wire, quantum dot - nanoporous materials - zeolite, mesoporous materials, carbon nanotubes, grapheme - nanocomposites - applications (qualitative): Molecular electronics-nanoelectronics – nanophotonics - single electron transistor-drug delivery.

MODULE II SYNTHESIS AND IMAGING TECHNIQUES 12

Top-down and bottom up approaches – mechanical alloying and mechanical ball milling - sol-gel approach - hydrothermal method - precipitation method - spray pyrolysis - spin coating-self assembled monolayer (SAM) - Chemical vapour deposition method – Physical vapour deposition method: laser ablation method, sputtering method.

Optical microscopy – Phase contrast and interference microscopy – confocal microscopy - high resolution Scanning electron microscope (HRSEM) - high resolution Transmission electron microscope (HRTEM) - Atomic force microscope - Scanning Tunnelling microscope (STM).

MODULE III NANOFABRICATION 8

Photolithgraphy - electron beam lithography - X-ray and Ion beam lithography - nanoimprint lithography - soft lithograpy - nanoelectromechnical systems (NEMS) - nanoindentation principles.

PRACTICALS

1. Synthesis of nanomaterials by sol-gel method.
2. Synthesis of nanomaterials by hydrothermal method.
3. Synthesis of nanomaterials by solid state reaction method.
4. Synthesis of nanomaterials by chemical bath deposition method.
5. Synthesis of nanomaterials by co-precipitation method.
6. Synthesis of nano thin films by spray pyrolysis method.
7. Synthesis of nano thin films by pulsed laser deposition (PLD) method.
8. Analysis of size effect on the absorption spectrum of nanomaterials.
9. SEM characterization of nanomaterials.
10. AFM characterization of nano thin films.
11. Phase confirmation by XRD.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Charles P.Poole and Frank J. Owens, "Introduction to nanotechnology", Wiley (India), 2009.
2. Cao. G., "Nanostructures & Nanomaterials: Synthesis, Properties & Applications", Imperial College Press, 2004.
3. Gaddand. W., Brenner. D., Lysherski. S. and Infrate. G.J., "Handbook of NanoScience Engineering and Technology", CRC Press, 2002.
4. Pradeep. T., "Textbook of Nanoscience and Nanotechnology", McGraw Hill Education (India) Private Limited, New York, 2012.
5. Chris Mack, "Fundamental Principles of Optical Lithography: The Science of Microfabrication", John Wiley & Sons, 2008.
6. Bandyopadhyay A.K., "Nano Materials", New Age International Publishers, New Delhi, 2008.

OUTCOMES:

At the end of the course, the students will be able to

- understand the importance and basic concepts of the nanomaterials.
- comprehend the imaging techniques for nanomaterials.
- illustrate the various nanofabrication techniques.
- complement the knowledge acquired in the theory class and correlate the results for applications.

PHCX 04 LASERS AND THEIR APPLICATIONS

L	T	P	C
2	0	2	3

OBJECTIVES:

- To recognize the fundamentals of laser and its characteristics.
- To comprehend and compare the different laser systems.
- To apply lasers in metrology and material processing.
- To understand the working of laser instrumentation.
- To correlate the experimental results for applications.

MODULE I LASER THEORY 8

Spontaneous and stimulated emission - Population inversion – Einstein's A & B coefficients - Threshold condition – super-radiance Laser – Three level and four level laser systems -conditions for CW and pulsed laser action. Q-Switching - experimental methods - cavity dumping - Mode locking - experimental methods - Spatial and Temporal coherence.

MODULE II DIFFERENT LASER SYSTEMS 8

Laser systems – General description - Laser structure - excitation mechanism - Different laser systems- He-Ne laser, Carbon-dioxide laser - Excimer laser – Free electron laser- Alexandrite laser - Ti-Sapphire laser – Semiconductor diode laser - Diode pumped solid state laser - Pulsed-CW dye laser- Fibre laser.

MODULE III METROLOGICAL AND MATERIAL PROCESSING APPLICATIONS 8

CW and Pulsed laser beam characteristics and its measurements - Beam focusing effects - spot size - Power and Energy density Measurements - Distance measurement - Interferometric techniques - LIDARS - different experimental arrangements - Pollution monitoring by remote sensing - Laser gyroscope - Laser welding, drilling, machining and cutting - Laser surface treatment - Laser vapour deposition – Biophotonic applications.

MODULE IV LASER INSTRUMENTATION 6

Laser for measurement of length, current and voltage – Laser Doppler Velocimetry - Holography and speckle in displacement and deformation measurements - Laser for communication with fiber optics as channel.

PRACTICALS

1. Tuning of Dye Laser using DFDL Arrangement
2. Determination of Brewster Angle using He-Ne laser
3. Study of transversely Pumped Dye Lasers
4. Study of longitudinally Pumped Dye Lasers
5. Determination of power and wavelength using Distributed Feedback Dye Laser (DFDL)
6. Determination of fibre optic losses using semiconductor laser.
7. Bandgap determination of a semiconductor diode.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. William T. Silfvast, “Laser Fundamentals”, Cambridge University Press, 2009.
2. Ghatak. A. & Thyagarajan. K. “Optical Electronics”, Cambridge University, 1994.
3. Laud.B.B., “Laser and Non-Linear Optics”, Second Edition, New Age International (p) Limited Publishers, 2011.
4. Nambiar. K.R., “Lasers Principle, Types and Applications”, New Age International (p) Ltd, 2004.
5. Wilson. J. & Hawkes. J.F.B., “Opto Electronics - An Introduction”, Prentice Hall, 1992.
6. William M.Steen, ”Laser Material Processing”, Springer-Verlag, Berlin, Third Edn., 2005.

OUTCOMES:

At the end of the course, the students will be able

- To complement the knowledge acquired in the theory class.
- To work with dye lasers for tunability of laser wavelength.
- To measure the loss of information involved in fibre optic communication.
- To correlate the results for application.

PHCX 05 **MATERIALS SCIENCE** **L T P C**

2 0 2 3

OBJECTIVES:

- To gain basic knowledge in conducting and semiconducting materials and their properties.
- To provide basic understanding of properties and applications of dielectric materials.
- To impart knowledge on magnetic and optical materials and their properties & applications.
- To enable the students to correlate theoretical principles with practical applications.

MODULE I CONDUCTING AND SEMICONDUCTING MATERIALS 10

Quantum free electron theory of metals and its importance - Energy distribution of electrons in metals - Fermi distribution function - Density of energy states and carrier concentration in metals - Fermi energy – Classification of solids into conductors, semiconductors and insulators on the basis of Band theory – Introduction to Elemental and Compound semiconductors - Carrier concentration derivation for Intrinsic semiconductors - Density of electrons in conduction band & Density of holes in valence band- intrinsic carrier concentration - Fermi energy & Variation of Fermi energy level with temperature - Mobility and electrical conductivity - Band gap determination.

MODULE II DIELECTRIC MATERIALS 7

Introduction to dielectric materials & basic definitions – Electronic, Ionic, Orientation & Space charge polarizations - Total polarization – Frequency and temperature dependence of polarization - Internal field in a dielectric material - Deduction of Clausius - Mosotti's relation - dielectric loss & loss tangent – Different types of dielectric breakdown – Applications of dielectric materials : Capacitors and Transformers.

MODULE III MAGNETIC MATERIALS 6

Introduction to magnetic materials & origin of magnetic moment - Different types of magnetic materials and their properties - Ferromagnetism & Domain theory of ferromagnetism - Hysteresis, Soft and Hard magnetic materials - Antiferromagnetic materials - Ferrites and its applications – Applications of magnetic materials : Data storage.

MODULE IV OPTICAL MATERIALS 7

Optical properties of semiconductors - Direct and Indirect bandgap semiconductors – Traps, recombination centre, color center and exciton – Luminescence : Fluorescence and Phosphorescence - Liquid crystal display : twisted nematic crystal display – Applications of Optical materials - Optical Sources : light emitting diode and laser diode - Photo detectors : PIN photodiode and Avalanche Photodiode - Pyroelectric devices - Electro optic effect : Kerr effect and Faraday effect.

PRACTICALS

1. Resistivity measurement of a semiconductor using four point probe method.
2. Determination of band gap of a semiconductor diode.
3. Determination of Hall coefficient of a given semiconductor material.
4. Determination of dielectric constant of a given non-polar liquid.
5. Determination of magnetic susceptibility of a given paramagnetic liquid using Quincke's method.
6. Determination of energy loss of a given transformer core using hysteresis method.
7. To study the I-V characteristics of a photodiode.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Palanisamy P.K., ''Physics II'', Material Science for ECE, Scitech Publications (India) Pvt. Ltd., 2006.
2. Kasap. S.O., ''Principles of Electronic materials and devices'', McGraw Hill Publishers, 3rd Edition, 2007.
3. Arumugam. M, "Physics II'', Material Science for ECE, Anuradha Publishers, 5th Edition, 2005.
4. Sze. S.M., ''Semiconductor Devices – Physics and Technology'', John Wiley, 2nd Edition. 2002.
5. Raghavan. V, ''Materials Science and Engineering'', Prentice Hall of India, 5th Edition, 2004.

OUTCOMES:

On the completion of this course, the students will be able to

- Gain knowledge about fundamentals of conducting and semiconducting materials.
- Understand concepts and applications of Dielectric and Magnetic materials.
- Familiarize Optical materials and their applications in Engineering and Medical fields.
- Complement the knowledge acquired in the theory class and correlate the results for applications.

PHCX 06	NON-DESTRUCTIVE TESTING	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To study the process and applications of ultrasonic inspection method.
- To understand the basic concepts of radiographic inspection method.
- To acquire the knowledge about the various surface Non-Destructive Testing (NDT) techniques.
- To enable the students to correlate theoretical principles with practical applications.

MODULE I ULTRASONIC INSPECTION METHOD 10

Ultrasonic Testing - Principle of operations - types of sound waves - types of Transducers - transmission and pulse-echo method - straight beam and angle beam, instrumentation - calibration methods - ultrasonic testing technique- data representation, A Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight. Diffraction - thickness determination - advantages, disadvantages and applications.

MODULE II RADIOGRAPHIC INSPECTION METHOD 10

Radiographic testing – Principle - Interaction of X-ray with matter - X-ray radiography - method of generation-industrial radiography inspection techniques – Equipment - Exposure charts - Types of films – Fluoroscopy - Xero-Radiography – Limitations - Gamma radiography - Equipment, radiation sources - method of generation - film processing - interpretations of radiography - safety in industrial radiography.

MODULE III SURFACE NDT TECHNIQUES 10

Liquid Penetrant Testing – Principles, Characteristics and types of liquid penetrants – developers - advantages and disadvantages of various methods - Inspection Procedure and Interpretation of results. Applications of Liquid Penetrant testing.

Magnetic Particle Testing - Principle-magnetizing technique - procedure –equipment - Interpretation and evaluation of test indications - applications and limitations - demagnetization.

PRACTICALS

1. Inspection of welds using solvent removable visible dye penetrant.

2. Inspection of welds using solvent removable fluorescent dye penetrant.
3. Inspection on non magnetic materials by eddy current method.
4. Inspection on magnetic materials by eddy current method.
5. Inspection of welds by Eddy current Testing.
6. Inspection of welds by Magnetic Particle Testing - Dry method.
7. Inspection of welds by Magnetic Particle Testing - Wet method.
8. Ultrasonic flaw detector - Inspection of defects.
9. Demonstration of Radiographic inspection.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Baldev Raj., Jayakumar T.,Thavasimuthu., “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.
2. Ravi Prakash., “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010.
3. ASM Metals Handbook of Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio, USA, Volume-17, 2000.
4. Paul E Mix,”Introduction to Non-destructive testing: a training guide”, Wiley, 2nd Edition New Jersey, 2005.
5. Charles J., Hellier, “Handbook of Nondestructive evaluation”, McGraw Hill, New York, 2001.

OUTCOMES:

Upon completion of this course, the students will be able to

- illustrate the ultrasonic inspection methods of NDT.
- understand the basic concept of radiographic inspection method.
- test the surfaces by the various surface NDT techniques.
- complement the knowledge acquired in the theory class and correlate the results for applications.

PHCX 07	**PROPERTIES OF MATTER AND ACOUSTICS**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

OBJECTIVES:

- To understand principles and properties of elasticity.
- To understand the basic concepts and application of viscosity.
- To analysis acoustic of building.
- To know about photoelasticity and its applications.

MODULE I ELASTICITY 8

Stress and strain - Hooke's Law of elasticity - Elastic moduli - Stress-Strain Diagram - Poisson's Ratio - Relation between elastic constants - Work done in stretching and twisting a wire - Twisting couple on a cylinder- Expression for bending moment - Cantilever–Expression for depression - Uniform bending and Non-uniform bending of beams (theory & experiment) - I form Girders (qualitative treatment) and applications.

MODULE II VISCOSITY 8

Viscosity- Newton’s formula for viscous flow - Streamline and turbulent motion - Reynolds number - Poiseuille's formula - Determination of coefficient of viscosity- factors affecting viscosity - capillary flow method - Stoke's formula- viscosity of highly viscous liquids – Stoke’s method - Lubricants and its applications –viscosity measurements - Viscometer - Variation of Viscosity with Temperature.

MODULE III ACOUSTICS OF BUILDING 7

Basic requirement for the acoustically good halls - Reverberation and time of reverberation – Sabine’s formula for reverberation time - Absorption coefficient and its measurement -Transmission of sound and transmission loss - Factors affecting the architectural acoustics and their remedy-sound absorbing materials - vibration and noise control systems for buildings.

MODULE IV PHOTO ELASTICITY 7

Polarization - double refraction - Theory of Plane, Circularly and Elliptically polarized light - Quarter wave plate and half wave plate - photo elasticity - Theory of photo-elasticity - Stress optic relations - model materials - analysis techniques - Photo elastic bench - Three dimensional photo elasticity - Digital photo elasticity - Photo elastic coatings.

PRACTICALS

1. Determination of viscosity of liquid by Poiseuille's method.
2. Determination of viscosity of liquid by Stoke's method.
3. Analysis of stress by photo elastic method.
4. Verification of Hooke's law by spring method.
5. Determination of Young's modulus of the cantilever beam.
6. Determination of rigidity modulus by static torsion method.
7. Visit to acoustically good auditorium and identifying the sound absorbing materials in the auditorium.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Mathur D.S., "Elements of Properties of Matter", S.Chand & Co, Delhi, 2009.
2. Gaur R.K., Gupta S.L.,"Engineering Physics", Dhanpat Rai Publishers, 2010.
3. Brijlal and Subramaniam.," Properties of Matter", Eurasia Publishing Co, New Delhi, 2002.
4. Smith C.J.," General Properties of Matter", Orient & Longman,1960.
5. Kenneth G. Budinski and Michel K., Budinski, "Engineering Materials Properties and Selection", Pearson, Singapore, 2002.

OUTCOMES:

Upon completion of this course, the students will be able to

- understand the basic concepts of the elasticity of materials.
- comprehend the concepts of viscosity of liquid and measurement.
- demonstrate the acoustical aspects of building and its importance in construction.
- apply the fundamental concept of photo elasticity for the stress analysis of the object.

PHCX 08	**PROPERTIES OF MATTER AND NONDESTRUCTIVE TESTING**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

OBJECTIVES:

- To impart knowledge about the principles and properties of elasticity.
- To learn the laws governing the dynamic of rigid bodies.
- To acquire the knowledge of the various techniques of Non-Destructive Testing (NDT) of materials.
- To understand the principle and basic concept of low temperature applications.

MODULE I **ELASTICITY** **8**

Stress and strain - Hooke's Law of elasticity - Elastic moduli - Stress-Strain Diagram - Poisson's Ratio - Relation between elastic constants - Work done in stretching and twisting a wire - Twisting couple on a cylinder- Expression for bending moment- Cantilever–Expression for depression - Uniform Bending and Non-uniform bending of beams (theory & experiment) - I form Girders (qualitative treatment) and applications.

MODULE II **DYNAMICS OF RIGID BODIES** **8**

Rigid bodies - angular acceleration - Torque on a particle - angular momentum - law of conservation of angular momentum - moment of inertia and its significance - Theorem of parallel and perpendicular axis - moment of inertia of a thin uniform bar - moment of inertia of a rectangular lamina - moment of inertia of uniform circular disc - Moment of inertia of hollow and solid cylinders – flywheel (qualitative) - kinetic energy of rotating body – Routh rule.

MODULE III **NDT TECHNIQUES** **8**

Ultrasonic Testing- types of Transducers-transmission and pulse-echo method- Radiographic testing- Principle-Interaction of X-ray with matter-X-ray radiography- method of generation-industrial radiography inspection techniques- Liquid Penetrant Testing**-** Inspection Procedure and Interpretation of results.

MODULE IV **LOW TEMPERATURE PHYSICS** **8**

Definition of Refrigeration and Air-Conditioning - Types of **Refrigeration Systems-** Applications- Comfort Air Conditioning, Industrial Refrigeration, Food processing and food chain - Cryogenic treatment - Low temperature properties of engineering materials: Mechanical properties, Thermal properties, Electrical properties.

PRACTICALS

1. Verification of Hooke's law by spring method.
2. Determination of Young's modulus of the beam by bending method.
3. Inspection of welds using solvent removable visible dye penetrant.
   Inspection of welds using solvent removable fluorescence dye penetrant.
5. Inspection of welds by Magnetic Particle Testing.
6. Determination of moment of inertia of the disc by torsion pendulum method.
7. Determination of moment of inertia of the disc by static torsion method.
8. Demonstration of working of flywheel.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Mathur D.S.,"Elements of Properties of Matter", S.Chand & Co, Delhi, 2009.
2. Brijlal & Subramaniam," Properties of Matter", Eurasia Publishing Co, Delhi, 2002.
3. Gaur R.K., Gupta S.L., "Engineering Physics" Dhanpat Rai Publishers, 2010.
4. Baldev Raj.,Jayakumar T., Thavasimuthu M.,"Practical Non-Destructive testing", Narosa Publishing House, 2009.
5. Brijlal & Subrahmanyam., "Heat and Thermodynamics" S.Chand & Company Ltd, 2002.
6. Paul E Mix.," Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition, New Jersey, 2005.
7. Charles J., Hellier.," Handbook of Nondestructive evaluation", McGraw Hill, New York, 2001.

OUTCOMES:

Upon completion of this course, the students will be able to

- understand the basic of concept of elasticity of materials.
- comprehend the basic concepts of motion of rigid bodies and its applications.
- demonstrate the various NDT techniques and its importance.
- know the low temperature systems and its applications.

PHCX 09	SEMICONDUCTOR PHYSICS AND OPTOELECTRONICS	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To understand the Physics of Semiconductor devices.
- To make the students learn the fundamentals of Photoluminous - semiconductors, Optoelectronic devices, Optical modulators/detectors.
- To make them understand the technology behind latest Display devices like LCD, Plasma and LED Panels.
- To enable the students to correlate theoretical principles with practical applications.

MODULE I PHYSICS OF SEMICONDUCTORS 8

Elemental and compound semiconductors – Drift and diffusion current - Intrinsic semiconductors – Carrier concentration (derivation) – Fermi energy – Variation of Fermi energy level with temperature – Mobility and electrical conductivity – Band gap determination – Extrinsic semiconductors – Carrier concentration in n-type and p-type semiconductor (derivation) – Variation of Fermi level with temperature and impurity concentration – Variation of Electrical conductivity with temperature – Hall effect – Experiment and applications of Hall effect.

MODULE II OPTOELECTRONIC DEVICES 7

Light Emitting Diodes (LED) – power and efficiency - double hetero LED - LED structure - LED characteristics - White LED – Applications. Liquid crystal displays – Dynamic scattering and Twisted nematic display, Semiconductor Lasers, Homojunction and Heterojunction laser diodes - Optical processes in semiconductor lasers.

MODULE III OPTICAL MODULATORS 7

Modulation of light – birefringence –Modulation Techniques - Electro optic effect – Electro optic materials –Types of Electro optic Modulators : Kerr and Pockel modulators –- Magneto optic effect - Magneto optic Modulators – Acousto Optic modulators.

MODULE IV OPTICAL DETECTORS 8

Photo detectors - photodiodes - phototransistors - noise characteristics - PIN diode – Avalanche Photodiode (APD) characteristics - APD design of detector arrays –

Charged Couple Device - Solar cells - Materials and design considerations, Thin film solar cells, amorphous silicon solar cells.

PRACTICALS

1. Resistivity measurement of a semiconductor using four point probe method.
2. Determination of band gap of a semiconductor diode.
3. Determination of Hall coefficient of a given semiconductor material.
4. Determination of the wavelength of a given laser source using diffraction grating.
5. Determination of Planck's constant using LED.
6. To study the I-V characteristics of photodiode and phototransistor.
7. To study the characteristics of a solar cell.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Arumugam. M, "Physics II", Anuradha Publishers, 5th Edition, 2005.
2. Sze. S.M., "Semiconductor Devices – Physics and Technology", 2nd edn. John Wiley, 2002.
3. Wilson & J.F.B. Hawkes, "Optoelectronics – An Introduction", Prentice Hall, India, 1996.
4. Bhattacharya, "Semiconductor optoelectronic devices", Second Edn, Pearson Education, 2002.
5. Safa O. Kasap, "Optoelectronics & Photonics: Principles & Practices", Second Edn, Pearson Education,2013.
6. Palanisamy P.K., "Semiconductor physics and optoelectronics" Scitech Publications, 2003.

OUTCOMES:

On completion of this course, the student will be able to

- understand the principles of Physics behind semiconductor devices.
- choose the correct semiconductors for electronic devices and display.
- differentiate the working principle of LED and Diode Laser.
- apply the knowledge of modulation of light for different types of optical modulators.
- select suitable photodetectors for different types of applications.
- complement the knowledge acquired in the theory class and correlate the results for applications.

Chemistry Elective Courses
(To be offered II Semester)

CHCX01	**ANALYTICAL INSTRUMENTATION**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

OBJECTIVES:

To make the student conversant with

- principles, instrumentation and applications of different electroanalytical techniques
- different chromatographic techniques
- principles, instrumentation and applications of various types of absorption and emission spectroscopy
- different thermal analytical methods and their applications

MODULE I ELECTROANALYTICAL TECHNIQUES 7

Principle and applications: conductometric titrations – potentiometrIc titrations, ion-selective electrodes and pH-metry – coulometry – voltammetry - polarography, amperometric titrations.

MODULE II CHROMATOGRAPHY 8

Basic concepts of chromatography – paper chromatography – column chromatography – thin layer chromatography – gas chromatography – high performance liquid chromatography – gel permeation chromatography.

MODULE III SPECTROSCOPY 8

Absorption spectroscopy (principle, instrumentation and applications): Colorimetric analysis – UV-Visible spectroscopy – FTIR spectroscopy - Emission Spectroscopy (principle, instrumentation and applications): fluorescence, phosphorescence and chemiluminescence – Atomic absorption spectroscopy – flame emission spectroscopy.

MODULE IV THERMAL ANALYSIS 7

Principle, instrumentation and applications: Thermo gravimetric analysis – Differential thermal analysis – Differential scanning calorimetry

PRACTICALS

1. Conductometric titrations: acid-base and precipitation titrations
2. Potentiometric titrations
3. Determination of pH of the unknown solution
4. Estimation of alkali metals using flame emission spectroscopy
5. Estimation of metal ions of coloured solutions using colorimetric analysis
6. Separation of compounds using gas chromatography
7. Separation of compounds using high performance liquid chromatography
8. Analysis of the given sample and interpretation of the data using IR, UV-Visible spectroscopy
9. Demonstration of TGA/DTA and DSC and interpretation of data.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Skoog D.A., West D.M., Holler F.J. and Crouch S.R., Fundamentals of Analytical Chemistry, 8th Edition, Thomson Brooks/Cole Publication., Singapore, 2004.
2. Willard H.H., Merritt L.L., Dean J.A. and Settle F.A., Instrumental Methods of Analysis, 7th Edition, CBS Publication, New Delhi Reprint, 2004.
3. A.I. Vogel, Vogel's Textbook of Practical Organic Chemistry, 5th Edition, Prentice Hall, London, 2008.
4. Christian G.D., Analytical Chemistry, 6th Edition, John Wiley, Singapore, 2003.
5. Fifield F.W. and Kealey D., Principles and Practice of Analytical Chemistry, 5th Edition, Blackwell Publication, London, 2000.
6. Settle F. (Editor), Handbook of Instrumental Techniques for Analytical Chemistry, Pearson Education, Singapore, 2004.

OUTCOMES:

The student will be able to

- state the principle and applications of various electro-analytical techniques
- identify the right separation method for a given sample using different chromatographic techniques
- explain the principle, instrumentation & applications of various spectroscopic methods and also to interpret the data
- elaborate the principle, instrumentation and applications of various thermal analytical techniques and interpret the data.

CHCX02	CORROSION AND ITS CONTROL	L	T	P	C
		2	0	2	3

OBJECTIVES:

The students should be conversant with the

- Basic concepts, principles and factors affecting corrosion
- Types and mechanism of corrosion
- Control measures of corrosion by material selection, proper design and by applying organic coatings
- Control of corrosion by applying inorganic coating

MODULE I BASIC CONCEPTS OF CORROSION 8

Corrosion – causes and impacts of corrosion – mechanism of corrosion: Dry corrosion- oxidation corrosion - corrosion by other gases – Pilling-Bedworth rule- Corrosion by hydrogen: hydrogen blistering, hydrogen embritttlement, decarburization and hydrogen attack – corrosion of silver and copper by sulphur compounds – liquid metal corrosion (embritttlement or cracking) – Wet corrosion : hydrogen evolution – presence and absence of oxygen and absorption of oxygen – difference between dry and wet corrosion-factors influencing corrosion-polarization-passivity-emf series and galvanic series- corrosion current -rate of corrosion.

MODULE II FORMS OF CORROSION 7

Forms of corrosion-conditions for electrochemical corrosion –galvanic corrosion – differential aeration corrosion: pitting, water line, wire fencing, crevice and filiform corrosion – stress corrosion – Intergranular corrosion- erosion corrosion – soil corrosion – microbiological corrosion- fretting corrosion- corrosion in composites.

MODULE III CORROSION CONTROL AND ORGANIC COATINGS 8

Corrosion control – selection of materials and designing- cathodic protection – sacrificial anode and impressed current cathodic protection – corrosion inhibitors: anodic, cathodic and vapour phase inhibitors.

Organic protective coatings – paints: constituents – functions – varnishes : types-constituents – functions – lacquers : constituents – functions –enamels-constituents – functions – special paints : fire retardant, water repellant, heat resistant, temperature indicating and luminous paints.

MODULE IV INORGANIC COATINGS 7

Treatment of metal surface-inorganic coatings- classification- metallic coatings : anodic and cathodic coatings-hot dipping : galvanizing and tinning- electroplating— electroless plating – cementation (diffusion) : sherardizing, calorizing and chromizing – metal cladding-metal spraying – non metallic coatings (chemical conversion coatings) : phosphate, chromate, oxide coatings and anodizing – comparison of anodic and cathodic protection.

PRACTICALS

1. Determination and comparison of rate of corrosion of metals in the presence of acid, base and neutral medium by weight loss method.
2. Determination of rate of corrosion of iron in the presence of various acids by weight loss method.
3. Determination of rate of corrosion of iron in the presence and absence of anodic Inhibitor by weight loss method.
4. Determination of rate of corrosion of iron in the presence and absence of cathodic Inhibitor by weight loss method.
5. Electroplating of base metal with copper.
6. Electrolessplating of base metal with copper
7. Chemical conversion coatings such as chromate and phosphate coatings.
8. Demonstration on the study of rate of corrosion by using cyclic voltametry.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. P.C Jain & Monica Jain, Engineering Chemistry Dhanpatrai Publishing Company (P) Ltd., New Delhi (2013).
2. S S Umare & S S Dara, A text Book of Engineering Chemistry, S. Chand& Company Ltd, New Delhi, 2014.
3. M.G. Fontana and N.G. Green, Corrosion Engineering, McGraw Hill Book Company, NewYork, 1984.
4. S. Banerjee, A.K. Tyagi, Functional Materials- Preparation, Processing and Applications, ELSEVIER Publications, London ; Waltham, MA : 2011

OUTCOMES:

Students will be able to

- explain the mechanism, compare and enumerate the factors affecting corrosion

- describe and identify the place and types for a given situation.
- choose and elaborate the suitable organic coating method for a given real time situation.
- apply a suitable metallic coating for a given situation

CHCX03	ELECTRICAL MATERIALS AND BATTERIES	L	T	P	C
		2	0	2	3

OBJECTIVES:

The students should be conversant with

- preparation, properties and applications of plastics used in electrical and electronic applications
- properties and uses of electrical engineering materials
- classification and description of different types of batteries.
- classification and types of fuel cells

MODULE I POLYMERS FOR ELECTRICAL AND ELECTRONIC APPLICATIONS 8

Preparation, properties and applications **:** polyethylene, polypropylene, EPDM, Nylon-6,6, PVC, PTFE, polycarbonates, ABS, phenol formaldehyde, urea formaldehyde, epoxy resins – polymer blends and alloys.

MODULE II ELECTRICAL ENGINEERING MATERIALS 7

Conductors: Silver, Copper, Gold, Aluminum – Semiconductors: Germanium, Silicon, Gallium Arsenic – Insulating Materials: Rubbers, Mica, Plastics, Ceramics, Insulating papers – Magnetic Materials: ferromagnetic materials, paramagnetic materials, diamagnetic materials, antiferromagnetic materials, ferrites

MODULE III BATTERIES 7

Electrochemical and electrolytic cell – batteries : types (primary, secondary and flow cell) – primary batteries : dry cells, alkaline batteries – secondary batteries : nickel-cadmium cell – lead acid storage cell, lithium battery : primary and secondary type – solar cell – dye sensitized solar cell.

MODULE IV FUEL CELLS 8

Difference between batteries and fuel cells - chemistry of fuel cells - types of fuel cell (based on temperature and electrolyte) – principle, characteristic features, advantages, disadvantages and applications of polymer electrolyte membrane or proton exchange membrane fuel cell (PEMFC), direct methanol fuel cell (DMFC), alkaline fuel cell (AFC), phosphoric acid fuel cell (PAFC), molten carbonate fuel cell (MCFC) and solid oxide fuel cells (SOFC).

PRACTICALS

1. Free radical polymerization of styrene.
2. Free radical polymerization of PMMA.
3. Preparation of phenol-formaldehyde.
4. Preparation of urea-formaldehyde.
5. Synthesis of epoxy resin.
6. Demonstration of mechanical properties of insulating materials using UTM
7. Demonstration of electrical properties of insulating materials
8. Construction of batteries using natural resources
9. Measurement of EMF for different batteries.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Jain P.C. and Renuka Jain, Engineering Chemistry, Dhanpat Rai Publication Co. (P) Ltd., New Delhi, 2013.
2. Michael L. Berins, Plastics Engineering Hand Book, 5th Edition, Chapman and Hall, New York, 1991.
3. H.F. Mark and N. Gaylord, Encyclopedia of Polymer Science and Technology, Vol. 1 to XIV Interscience, 2nd Ed. 1988.
4. Gowarikar V.R., Viswanathan N.V and Jayadev Sreedhar, Polymer Science, Wiley Eastern Limited, Madras, 1981.
5. R.K. Rajput,A Textbook of Electrical Engineering Materials, Firewall Media, 2004
6. Vladimir S. Bagotsky, Fuel Cells: Problems and Solutions, 2nd Edition, John Wiley and Sons, 2012.
7. B. Viswanathan and M. Aulice Scibioh, Fuel Cells: Principles and Applications, Taylor and Francis Group, 2007.

OUTCOMES:

The student will be able to

- summarise the preparation, properties and applications of plastics used in electrical and electronic applications
- enumerate the properties and uses of electrical engineering materials
- illustrate various types of batteries with the aid of a diagram

- classify the fuel cells and elaborate the different types of fuel cells.

CHCX04	ENGINEERING MATERIALS	L	T	P	C
		2	0	2	3

OBJECTIVES:

The students should be conversant with

- properties and uses of different types of refractories and abrasives
- adhesives, cements and lime, setting of cements and their chemical behaviors.
- types, properties and uses of lubricants.
- various types of composite materials.

MODULE I REFRACTORIES AND ABRASIVES 8

Introduction refractory: -classification - based on chemical nature- characteristic and selection of good refractory - general manufacture of refractory- preparation properties and uses of: silica refractory - magnesite refractory - zirconia refractory, properties of refractories: refractoriness - refractoriness under load - thermal spalling - porosity and dimensional stability, Cermets - super refractory.

Abrasives : introduction - Moh's scale - natural abrasives: diamond – corundum – emery - garnet and quartz, synthetic abrasives: preparation properties and uses: carborundum (silicon carbide)– alundum - boron (norbide) carbide

MODULE II ADHESIVES AND BINDING MATERIALS 7

Introduction - classification of adhesives –advantage –limitation of adhesive bonding – development of adhesive- factors influencing adhesive action: chemical and physical, application techniques of adhesive – Lime: classification – manufacture - setting and hardening, Gypsum: -Manufacture and properties and uses - Cement : chemical composition- Manufacture – setting and hardening – concrete – weathering of cement and concrete and its prevention- special cements: high alumina cement - sorel cement - white portland cement – water proof cement.

MODULE III LUBRICANTS 7

Introduction –functions of lubricant- mechanism of lubrication - classification of lubricant – liquid lubricant: vegetable and animal oils – mineral oils, semisolid: grease(calcium, lithium, aluminium) – petroleum jelly, solid lubricant: graphite - molybdenum disulphide, Properties of lubricant: viscosity - viscosity index - flash point and fire point - cloud point and pour point – oiliness - aniline point - carbon residue.

MODULE IV COMPOSITE MATERIALS 8

Introduction – advantageous characteristics of composites, applications of composites, main constituent of composites, types and applications of composites: RCC fibre-reinforced plastics (glass , carbon and aramid) - particulate composite - metal matrix composite - layered composites - failures in fibre-reinforced composites, ceramic matrix composites (CMC) – properties and applications.

PRACTICALS

1. Preparation of refractory bricks
2. Preparation of abrasive papers/cloth
3. Preparation of simple adhesives
4. Estimation of alkalinity in cements
5. Determination of cloud point and pour point
6. Determination of flash point and fire point
7. Preparation of fibre-reinforced composite

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. P.C Jain & Monica Jain, Engineering Chemistry Dhanpatrai Publishing Company (P) Ltd., New Delhi (2013).
2. B.Sivasnakar, “Engineering Chemistry”, Tata McGrow-Hill Publication Limited, New Delhi, second reprint 2008.
3. Engineering Chemistry, Wiley India Editorial Team, Willey India Publisher, New Delhi, 2011.
4. S S Umare & S S Dara, A text Book of Engineering Chemistry, S. Chand& Company Ltd, New Delhi, 2014.

OUTCOMES:

The student will be able to

- classify and describe the manufacture the refractories and enumerate the properties and uses of abrasive materials.
- elaborate the manufacture, properties and uses of various adhesives and binding materials.
- classify lubricants and describe the properties and uses of them
- enumerate the properties and uses of various composite materials.

CHCX05	FUELS AND COMBUSTION	L	T	P	C
		2	0	2	3

OBJECTIVES:

To make the students conversant with the

- three types of fuels available and the different processes involved in it.
- analysis of fuel characteristics and manufacture of fuels
- calculations involved in calorific values and minimum air requirement for complete combustion.
- classification, functions, mechanism and properties of lubricants.

MODULE I SOLID FUELS 7

Characteristics of good fuel. Solid fuel – Wood, Coal – Ranking of coal – selection of coal. Analysis of coal – Proximate analysis. Pulverized coal – Metallurgical coke – Carbonization of coal – types. Manufacture of metallurgical coke – Beehive oven and Otto Hoffman's by-product oven methods.

MODULE II LIQUID AND GASEOUS FUELS 8

Liquid fuel: Petroleum: Refining of petroleum, Liquid fuels derived from petroleum – Cracking: Thermal (Liquid and Vapour phase) – Catalytic (fixed bed and moving bed cracking – Synthetic petrol: Fischer-Tropsch method– Knocking in petrol and diesel engine: octane number and antiknocking – cetane number and improvement of cetane number – biodiesel (trans-esterification) – Gaseous fuels: Compressed natural gas (CNG) – LPG – oil gas – producer gas – water (blue) gas – biogas.

MODULE III COMBUSTION 8

Calorific value: Gross and net caloric value – Bomb Calorimeter, Gas calorimeter - Definition of combustion – calculation of minimum requirement of air (problems) – theoretical calculation of calorific values (Dulong's formula), Gross and net calorific values ((problems) – Analysis of flue gas: Orsat's gas analysis method, explosive range, Ignition temperature. Introduction to air pollution from IC (Internal combustion) engines, photochemical smog, primary and secondary pollutants.

MODULE IV LUBRICANTS 7

Friction and wear – lubricants: definition, functions and mechanism of lubrication (thick film and thin film) –classification: liquid lubricants: animal and vegetable origin, mineral oil, blended oils, lubricating emulsions and silicones – properties of lubricating oils: viscosity and viscosity index; Flash and fire-point, Cloud and pour point, oiliness, emulsification number, volatility, carbon residue, aniline point – semisolid lubricant: greases and waxes – solid lubricant: graphite and molybdenum disulphide –nanolubricants.

PRACTICALS

1. Testing of fuels - proximate analysis (moisture, volatile matter, ash content and fixed carbon present in coal, coke, charcoal etc)
2. Ash content and carbon residue test
3. Biodiesel synthesis by trans-esterification method (from coconut, groundnut, mustard oil, palm oil)
4. Determination of calorific value of a solid fuel using Bomb calorimeter (coal, charcoal, coke etc)
5. Determination of calorific value of a liquid fuel using Bomb calorimeter (petrol, diesel, biodiesel etc)
6. Determination of cloud point and pour point of a lubricant
7. Determination of flash and fire point of diesel.
8. Aniline Point of diesel
9. Viscosity Index of lubricants and Fuels by Viscometer
10. Flue gas analysis by Orsat's gas analysis method – Demonstration
11. Working of internal combustion engine – Demonstration

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Jain P.C and Renuka Jain, Physical Chemistry for Engineers, Dhanpat Rai and Sons, New Delhi, 2001.
2. Engineering Chemistry, Wiley India Editorial Team, Willey India Publisher, New Delhi, 2011.
3. John Griswold, Fuels Combustion and Furnaces, Mc-Graw Hill Book Company Inc. University of Michigan, 1946.
4. J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill International Editions, 1989.
5. Bahl B.S., Tuli and Arun Bahl, Essentials of Physical Chemistry, S. Chand and Company Ltd., New Delhi, 2004.

OUTCOMES:

The students will be able to

- compare and contrast the solid, liquid and gaseous fuels and also describe the processes involved in liquid and gaseous fuels.
- analyse the fuel properties such as moisture, votalite matter, ash content, calorific value etc
- calculate minimum air required for complete combustion and calorific values of fuels.
- categorize different lubricants into three types, explain the preparation and determine their properties.

CHCX06	FUNDAMENTALS OF PHYSICAL CHEMISTRY	L	T	P	C
		2	0	2	3

OBJECTIVES:

The students will be conversant with the

- various thermodynamic terms and relate the laws of thermodynamics in chemical processes
- molecularity and order of reaction and derive the rate constant for different order of reactions
- basics of adsorption of different materials and propose mechanisms and surface area measurement
- conditions for equilibrium and learn different components at equilibrium

MODULE I BASIC THERMODYNAMICS 8

Introduction - Thermodynamic terms - Thermodynamic equilibrium and processes - 1st law of thermodynamics: internal energy, enthalpy, heat capacity, isothermal and adiabatic expansion, Joule-Thomson effect - Zeroth law of thermodynamics: absolute temperature - 2nd law of thermodynamics: - spontaneous and cyclic process, Entropy in isothermal, isobaric and isochoric processes, work and free energy function, Maxwell's relation - 3rd law of thermodynamics

MODULE II CHEMICAL KINETICS 8

Rate of chemical reaction - order and molecularity of a reaction - Rate constant - kinetics of opposing, parallel and consecutive and chain reactions - isotope effects - effect of temperature on reaction rate - collision theory - absolute reaction rate theory - kinetics in enzyme catalysis

MODULE III SURFACE SCIENCE AND CATALYSIS 8

Adsorption - adsorption isotherms - uni and bimolecular adsorption reactions - parahydrogen conversion - factors affecting adsorption – Langmuir adsorption isotherm - Hinshelwood mechanism and *Eley-Rideal* mechanism with example - adsorption of gases on solids and surface area measurement by BET method - Terms in catalysis - homogeneous and heterogeneous and enzyme catalysis with example

MODULE IV PHASE RULE 6

Terms involved - Conditions for equilibrium - application of phase rule to water, lead-silver system, freezing mixtures, thermal analysis: cooling curves.

PRACTICALS

1. Determination of the heat capacity of benzoic acid, internal energy of combustion of camphor using Bomb calorimeter. Calculation of enthalpy of combustion and formation for camphor.
2. Determination of adsorption isotherm of (i) acetic acid on charcoal (ii) oxalic acid on charcoal.
3. *Kineticsoffirst and second order reactions.*
4. Phase rule experiments with organic compounds: (i) naphthalene and p-dichloro benzene (ii) naphthalene and diphenyl (iii) m-dinitrobenzenzene and p-nitro toluene.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Rajaram J. and Kuriacose J.C., Chemical Thermodynamics: Classical, Statistical and Irreversible, Pearson Education, India, 2013.
2. Samuel Glasstone, Thermodynamics for Chemists, Read Books, United Kingdom, 2007.
3. James E. House, Principles of Chemical Kinetics, 2nd Edition, Academic Press, United States of America, 2007.
4. Keith J. Laidler, Chemical Kinetics, Pearson Education, India, 1987.
5. Douglas M. Ruthven, Principles of Adsorption and Adsorption Processes, John Wiley & Sons, 1984.
6. Puri B.R., Sharma L.R. and Pathania M.S., Principles of Physical Chemistry, 47th Edition, Vishal Publishing Co. India, 2016.

OUTCOMES:

The student will be able to

- calculate entropy, enthalpy and free energy change for different chemical processes
- calculate the rate constant for any chemical and biochemical processes
- differentiate the adsorption processes and calculate the surface area and

predict the suitability of catalysts for different chemical processes

- predict the equilibrium conditions for water, alloys, freezing mixtures and draw the thermal curves for phase transition

CHCX07	GREEN TECHNOLOGY	L	T	P	C
		2	0	2	3

OBJECTIVES:

To make students conversant with the

- basic principles of green chemistry and green technology.
- wastes that causes hazards to human health
- chemicals that harms our environment
- need for green processes in various industries

MODULE I GREEN CHEMISTRY PROTOCOL 7

Need – Significance – 12 Principles with examples – R4 model – Life cycle analysis – sustainable and cleaner production - Green Technology: definition, examples: CFC free refrigerants, green building, energy, 3D printers, nanotechnology – Awards for Green chemistry – organization promoting green chemistry.

MODULE II WASTE & WASTE MINIMISATION 8

Source of wastes: domestic, industrial, medical, nuclear, e-waste; problems; prevention – economy of waste disposal – Waste minimization techniques: general waste treatment and recycling – alternate waste water treatment technologies: hybrid process – Green computing: goals, green cloud, green ICT - Pollution statistics from various industries (Industrial case studies).

MODULE III GREEN SYNTHESIS 7

Introduction - Solvent free reactions - green reagents, green solvents in synthesis - microwave and ultrasound assisted reactions – supercritical fluid extraction – green oxidation and photochemical reactions – catalyst and biocatalysts.

MODULE IV GREEN INDUSTRIAL PROCESSES 8

Polymer industry: biodegradable polymer - textile industry: greener approaches of dyeing, waste disposal – ecofriendly agrochemicals: biofertilizers, biopesticides – Pharmaceutical industry: atom economy, reduction of toxicity, use of biocatalyst, zero waste disposal – Leather industry: greener process in tanning, crusting, surface coating – ecofriendly batteries & fuel cells.

PRACTICALS

1. Synthesis of an ionic liquids (Ex: imidazolium) and testing the solubility of organic

chemicals.

2. Green bromination of stilbene (using pyridine hydrobromide).
3. Green synthesis: Photocatalytic reactions, solvent-free organic reaction – Aldol; green oxidation, green reduction.
4. Microwave assisted chemical reaction. (synthesis of aspirin, pinacol-pinacolone reaction, etc).
5. Comparison of conventional reaction with microwave assisted reactions (atom economy, solvent, etc) [Ex: aldehyde and ketones with hydrazines to give hydrazones].
6. Diels-Alder reaction in eucalyptus oil (green process).

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Jain P.C and Renuka Jain, Physical Chemistry for Engineers, Dhanpat Rai and Sons, New Delhi. 2001.
2. V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, Ane Books India, New Delhi, 2006.
3. Paul Anastas, John C.Warner, John Warner Joint; Green Chemistry: Theory & Practice New Ed Edition; Oxford University press, USA, 2000.
4. Rashmi Sanghi, M. M. Srivastava, Green chemistry, Narosa publishers, New Delhi, 2003.

OUTCOMES:

The students will be able to

- outline the principles and implications of green chemistry.
- comprehend the potential risks of waste generated and analyse the threats to human and environment.
- integrate information into design of molecules to avoid/eliminate toxic solvents & reagents or reduce toxic products.
- identify various alternate greener technologies for various industries.

CHCX08	ORGANIC CHEMISTRY OF BIOMOLECULES	L	T	P	C
		2	0	2	3

OBJECTIVES:

To make students conversant with the

- basic concepts in organic chemistry
- types and structure of carbohydrates and lipids
- formation of different structures of proteins from amino acid
- structure of nucleic acids

MODULE I BASIC CONCEPTS IN ORGANIC CHEMISTRY 8

Classification and IUPAC nomenclature of organic compounds – stereochemistry – optical, stereo and geometrical isomerism – types of reagents: electrophiles and nucleophiles – types of reactions: addition, substitution, elimination and rearrangement reactions.

MODULE II CARBOHYDRATES, LIPIDS AND VITAMINS 7

Structure and functions of carbohydrates: mono, di, oligo and polysaccharides – lipids: phospholipids, glycolipids, sphingolipids – cholesterol – steroids – Structure, functions and deficiency disorders of fat soluble vitamins: A, D, E & K - Water soluble vitamins B & C: Thiamine, riboflavin, pantothenic acid, niacin, pyridoxine, biotin, cobalamine, folic acid and ascorbic acid.

MODULE III AMINO ACIDS, PEPTIDES AND PROTEINS 7

Aminoacids: classification, properties - peptides – polypeptides – proteins: primary, secondary, tertiary and quaternary structure – glycoproteins – lipoproteins – Enzymes: classification and functions

MODULE IV NUCLEIC ACIDS 8

Nucleic acids – importance - structure of purines and pyrimidines – nucleotides – polynucleotides - RNA – types & structure - DNA – phosphodiester bonds – chemical, helical structure and functions – DNA replication – gene modification.

PRACTICALS

1. Qualitative tests to identify carbohydrates.

2. Quantitative estimation of carbohydrates.
3. Separation of sugars – TLC and/or paper chromatography.
4. Quantitative estimation of lipids.
5. Separation of amino acids – TLC and/or paper chromatography.
6. Quantitative estimation of proteins by Lowry's method.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. V. K. Ahluwalia, Organic Reaction Mechanism, Narosa Publishers, New Delhi, 2002.
2. Johnson Arthur T., Biology for Engineers, CRC Press, Finland, 2011.
3. Jain P.C and Renuka Jain, Physical Chemistry for Engineers, Dhanpat Rai and Sons, New Delhi. 2001.
4. David L. Nelson, Michael M. Cox, Lehninger Principles of biochemistry, Macmillan press, London, 2010

OUTCOMES:

The students will be able to

- classify organic compounds and explain the mechanism of various organic reactions.
- draw the structures and enumerate the functions of carbohydrate, lipids and vitamins.
- correlate the relationship among amino acids, peptides and proteins.
- recognize the role of nucleic acid in the formation of RNA & DNA and differentiate DNA & RNA using their structure and function.

CHCX09	**POLYMER SCIENCE AND TECHNOLOGY**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

OBJECTIVES:

To make the student conversant with the

- basic concepts of polymers, classification, types of polymerization and molecular weight & its distribution
- preparation, properties and applications of thermoplastics and introduction to biodegradable polymers
- properties and applications of thermosets, elastomers and FRP
- different types of moulding techniques

MODULE I BASIC CONCEPTS OF POLYMERS 8

Definitions: monomer, polymer, functionality, degree of polymerization – classification of polymers: source, structure, application, thermal processing behavior (thermoplastics and thermosets), composition and structure (addition and condensation), mechanism (chain growth and step-wise growth) – copolymer: types – Definition –nomenclature of polymers – tacticity – types of polymerization : free radical, cationic and anionic polymerization (concepts only) – average molecular weight of polymer: number, weight – molecular weight distribution (problems)

MODULE II THERMOPLASTICS AND BIODEGRADABLE POLYMERS 8

Preparation, properties and applications : LDPE, HDPE, polypropylene, PVC, PTFE, PET, polyamides (Nylon-6 and Nylon 6,6) and polycarbonates – polymer blends and alloys – basics of biodegradable polymers.

MODULE III THERMOSET RESINS, ELASTOMERS AND FRP 7

Thermoset resins : phenolic resins, amino resins (urea and melamine formaldehyde), epoxy resins, unsaturated polyesters – polyurethanes – elastomers : vulcanization of natural rubber, diene based elastomers –fibre reinforced plastics: glass, aramid and carbon.

MODULE IV MOULDING TECHNIQUES 7

Moulding constituents**:** functions – moulding techniques**:** compression, injection, extrusion (single screw), blow moulding, thermoforming, (mechanical and vacuum forming), lamination.

PRACTICALS

1. Determination of molecular weight and degree of polymerization using Oswald's viscometer.
2. Free radical polymerization of styrene.
3. Free radical polymerization of PMMA.
4. Preparation of phenol-formaldehyde.
5. Preparation of urea-formaldehyde.
6. Synthesis of epoxy resin.
7. Synthesis of unsaturated polyester.
8. Preparation of FRP laminates.
9. Demonstration of injection moulding, compression moulding and blow moulding.

L – 30; P – 30; TOTAL HOURS – 60

REFERENCES:

1. Billmeyer F.N., Text Book of Polymer Science, 3rd Edition, John Wiley and Sons, New York, 1994.
2. George Odian, Principles of Polymerisation, 3rd Edition, McGraw Hill Book Company, New York, 1991.
3. Michael L. Berins, Plastics Engineering Hand Book, 5th Edition, Chapman and Hall, New York, 1991.
4. Jacqueline I., Kroschwitz, Concise Encyclopedia of Polymer Science and Engineering, John Wiley and Sons, New York, 1998.
5. Encyclopedia of Polymer Science and Technology, Vol. 1 to XIV, H.F. Mark and N. Gaylord, Interscience, 2nd Ed. 1988.
6. Gowarikar V.R., Viswanathan N.V and Jayadev Sreedhar, Polymer Science, Wiley Eastern Limited, Madras, 1981.

OUTCOMES:

The student will be able to

- classify various polymers, name the polymers and types of polymerization reactions, calculate molecular weight of polymers,
- summarise preparation, properties and applications of thermoplastics and give

examples of biodegradable polymers

- elaborate the properties and applications of thermosets, elastomers and FRP
- select the appropriate moulding technique for a given polymer, based on the application

Maths Elective Courses
(to be offered in IV
Semester)

MACX 01 DISCRETE MATHEMATICS AND GRAPH THEORY

L	T	P	C
3	1	0	4

OBJECTIVES:

The aims of this course are to

- introduce Logical and Mathematical ability to deal with abstraction.
- familiarize the basic mathematical ideas and terminologies used in computer science.
- translate real life situations into diagrammatic representations.

MODULE I PROPOSITIONAL CALCULUS 8+2

Propositions – Logical connectives – Compound propositions – Conditional and biconditional propositions – Truth tables – Tautologies and contradictions – Contrapositive – Logical equivalences and implications – DeMorgan's Laws – Normal forms – Principal conjunctive and disjunctive normal forms – Rules of inference – Arguments – Validity of arguments.

MODULE II PREDICATE CALCULUS 7+3

Predicates – Statement function – Variables – Free and bound variables – Quantifiers – Universe of discourse – Logical equivalences and implications for quantified statements – Theory of inference – The rules of universal specification and generalization – Validity of arguments.

MODULE III FUNCTIONS 7+3

Functions – Classification of functions –– Composition of functions – Inverse functions – Binary and n–ary operations – Characteristic function of a set – Hashing functions – Recursive functions – Permutation functions.

MODULE IV ALGEBRAIC SYSTEMS 8+2

Groups, Cyclic Groups, Subgroups, Cosets, Lagrange's theorem, Normal subgroups – Codes and group codes – Basic notions of error correlation – Error recovery in group codes.

MODULE V GRAPH THEORY 7+3

Graphs – incidence and degree – subgraphs – isomorphism – complement of a graph – operations on graphs

MODULE VI PATH AND CIRCUIT 8+2

Walks, trails and paths – Eulerian graphs – Konigsburg bridge problem - Hamiltonian graphs

L – 45; T – 15; TOTAL HOURS – 60

REFERENCES:

1 Trembly J.P and Manohar R, “Discrete Mathematical Structures with Applications to Computer Science”, Tata McGraw-Hill Pub. Co. Ltd, New Delhi, 30th Reprint 2011.
2 Kenneth H.Rosen, “Discrete Mathematics and its Applications:, 7th Edition, Tata McGraw-Hill Pub. Co. Ltd, New Delhi, Special Indian Edition, 2011.
3 Ralph.P.Grimaldi, “Discrete and Combinatorial Mathematics: An Introduction”, 4th Edition, Pearson Education Asia, Delhi, 2007.
4 Thomas Koshy, “Discrete Mathematics with Applications”, Elsevier Publications, 2006.
5 C.L.Liu, D.P.Mohapatra, “Elements of Discrete Mathematics”, 4th Edition, Tata McGraw-Hill Pub. Co. Ltd, New Delhi, 2012.

OUTCOMES:

At the end of the course, student will be able to

- use the concepts of propositional calculus.
- use the concepts of predicate calculus.
- identify types of functions and their importance.
- decode and encode the messages using group theory concepts.
- apply the basic concepts of graph theory.
- represent some real life situations into diagrammatic representation.

MACX 02 PROBABLITY AND STATISTICS

L	T	P	C
3	1	0	4

OBJECTIVES:

The aims of this course are to impart the

- knowledge of the theory of probability and random variables
- techniques to carry out probability calculations and identifying probability distributions
- application of statistical inference in practical data analysis

MODULE I BASICS OF PROBABILITY AND STATISTICS 8+2

Sample space, events- axioms of probability and interpretation – Addition, multiplication rules – conditional probability, Independent events - Total probability – Baye’s theorem - Descriptive Statistics.

MODULE II ONE DIMENSIONAL RANDOM VARIABLE AND PROBABILITY DISTRIBUTION FUNCTIONS 7+3

Discrete random variable –continuous random variable – Expectation - probability distribution - Moment generating function – Binomial, Poisson, Geometric, Uniform (continuous), Exponential and Normal distributions.

MODULE III TWO DIMENSIONAL RANDOM VARIABLES 8+2

Joint, marginal, conditional probability distributions –covariance, correlation - transformation of random variables.

MODULE IV SAMPLING AND ESTIMATION 7+3

Sampling distributions – basic knowledge on Random , simple random , stratified and cluster samplings – Test of Hypotheses - concepts- Point estimation and Interval estimation.

MODULE V THEORY OF INFERENCE 8+2

Large sample tests – test for single and difference on proportions, single mean, difference of means, difference of variances – confidence intervals. Small sample tests – Student’s t test, F test and Chi square test on theory of goodness of fit and analyses of independence of attributes.

MODULE VI DESIGN OF EXPERIMENTS 7+3

Analysis of variance – one way classification – two way classification – Completely Randomised Block Designs – Randomised Block Design – Latin square designs - Interpretations - case studies.

L – 45; T – 15; TOTAL HOURS – 60

REFERENCES:

1. T.Veerarajan, "Probability and Statistics", Tata McGraw-Hill Education, 2008.
2. Miller, I., Miller, M.,Freund, J. E., "Mathematical statistics", 7th Edition, Prentice Hall International, 1999.
3. S.P.Gupta, "Applied Statistics", Sultan Chand & Sons
4. S.M.Ross, "Introduction to Probability and Statistics for Engineers and Scientists" Fifth Edition, Elesvier.
5. S.C.Gupta and V.K.Kapoor, "Fundamentals of Mathematical Statistics" First edition, Sultan Chand and Sons.
6. Arora and Arora, "Comphrensive Statistical Methods", S. Chand, 2007

OUTCOMES:

On completion of the course, students will be able to

- do basic problems on probability and descriptive statistics.
- derive the probability mass / density function of a random variable.
- calculate probabilities and derive the marginal and conditional distributions of bivariate random variables.
- calculate point and interval estimates.
- apply some large sample tests and small sample tests.
- carry out the data collection representation analysis and implications and the importance of inferences.

MACX 03	**RANDOM PROCESSES**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

OBJECTIVES:

The aims of the course are to

- acquire the knowledge of the theory of probability and random variables
- study discrete and continuous probability distributions.
- demonstrate the techniques of two dimensional random variables and its distributions.
- introduce the random process, stationarity, Markov process and the study of correlation function and spectral analysis.

MODULE I BASICS OF PROBABILITY 7+3

Sample space, events- axioms of probability and interpretation – Addition, multiplication rules – conditional probability, Independent events - Total probability – Baye's theorem - Tchebychev's inequality.

MODULE II ONE DIMENSIONAL RANDOM VARIABLE AND PROBABILITY DISTRIBUTION FUNCTIONS 7+3

Discrete random variable –continuous random variable – Expectation - probability distribution - Moment generating function – Binomial, Poisson, Geometric, Uniform (continuous), Exponential and Normal distributions.

MODULE III TWO DIMENSIONAL RANDOM VARIABLES 7+3

Joint, marginal, conditional probability distributions - covariance, correlation and regression lines - transformation of random variables.

MODULE IV RANDOM PROCESSES 8+2

Classification of Random process - Stationary process - WSS and SSS processes - Poisson process – Markov Chain and transition probabilities.

MODULE V CORRELATION FUNCTIONS 8+2

Autocorrelation function and its properties - Cross Correlation function and its properties - Linear system with random inputs – Ergodicity.

MODULE VI SPECTRAL DENSITY 8+2

Power spectral Density Function - Properties - System in the form of convolution -

Unit Impulse Response of the System – Weiner-Khinchine Theorem - Cross Power Density Spectrum.

L – 45; T – 15; TOTAL HOURS – 60

REFERENCES:

1. Veerarajan T., "Probability, Statistics and Random Processes", Tata McGraw Hill,3rd edition, 2008.
2. Papoulis, "Probability, Random Variables and Stochastic Processes", 4th Edition, Tata McGraw Hill Company, 2002.
3. S.M.Ross, "Introduction to Probability and Statistics for Engineers and Scientists" Fifth Edition, Elesvier.
4. Scott L. Miller,Donald G. Childers, Probability and Random Processes, Academic Press,2009.
5. Trivedi K S, " Probability and Statistics with reliability, Queueing and Computer Science Applications",Prentice Hall of India,New Delhi,2nd revised edition, 2002.

OUTCOMES:

On completion of the course, students will be able to

- do basic problems on probability.
- derive the probability mass / density function of a random variable.
- calculate probabilities and derive the marginal and conditional distributions of bivariate random variables.
- identify and study the different random processes.
- compute correlation functions and related identities.
- compute power spectral density functions and apply Weiner-Khinchine formula.

MACX 04	APPLIED NUMERICAL METHODS	L	T	P	C
		3	1	0	4

OBJECTIVES:

The aims of the course are to

- introduce basic computational methods for analyzing problems that arise in engineering and physical sciences.
- acquire knowledge about approximation theory and convergence analysis associated with numerical computation.

MODULE I NUMERICAL SOLUTIONS OF EQUATIONS 7+3

Bisection method - Regula Falsi method – Secant method - Fixed point iteration method - Newton's Raphson method –Gauss Elimination method - Gauss-Jordon method – Gauss Jacobi method - Gauss-Seidel method.

MODULE II INTERPOLATION 8+2

Finite difference operators – Gregory Newton's forward and backward interpolations – Cubic spline interpolation - Lagrange interpolation - Newton's divided difference formula.

MODULE III NUMERICAL DIFFERENTIATION AND INTEGRATION 8+2

Numerical differentiation using Newton's forward and backward formulae – Numerical integration : Trapezoidal and Simpson's 1/3 and 3/8 rules – Romberg's method – Gaussian Two Point and Three Point Quadrature formulae – Double integrals using Trapezoidal and Simpson's 1/3 rule.

MODULE IV INITIAL VALUE PROBLEMS FOR FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS 7+3

Numerical solutions by Taylor's Series method, Euler's method, Modified Euler's Method - Runge – Kutta Method of fourth order – Milne's and Adam's Bashforth Predictor and Corrector methods

MODULE V INITIAL AND BOUNDARY VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 8+2

Numerical solutions by Taylor's Series method - Runge – Kutta Method of fourth order of second order ODE. Finite difference methods.

MODULE VI BOUNDARY VALUE PROBLEMS FOR PARTIAL DIFFERENTIAL EQUATIONS 7+3

Finite difference solution of one dimensional heat equation by explicit and implicit methods – One dimensional wave equation and two dimensional Laplace equation.

L – 45; T – 15; TOTAL HOURS – 60

REFERENCES:

1. Grewal, B.S., “Numerical methods in Engineering and Science”, 7th edition, Khanna
   Publishers, 2007.
2. C.F.Gerald, P.O.Wheatley, “Applied Numerical Analysis” ,Pearson Education, New Delhi, 2002.
3. Chapra S.C, Canale R.P. “Numerical Methods for Engineers”, 5th Ed., McGraw Hill, 2006.
4. M.K.Jain, S.R.K.Iyengar, R.K.Jain, “Numerical methods for Scientific and Engineering Computation”, New Age International Publishers, New Delhi, 2003

OUTCOMES:

At the end of this course, students will be able to

- solve algebraic, transcendental and system of equations.
- apply interpolation techniques.
- carry out numerical differentiation and integration using different methods.
- solve first order ODE using single and multi step methods.
- solve second order ODE, initial and boundary value problems.
- solve the boundary value problems in PDE.

Maths Elective Courses
(To be offered in VI Semester)

MACX 05 MATHEMATICAL PROGRAMMING

L	T	P	C
2	0	0	2

OBJECTIVES:

The aims of the course are to

- acquire knowledge and training in optimization techniques.
- obtain knowledge about optimization in utilization of resources.
- understand and apply operations research techniques to industrial operations.

MODULE I LINEAR PROGRAMMING PROBLEM 10

Linear programming – formulation of the problem - graphical interpretation of optimality - Simplex method – to obtain basic feasible solution – types of linear programming solution – complications and their resolution.

MODULE II ADVANCED LINEAR PROGRAMMING PROBLEMS 8

Artificial variable - Big M method – Two phase method – alternative optimal solution – unbounded solution - Duality – primal dual relationships.

MODULE III TRANSPORTATION PROBLEM 7

Transportation problems – Initial basic feasible solutions, MODI method, Unbalanced transportation problem, Degeneracy in transportation models,.

MODULE IV ASSIGNMENT PROBLEM 5

Assignment problem – Minimization and Maximization type of problems by Hungarian method.

TOTAL HOURS – 30

REFERENCES:

1. Hamdy A Taha, “Operations Research - An introduction”, 8th edition, Phil Pearson, 2007.
2. Winston.W.L., “Operations Research”, 4th edition, Thompson-Brooks/Cole, 2003.
3. Wayne.L. Winston, “Operations Research Applications and Algorithms”, 4th edition, Thomson learning, 2007.
4. Frederick. S. Hiller and Gerald J Lieberman, “Operations Research Concepts

and Cases", 8th edition (SIE), Tata McGraw – Hill Pub. Co. Ltd., New Delhi, 2006.

5. A. Ravindran, D. T. Phillips and J. J. Solberg, "Operations Research: Principles and Practice", 2nd edition, John Wiley & Sons, New York, 1992.
6. Robertazzi. T.G., "Computer networks and systems-Queuing theory and performance evaluation", 3rd edition, Springer, 2002.

OUTCOMES:

At the end of the course, students will be able to

- formulate industrial problems as mathematical programming problems.
- solve linear programming problems by different methods.
- solve transportation problems by different methods.
- solve assignment problems by Hungarian method.

MACX 06 STATISTICAL METHODS FOR DATA ANALYSIS

L	T	P	C
2	0	0	2

OBJECTIVES:

The aim of the course is to

- introduce statistical quality control tools.

MODULE I TESTS OF HYPOTHESES AND STATISTICAL INFERENCES 8

Small sample tests – Student's ' t ' test for single mean , difference of means, paired t test – F test for difference of variances – Chi square test on theory of goodness of fit and analyses of independence of attributes.

MODULE II DESIGN OF EXPERIMENTS 7

Analysis of variance – one way classification – two way classification – Completely Randomised Block Designs – Randomised Block Design – Latin square designs - Statistical analysis -Interpretations - case studies.

MODULE III STATISTICAL QUALITY CONTROL-I 8

Quality improvement and statistics –Statistical quality control- statistical process control – control charts – design of control charts –analysis of patterns on control charts - X bar chart, R chart and S chart.

MODULE IV STATISTICAL QUALITY CONTROL-II 7

Process and product control – attribute charts – P, np and C charts – control charts performance.

TOTAL HOURS –30

REFERENCES:

1. Douglas C.Montgomery, George C. Runger "Applied Statistics and probability for Engineers" V Edition – John Wiley & Sons Inc.
2. Miller, I., Miller, M., Freund, J. E. "Mathematical statistics" 7th Edition. Prentice Hall International, 1999.
3. Dekking, F.M., Kraaikamp, C., Lopuhaä, H.P., Meester, L.E. "A Modern Introduction to Probability and Statistics" Springer, 2nd Edition.
4. Chin Long chiang "Statistical Methods of Analysis "World Scientific Books, 2003.
5. S.C.Gupta and V.K. Kapoor, "Mathematical Statistics" , Sultan Chand

publications.
6. Veerarajan "Fundamentals of Mathematical Statistics" I Edition, Yes Dee Publishing Pvt. Ltd., 2017.

OUTCOMES:

On completion of the course, students will be able to

- develop and test hypothesis for different statistical tests
- design an experiment and case study the experiment with different data.
- analyze the industrial data using quality control design tools statistically.
- analyze the industrial data using process and product control tools statistically.

MACX 07	**NUMERICAL METHODS FOR INTEGRATION AND DIFFERENTIAL EQUATIONS**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

OBJECTIVES:

- This course aims to solve numerically integral and differential equations.

MODULE I NUMERICAL INTEGRATION 8

Numerical integration by trapezoidal and Simpson's 1/3 and 3/8 rules – Romberg's method – Two Point and Three point Gaussian quadrature formulae.

MODULE II NUMERICAL DOUBLE INTEGRATION 6

Double integrals using trapezoidal and Simpson's 1/3 rules

MODULE III NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS 8

Milne's Predictor and Corrector Method – Adam's Predictor-Corrector Method - Finite difference methods for two – point Boundary Value problems for Ordinary Differential Equations.

MODULE IV BOUNDARY VALUE PROBLEMS FOR PARTIAL DIFFERENTIAL EQUATIONS 8

Finite difference solution of one dimensional heat equation by explicit and implicit methods – One dimensional wave equation and two dimensional Laplace and Poisson equations

TOTAL HOURS – 30

REFERENCES:

1. M.K.Jain, S.R.K.Iyengar, R.K.Jain, "Numerical methods for Scientific and Engineering Computation", New Age International Publishers, New Delhi, 2003.
2. Grewal, B.S., "Numerical methods in Engineering and Science" 7^{th} edition, Khanna Publishers, 2007
3. C.F.Gerald, P.O.Wheatley, "Applied Numerical Analysis" Pearson Education, New Delhi 2002.
4. P.Dechaumphai, N. Wansophark, "Numerical Methods in Engineering", Narosa Publications, 2012.

OUTCOMES:

At the end of the course students will be able to

- solve the integration by numerical methods.
- solve the double integration by numerical methods
- find numerical solution of ordinary differential equations in engineering problems.
- find numerical solution of partial differential equations in engineering problems.

MACX 08 MATHEMATICAL MODELLING

L	T	P	C
3	0	0	3

OBJECTIVES:

The aims of the course are to

- provide basic idea of formation and use of Mathematical models for different purposes.
- determine the extent to which models are able to replicate real-world phenomena under different conditions

MODULE I PRINCIPLES OF MATHEMATICAL MODELING 7

Mathematics as a modelling language - Classification of models - Building, studying, testing and using models - Black and white box models – Difference equations

MODULE II PHENOMENOLOGICAL MODELS 7

Linear, Multiple linear and nonlinear regression - Neural networks - Fuzzy model - Stability and higher dimensional systems.

MODULE III MECHANISTIC MODELS –I 8

Setting up ODE models – Initial and Boundary value problems – Numerical solutions - Fitting ODE to data - Applications

MODULE IV MECHANISTIC MODELS –II 8

Linear and nonlinear equations - Elliptic, parabolic and hyperbolic equations - Closed form solutions - Finite difference and finite element methods

TOTAL HOURS – 30

REFERENCES:

1. G . Ledder , “Calculus, modelling , probability and dynamic systems”, Springer 2013
2. Kei Velten, “Mathematical modelling and simulation”, J. Wiley and sons,2009
3. Michael D Alder, “An introduction to Mathematical modelling”, Heaven for Books.com
4. Alfio Quarteroni, “Mathematical models in science and engineering”, Notices of AMS.
5. J.N. Kapur, “Mathematical models in Biology and Medicine”, Affiliated East West Press Private Limited, New Delhi, 1992.

OUTCOMES:

On completion of the course, the students will be able to

- identify the relationship between real world and mathematical models
- Classify the data and choose the appropriate model
- Distinguish between linear and nonlinear models
- identify the relationship between empirical and mechanistic models

MACX 09	GRAPH THEORY	L	T	P	C
		3	0	0	3

OBJECTIVES:

The aims of this course are to

- represent the real life situations diagrammatically.
- appraise different methods to find solutions to graph theory problems.

MODULE I INTRODUCTION TO GRAPH THEORY 8

Graphs - finite and infinite graphs - Incident and degree-isolated vertex, pendent vertex and null vertex.

MODULE II PATH AND CIRCUIT 8

Isomorphism – sub graphs-walks, paths and circuits – connected and disconnected graphs- Euler graphs – operation on a graph.

MODULE III TREES AND FUNDAMENTAL CIRCUITS 7

Trees- some properties of trees- pendent vertices in a tree – rooted binary tree-spanning trees-fundamental circuits.

MODULE IV CUT SETS AND CUT VERTICES 7

Cut sets – some properties of cut sets- fundamental circuits and cut sets-network flows.

TOTAL HOURS – 30

REFERENCES:

1. NARSINGH DEO, Graph theory with applications to Engineering and Computer Science, Prentice Hall INC, New Delhi,
2. J.A. Pondy and U.S.R. Murthy, North Holland, Oxford, New York Graph theory with applications.
3. Trembly J.P and Manohar R, “Discrete Mathematical Structures with Applications to Computer Science”, Tata McGraw-Hill Pub. Co. Ltd, New Delhi, 30th Reprint 2011.
4. Kenneth H.Rosen, “Discrete Mathematics and its Applications”, 7th Edition, Tata McGraw-Hill Pub. Co. Ltd, New Delhi, Special Indian Edition, 2011
5. Md. Saidur Rahman, “Basic graph theory”, Springer, 2017

OUTCOMES:

At the end of the course, students will be able to

- demonstrate the basic concepts of Graph theory.
- explore connected and disconnected graphs.
- identify the real life problems with trees and circuits.
- bring out the cut set properties and network flows properties.

Humanities Elective I

(To be offered in III Semester)

		L	T	P	C
SSCXO1	**FUNDAMENTALS OF ECONOMICS**	**2**	**0**	**0**	**2**

OBJECTIVES:

- To identify and present the basic concepts of demand, supply and equilibrium.
- To explain and discuss the types and concepts of national income and inflation.
- To illustrate the fundamental concepts of money, banking and public finance.
- To apprise the students about Indian economy and the role of engineers in economic development.

MODULE I DEMAND AND SUPPLY ANALYSIS 8

Classification of economy – open and closed economy, Demand - Types of demand - Determinants of demand – Law of Demand - Demand elasticity - Supply - Determinants of Supply – Law of Supply - Supply elasticity - Pricing strategies.

MODULE II NATIONAL INCOME AND INFLATION 7

Concepts of National income and measurement – Importance and difficulties of estimating National Income in India - Aggregate demand and aggregate supply, Macroeconomic equilibrium – meaning of inflation- types - causes and preventive measures

MODULE III MONEY, BANKING AND PUBLIC FINANCE 9

Money – Meaning, types, functions, importance - Commercial Banks - Central Bank - Monetary policy – meaning, objectives, Methods of Credit Control By RBI, Government Budget – Government revenue and Expenditures – Fiscal policy - Its objectives, instruments and limitations - Deficit Financing - The Fiscal Responsibility and Budget Management Act, 2003 (FRBMA) .

MODULE IV INDIAN ECONOMY AND THE ROLE OF ENGINEERS 6

Economic reforms – Liberalization, Privatization and Globalization - challenges and opportunities, Engineers – Engineers' contributions to the economic growth.

L – 30; T – 0; TOTAL HOURS – 30

TEXT BOOKS:

1. Dutt and Sundharam (2013), *Indian Economy*, S. Chand & Company Pvt. Ltd, New Delhi.
2. Hussain, Moon Moon (2015), *Economics for Engineers*, Himalaya Publishing House, New Delhi.
3. Cleaver Tony (2004), "*Economics: The Basics*", Routledge, London.
4. Mell Andrew and Walker Oliver (2014), "*The Rough Guide to Economics*", Rough Guide Ltd.

OUTCOMES:

On successful completion of this course,

- Students will have had exposure to the basic concepts of demand, supply and various pricing strategies.
- Students will have understood the macroeconomic concepts of national income and inflation.
- Students will be able to apply the knowledge of money, banking and public finance in their real life situations.
- Students will have an overview of the economic reforms introduced in Indian economy.

SSCXO2	**PRINCIPLES OF SOCIOLOGY**.	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

OBJECTIVES:

- To acquaint the students with Concepts and perspectives of Sociology
- To explain the reflection of society in Individuals and vice versa
- To describe the hierarchical arrangement of individuals and groups in society
- To explicate the dimensions, forms and factors of Social change.
- To examine the context, impact and agencies of Globalization

MODULE I THE FOUNDATIONAL CANON 8

Sociology-Definition, scope and importance; Major theoretical perspectives-Functionalism, Conflict Theorising and Interactionism; Elements of social formation-Society, Community, Groups and Association; Associative Social Process- Co-operation, Accommodation and Assimilation; Dissociative Social Process-Competition and Conflict.

MODULE II INDIVIDUAL AND SOCIETY 7

Culture-definition, characteristics, functions, types, cultural lag and civilization, Socialization – definition, process, stages, agencies and anticipatory socialization; Social Control- definition, characteristics, importance, types & agencies.

MODULE III SOCIAL INEQUALITY AND STRATIFICATION 7

Concepts- inequality, hierarchy, differentiation, Social Exclusion, and Social Stratification. Forms of Social Stratification- Caste, Class and Estate. Gender and Social Stratification- sex and gender, patriarchy, factors perpetuating gender stratification; Globalization and gender inequality

MODULE IV SOCIAL CHANGE AND GLOBALIZATION 8

Social Change-definition, nature, direction; Forms- evolution, development, progress and transformation; Factors of social change- demography, economy, technology, polity and culture. Globalization- definition, characteristics, historical and social context and Impact, agencies of globalization- IGOs, INGOs, Nation-State, MNEs and Media

L – 30; TOTAL HOURS – 30

REFERENCES:

1. Giddens A. 1989. “Sociology” Cambridge: Polity Press.
2. Heald Haralambos, R.M(2014) . ‘‘Sociology Themes and Perspectives”, Oxford, New Delhi-92
3. Bhushan Vidya and D.R. Sachdeva (2012). ‘‘Fundamental of Sociology”, Pearson, Delhi.
4. Das Gupta, Samir and Paulomi Saha (2012), ‘‘An Introduction to Sociology”, Pearson, Delhi
5. Bottomore, T.B. 1972. *Sociology- A Guide to Literature and Problems*, New Delhi.

OUTCOMES:

On successful completion of this course,

- Students will have exposure to the fundamentals tenets of Sociology.
- Students will be trained to understand social reality with sociological perspective.
- Students will be oriented to constructively analyze human interactions, social relationship and social issues
- Students will gain exposure to the dynamics of human society with special reference to the contemporary trends of globalization.

SSCXO3 SOCIOLOGY OF INDIAN SOCIETY.

L	T	P	C
2	0	0	2

OBJECTIVES:

- To present a portrayal of the components of the Indian Social structure
- To describe the nature and contemporary structure of Indian social Institutions.
- To examine the causality and magnitude of social problem facing the contemporary India.
- To elucidate the processes forms and impact of change and development in Indian society

MODULE I INDIAN SOCIAL STRUCTURE 7

Unity and Diversity; Concepts of unity and diversity- racial, religious, ethnic and linguistic composition of India. Types of communities-rural, urban and tribal; Social backwardness- OBC, SC and ST; Indian minorities- religious, ethnic, linguistic and LGBT

MODULE II INDIAN SOCIAL INSTITUTIONS 7

Family- definition, types, characteristics, functions of family; Joint Family- definition features, utility, changes; Marriage- definition, characteristics, marriage as sacrament or contract. Caste- definition, principles, contemporary changes, dominant caste, caste -class interface.

MODULE III SOCIAL PROBLEMS IN INDIA 8

Social Problem-definition, nature, social disorganization; Population explosion- causes, effects, relationship with development; Child Labour- causes, magnitude and consequences; Unemployment-nature , types, causes and effects; Gender issues- social status of women, violence against women and women in work place; Contemporary issues- communalism, terrorism and corruption.

MODULE IV SOCIAL CHANGE AND DEVELOPMENT IN INDIA 8

Socio-cultural Change- Sanskritization, Westernization, Secularization, Modernization; Processes of Social change- Industrialization, Urbanization, Globalization; Development- definition, elements, role of government, industry and corporate sector. Technology and change- invention and innovation, impact of technology on social institutions, technology and development.

L – 30; TOTAL HOURS –30

REFERENCES:

1. Sharma,K.L.2008. *Indian Social Structure and Change*. Jaipur: Rawat Publications,.
2. Shah, A.M. 1998. *The Family in India: Critical Essays*. New Delhi: Orient Longman,
3. Ahuja Ram. 1999. *Social problems in India*, Rawat Publication: New Delhi.
4. Ahuja Ram. 2014. *Society in India,*, Rawat Publication: New Delhi.
5. Jayapalan, N.(2001), **"**Indian Society and Social Institutions" Atlantic Publishers & Distri,
6. Atal, yogesh (2006), "Changing Indian Society" Rawat Publications, Jaipur.

OUTCOMES:

On successful completion of this course,

- Students will gain an in-depth understanding of the social structure and social institutions that constitute society in India.
- Students will be sensitized to the various categories ,Inequalities and their challenges
- Students will be exposed to the social problems encountered in contemporary India.
- Students will gain knowledge about the various forms and trends of the social change.
- Students will become aware about the challenges in the path of progress of Indian society and realize relevance of their role in bringing about development

Humanities Elective II

(To be offered in IV Semester)

SSCXO4	**ECONOMICS OF SUSTAINABLE DEVELOPMENT**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

OBJECTIVES:

- To have an increased awareness on the concept and components of sustainable development.
- To develop the ability to demonstrate the need of sustainable development and international responses to environmental challenges.
- To have an insight into global environmental issues and sustainable globalization.
- To establish a clear understanding of the policy instruments of sustainable development.

MODULE I CONCEPT OF SUSTAINABLE DEVELOPMENT 7

Evolution of the Concept – Rio Summit and sustainable development - various definitions of sustainable development - Components of sustainable development: Social, environmental and economic components.

MODULE II NEED FOR SUSTAINABLE DEVELOPMENT 8

Need for sustainability – Global environmental challenges: population growth, resource depletion, pollution, energy use, climate change, pollution, growing water scarcity, other urban problems, loss of biodiversity, hazardous wastes disposal.International responses to environmental challenges - Global policy such as Kyoto Protocol, Montreal Protocol, Basel Convention.

MODULE III GLOBALIZATION AND ENVIRONMENT SUSTAINABILITY 8

Impact of Globalization on sustainable development, Co - existence of globalization and Environment sustainability, Globalization and Global Governance.Green economy - Renewable energy, sustainable transport, sustainable construction, land and water management, waste management.

MODULE IV POLICIES FOR ACHIEVING SUSTAINABLE DEVELOPMENT 7

Principles of environmental policy for achieving sustainable development:

precautionary principle and polluter pays principle – Business Charter for Sustainable Development.Policy instruments for sustainable development: direct regulation – market based pollution control instruments such as pollution tax, subsidy, pollution permits.

L – 30; TOTAL HOURS – 30

REFERENCES:

1. Anderson, David A (2010), "*Environmental Economics and Natural Resource Management*", Routledge, 3rd edition.
2. Karpagam M (1999), "*Environmental Economics: A Textbook*", Sterling Publishers Pvt. Ltd, New Delhi.
3. Karpagam M and Jaikumar Geetha (2010), "*Green Management Theory and Applications*", Ane Books Pvt. Ltd, New Delhi.
4. Sengupta Ramprasad (2004), "*Ecology and Economics: An Approach to Sustainable Development*", Oxford University Press, New Delhi.

OUTCOMES:

On successful completion of this course,

- The students will have understood the concepts and components of sustainable development.
- The students will have a holistic overview on the challenges of sustainable development and International responses to environmental challenges.
- The students will have gained knowledge on the global environment issues and demonstrate responsible globalization through global governance.
- The students will have developed awareness of the ethical, economic, social and political dimensions that influence sustainable development.

SSCXO5	**INDUSTRIAL SOCIOLOGY**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

OBJECTIVES:

- To introduce sociological approaches and perspectives to understand the social relationship in manufacturing industries and corporate sector.
- To explain the structure and functions of industrial organizations.
- To elucidate the dynamics of organizational behavior, leadership and communication.
- To inculcate professional ethics and values to equip students to work in organizational settings.

MODULE I INTRODUCTION 8

Industrial Sociology- definition, scope and importance; Theoretical approaches- scientific management, human relations approach, theory of bureaucracy, Fordism and post-fordism; Production system- concept and characteristics of factory system, automation and rationalization; Industrial conflict- strike , lockout and trade unions.

MODULE II INDUSTRIAL ORGANIZATION 7

Formal organization- definition, features, utility; Informal organization- definition, characteristics, types and relevance; Structure of industrial organization- features and functions of line organization, characteristics and roles of staff organization, distinction;
Industrial hierarchy-white collar, blue collar, supervisors and managers.

MODULE III DYNAMICS OF INDUSTRIAL RELATIONS 8

Group dynamics- Definition, Group behaviour model, Group decision making process, group cohesiveness; Leadership- definitions, style and effective supervision; Communication- concepts, types, model barriers; Job satisfaction- nature, employee compensation and job satisfaction.

MODULE IV PROFESSIONAL ETHICS AND VALUES 7

Concepts- values- morals, and ethics, Integrity, work ethics , service learning - Civic Virtue - caring - Sharing - Honesty - Courage - Valuing Time - Co-operation - commitment - empathy - Self-Confidence - Environmental Ethics, Cyber issues - computer ethics, cyber crimes, plagiarism Ethical living-concept of harmony in life.

L – 30; TOTAL HOURS – 30

REFERENCES:

1. Narender Singh, Industrial Sociology, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.
2. Gisbert Pascal, Fundamentals of Industrial Sociology, Tata Mc. Graw Hill Publishing Co., New Delhi, 1972
3. Schneider Engeno. V, Industrial Sociology 2nd Edition, Mc. Graw Hill Publishing Co., New Delhi, 1979.
4. Robbins, Stephen, Organizational Behaviour , Prentice Hall of India PVT ltd new Delhi, 1985
5. Devis Keith , Human Behaviour at work place, Mc. Graw Hill Publishing Co., New Delhi,1984

OUTCOMES:

On successful completion of this course,

- Students will have acclimatized with sociological perspectives for dealing with social relationships in production and service organizations.
- Students will be familiar with structure of authority, roles and responsibility in organizational settings.
- Students will imbibe leadership, communication and behavioral acumen to govern organization
- Students will be sensitized to standards of desirable behavior to engage in industrial and corporate sector.

SSCX06	LAW FOR ENGINEERS	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To understand the Constitution and Governance of our country.
- To apprise the students of human rights - local and international and redressal mechanism.
- To have an insight into the industrial, corporate and labour laws of our country.
- To establish a clear understanding about the importance of intellectual property related laws.

MODULE I INDIAN CONSTITUTION AND GOVERNANCE 8

Constitution – salient features, Preamble, Citizenship, Fundamental rights, Fundamental duties, Directive principles, Union executive, Legislature – Union – State and union territories – Election Commission – Election for parliament and state legislature, Judiciary- basic functioning of the Supreme Court and High Courts, Right to information Act 2005 – evolution – concept – practice.

MODULE II HUMAN RIGHTS 7

Human rights – meaning and significance, Covenant on civil and political rights, Covenant on Economic, Social and Cultural rights, UN mechanism and agencies, The Protection of Human Rights Act, 1993 – watch on human rights and enforcement.

MODULE III INDUSTRIAL, CORPORATE AND LABOUR LAWS 8

Corporate laws – meaning and scope, Companies Act 1956 – Indian Contract Act 1872 - Principles of Arbitration - Industrial Employment (Standing Orders) Act 1946 - Industrial Disputes Act 1947 - Workmen’s Compensation Act 1923 - The Factories Act, 1948.

MODULE IV LAWS RELATED TO IPR 7

IPR – meaning and scope, International organization – WIPO – TRIPS, Major Indian IPR Acts – Copyright laws, Patent and Design Act, Trademarks Act, Trade Secret Act, Geographical Indicator.

L – 30; TOTAL HOURS – 30

REFERENCES:

1. M.P. Jain (2005) *Indian Constitutional Law*, Wadhwa & Co.
2. H. D, Agarwal (2008), *International Law and Human Rights,* Central Law Publications,
3. Rao, Meena (2006), *Fundamental Concepts in Law of Contract*, 3rd edn., Professional offset.
4. Ramappa (2010), *Intellectual Property Rights Law in India*, Asia Law House.
5. Singh, Avtar (2007), *Company Law*, Eastern Book Co.
6. R.F, Rustamji (1967)*, Introduction to the Law of Industrial Disputes*, Asia Publishing House.
7. Acts: Right to Information Act, Industrial Employees (standing order) Act, Factories Act, Workmen Compensate Act.

OUTCOMES:

On successful completion of this course,

- Students will `be able to apply the basic concepts of Indian Constitution, Governance and power in their real life situation.
- Students will have gained knowledge in human rights, cultural, social and political rights.
- Students will have synthesized knowledge about industrial, corporate and labour laws of our country.
- Students will have an overview of IPRs and laws related to Intellectual Property Rights.

General Elective Courses
Group I courses
(To be offered in V Semester)

GECX101	**DISASTER MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To give an exposure to various environmental hazards and disasters and various concepts and principles to manage disaster.
- To give exposure to various environmental policies & programs in India for disaster management

MODULE I ENVIRONMENTAL HAZARDS 7

Environmental hazards, Environmental Disasters and Environmental stress-Meaning and concepts. Vulnerability and disaster preparedness.

MODULE II NATURAL DISASTERS 7

Natural hazards and Disasters - Volcanic Eruption, Earthquakes, Tsunamis, Landslides, Cyclones, Lightning, Hailstorms, Floods, Droughts, Cold waves, Heat waves and Fire.

MODULE III MAN-MADE DISASTERS 7

Man induced hazards & Disasters - Soil Erosion, Chemical hazards, Population Explosion

MODULE IV DISASTER MANAGEMENT 8

Emerging approaches in Disaster Management- Preparing hazard zonation maps, Predictability / forecasting & warning, Preparing disaster preparedness plan, Land use zoning, Communication. Disaster resistant house construction, Population reduction in vulnerable areas, Awareness - Rescue training for search & operation at national & regional level - Immediate relief, Assessment surveys, Political, Administrative, Social, Economic, Environmental Aspects.

MODULE V NATURAL DISASTER REDUCTION & MANAGEMENT 8

Provision of Immediate relief measures to disaster affected people, Prediction of

Hazards & Disasters, Measures of adjustment to natural hazards

MODULE VI ENVIRONMENTAL POLICIES & PROGRAMMES IN INDIA 8

Regional survey of Land Subsidence, Coastal Disaster, Cyclonic Disaster & Disaster in Hills with particular reference to India. Ecological planning for sustainability & sustainable development in India, Sustainable rural development: A Remedy to Disasters, Role of Panchayats in Disaster mitigations, Environmental policies & programmes in India- Institutions & National Centers for Natural Disaster reduction, Environmental Legislations in India, Awareness, Conservation Movement, Education & training.

TOTAL HOURS – 45

REFERENCES:

1. Satender, “Disaster Management in Hills”, Concept Publishing Co., New Delhi, 2003.
2. Singh, R.B. (Ed.), “Environmental Geography”, Heritage Publishers, New Delhi,1990.
3. Savinder Singh, “Environmental Geography”, Prayag Pustak Bhawan,1997.
4. Kates, B.I. and White, G.F., “The Environment as Hazards”, Oxford University Press, New York, 1978.
5. Gupta, H.K., (Ed), “Disaster Management”, University Press, India, 2003.
6. Singh, R.B.,“Space Technology for Disaster Mitigation in India (INCED)”, University of Tokyo, 1994.
7. Bhandani, R.K., “An overview on Natural & Manmade Disaster & their Reduction”, IIPA Publication, CSIR, New Delhi, 1994.
8. Gupta, M.C., “Manuals on Natural Disaster management in India”, National Centre for Disaster Management, IIPA Publication, New Delhi, 2001.

OUTCOMES:

At the end of the course, the students will

- achieve sufficient knowledge on the disaster prevention strategy, early warning system, disaster preparedness, response and human resource development.
- be familiar with the National Policy on Disaster Management.

GECX102	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the various principles, practices of TQM to achieve quality.
- To get acquainted with the various statistical tools and approaches for quality control and continuous improvement.
- To get aware of the importance of ISO and Quality Systems.

MODULE I INTRODUCTION 8

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

MODULE II TQM PRINCIPLES 7

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits.

MODULE III TQM IMPROVEMENT PROCESS 8

Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

MODULE IV STATISTICAL PROCESS CONTROL (SPC) 8

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

MODULE V TQM TOOLS 7

Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA.

MODULE VI QUALITY SYSTEMS 7

Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System–Elements, Implementation of Quality System, Documentation, Quality Auditing, TS 16949, ISO 14000 – Concept, Requirements and Benefits.

TOTAL HOURS – 45

REFERENCES:

OUTCOMES:

The student should be able to

- apply the various statistical tools and approaches for Quality control.
- achieve continuous process improvement through TQM.

GECX103 ENERGY STUDIES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn the growing demand, supply of energy on global and national levels and the need for renewable energy promotion.
- To understand the basic need for energy conservation and waste heat recovery.
- To learn the important aspects of energy audit and management.
- To get acquainted with the global environmental issues and carbon credits.

MODULE I GLOBAL AND NATIONAL ENERGY SCENARIO 7

Role of energy in economic development, various energy resources - overall energy demand and availability- Energy consumption in various sectors and its changing pattern - Exponential increase in energy consumption and projected future demands. Need for renewable energy.

MODULE II SOLAR ENERGY 8

Solar Radiation – Measurements of Solar Radiation - Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation - Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications.

MODULE III OTHER RENEWABLE ENERGY SOURCES 8

Power from wind – wind turbine working and types, solar thermal power plants – low medium and high power generation, power from wave , tidal, geothermal sources, OTEC system. MHD power plants – working, types, merits and demerits. Energy from biomass.

MODULE IV COGENERATION, WASTE HEAT RECOVERY AND COMBINED CYCLE PLANTS 8

Cogeneration principles- topping and bottoming cycles, role in process industries. Energy from wastes- waste heat recovery- heat recovery from industrial processes. Heat exchange systems – recuperative and regenerative heat exchangers – commercially available waste heat recovery devices. Combined cycle plants – concept, need and advantages, different combinations and practical scope.

MODULE V ENERGY CONSERVATION AND MANAGEMENT 7

Need for energy conservation – use of energy efficient equipment. Energy conservation opportunities - in educational institutions, residential, transport, municipal, industrial and commercial sectors – concept of green building. Energy audit in industries – need, principle and advantages. Case studies.

MODULE VI GLOBAL ENERGY ISSUES AND CARBON CREDITS 7

Energy crisis, fossil consumption and its impact on environmental climate change. Energy treaties – Montreal and Kyoto protocols - Transition from carbon rich and nuclear to carbon free technologies, carbon foot print – credits – clean development mechanism.

TOTAL HOURS – 45

REFERENCES:

1. S.S. Rao and B.B. Parulekar, "Energy Technology", 3rd Edition, Khanna Publishers, New Delhi, 2011.
2. O. Callaghn. P.W., "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
3. G.D. Rai, "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 2011.
4. Archie, W Culp. "Principles of Energy Conservation", McGraw Hill, 1991.
5. D Patrick and S W Fardo, "Energy Management and Conservation", PHI,1990
6. P. O'Callaghan: "Energy Management", McGraw - Hill Book Company, 1993.
7. Kenney, W. F., "Energy Conservation in Process Industries", Academic Press, 1983.

OUTCOMES:

The student should be able to

- Realize the global and national energy status and need to switch over to renewable energy technology.
- Energy audit and suggest methodologies for energy savings.
- Utilize the available resources in an optimal way.
- Concern about the global environmental issues & promote carbon credits.

GECX104	ROBOTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To learn about the robots, various components, of Robots, programming and their applications.

MODULE I **8**

Definition- Need - Application, Types of robots – Classifications – Configuration, work volume, control loops, controls and intelligence- basic parts - functions – specifications. of robot, degrees of freedoms, end effectors – types, selection

MODULE II ROBOT DRIVES AND CONTROL **8**

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

MODULE III ROBOT SENSORS **8**

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.

MODULE IV ROBOT PROGRAMMING & AI TECHNIQUES **7**

Types of Programming – Teach pendant programming – Basic concepts in AI techniques – Concept of knowledge representations – Expert system and its components.

MODULE V ROBOTIC WORK CELLS AND APPLICATIONS OF ROBOTS **7**

Robotic cell layouts – Inter locks – Humanoid robots – Micro robots – Application of robots in surgery, Manufacturing industries, space and underwater.

MODULE VI ROBOT KINEMATICS AND DYNAMICS 7

Forward and inverse Kinematic equations, Denvit – Hartenbers representations Fundamental problems with D-H representation, differential motion and velocity of frames - Dynamic equations for sing, double and multiple DOF robots – static force analysis of robots.

TOTAL HOURS – 45

REFERENCES:

1. Yoram Koren,” Robotics for Engineers”, Mc Graw-Hill, 1987.
2. Kozyrey, Yu, “Industrial Robots”, MIR Publishers Moscow, 1985.
3. Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, “Robotics Engineering – An Integrated Approach”, Prentice-Hall of India Pvt. Ltd., 1984.
4. Deb, S.R. “Robotics Technology and Flexible Automation”, Tata Mc Graw-Hill, 1994.
5. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey, “Industrial Robotics Technology, Programming and Applications”, Mc Graw- Hill, Int. 1986.
6. Timothy Jordanides et al,”Expert Systems and Robotics”, Springer – Verlag, New York, May 1991.

OUTCOMES:

Students would be able to

- Understand about the robots, its various components.
- Design Robots for industrial applications.
- Do programming for robots and apply them in real time applications.

GECX105	TRANSPORT MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the transport fleet and their related activities for minimizing operational cost.
- To understand the need of maintenance and its importance.
- To understand the functions and applications of various types of transport system.

MODULE I INTRODUCTION 7

Personnel management; objectives and functions of personnel management, psychology, sociology and their relevance to organization, personality problems. Selection process: job description, employment tests, interviewing, introduction to training objectives, advantages, methods of training, training procedure, psychological tests.

MODULE II ORGANISATION AND MANAGEMENT 7

Forms of Ownership – principle of Transport Management – Staff administration – Recruitment and Training – welfare – health and safety. Basic principles of supervising. Organizing time and people. Driver and mechanic hiring - Driver checklist - Lists for driver and mechanic - Trip leasing - Vehicle operation and types of operations.

MODULE III TRANSPORT SYSTEMS 9

Introduction to various transport systems. Advantages of motor transport. Principal function of administrative, traffic, secretarial and engineering divisions. chain of responsibility, forms of ownership by state, municipality, public body and private undertakings.

MODULE IV SCHEDULING AND FARE STRUCTURE 8

Principal features of operating costs for transport vehicles with examples of estimating the costs. Fare structure and method of drawing up of a fare table. Various types of fare collecting methods. Basic factors of bus scheduling. Problems on bus scheduling.

MODULE V MOTOR VEHICLE ACT 7

Traffic signs, fitness certificate, registration requirements, permit insurance, constructional regulations, description of vehicle-tankers, tippers, delivery vans, recovery vans, Power wagons and fire fighting vehicles. Spread over, running time, test for competence to drive.

MODULE VI MAINTENANCE 7

Preventive maintenance system in transport industry, tyre maintenance procedures. Causes for uneven tyre wear; remedies, maintenance procedure for better fuel economy, Design of bus depot layout.

TOTAL HOURS – 45

REFERENCES:

1. John Duke, "Fleet Management", McGraw-Hill Co, USA, 1984.
2. Kitchin.L.D., "Bus Operation", III edition, Illiffee and Sons Co., London, 1992.
3. Government Motor Vehicle Act, Publication on latest act to be used as on date.

OUTCOMES:

Upon completion of the course, students will

- Know about different aspects related to transport system and management.
- Features of scheduling, fixing the fares.
- Know about the motor vehicle act and maintenance aspects of transport.

GECX106	CONTROL SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the system modeling and to derive their transfer function.
- To provide adequate knowledge of time response of systems and steady state error analysis.
- To accord basic knowledge in obtaining the open loop and closed–loop frequency responses of Control systems.

MODULE I BASIC CONCEPTS AND SYSTEM REPRESENTATION 8

Control System - Basic elements in control systems – Open and closed loop systems – Electrical analogy of mechanical and thermal systems – Transfer function – Block diagram reduction techniques – Signal flow graphs.

MODULE II TIME RESPONSE ANALYSIS AND DESIGN 8

Time response – Time domain specifications – Types of test input – First and Second order system - Type I and Type II System – Response - Error coefficients – Generalized error series – Steady state error – P, PI, PID modes of feedback control.

MODULE III FREQUENCY RESPONSE ANALYSIS AND DESIGN 7

Performance specifications - correlation to time domain specifications - bode plots and polar plots – gain and phase margin – constant M and N circles and Nichols chart – all pass and non-minimum phase systems.

MODULE IV STABILITY 8

Characteristics equation – Location of roots in s plane for stability – Routh Hurwitz criterion – Root locus construction – Effect of pole, zero addition – Gain margin and phase margin – Nyquist stability criterion.

MODULE V COMPENSATOR DESIGN 8

Performance criteria – Lag, lead and lag-lead networks – Compensator design using bode plots and root locus technique.

MODULE VI CONTROL SYSTEM COMPONENTS AND APPLICATION OF CONTROL SYSTEMS 6

Synchros – AC servomotors - DC Servo motors - Stepper motors - AC Tacho generator - DC Tacho generator - Typical applications of control system in industry.

TOTAL HOURS – 45

REFERENCES:

1. K. Ogata, "Modern Control Engineering", 4th Edition, Pearson Education, New Delhi, 2003.
2. I.J. Nagrath & M. Gopal, "Control Systems Engineering", New Age International Publishers, 2003.
3. C.J.Chesmond, "Basic Control System Technology", Viva student edition, 1998.
4. I.J.Nagarath and M.Gopal, "Control System Engineering", Wiley Eastern Ltd., Reprint, 1995.
5. R.C.Dorf and R.H.Bishop, "Modern Control Systems", Addison-Wesley (MATLAB Reference), 1995.

OUTCOMES:

At the end of the course, the student will have knowledge and achieve skills on the following:

- Ability to analyze complex systems using mathematical models.
- Get the time response of first and second order systems analytically and interpret the response.
- Perform frequency response analysis of physical systems and interpret the response.
- Design appropriate compensator for the given system to meet the desired specifications.
- Perform stability analyses of the system using conventional mathematical approach.
- Implement state space approach for the process and obtain the solution.

GECX107 INTRODUCTION TO VLSI DESIGN

L	T	P	C
3	0	0	3

OBJECTIVES:

- Basic concepts of HDL.
- Verilog language and its syntax constructs.
- Programmable Logic Devices and FPGAs
- MOS devices theory
- CMOS based combinational and sequential circuits

PREREQUISITES:

Fundamentals of Electronics

Basics knowledge in Digital Electronics.

MODULE I REVIEW OF BASIC DIGITAL SYSTEMS 7

Boolean algebra, Building blocks of combinational logic design-Adders, multiplexer, encoder, decoder, comparator, Latches & flip-flops, counters, shift registers.

MODULE II LOGIC DESIGN USING VERILOG HDL 8

Overview of Digital Design with Verilog HDL, Levels of Design Description, Concurrency, Hierarchical Modeling Concepts, Modules and Ports, Component instantiation Data flow and RTL, structural, gate level, switch level modeling and Behavioral Modeling.

MODULE III LANGUAGE CONSTRUCTS OF VERILOG HDL 7

Identifiers- gate primitives, gate delays, operators, timing controls, procedural assignments, conditional statements Variable types, arrays and tables, Tasks and functions, Test bench.

MODULE IV BUILDING BLOCKS OF DIGITAL VLSI SYSTEMS 8

HDL Design -Data Path Operations-Addition/Subtraction, Parity Generators, Comparators, Zero/One Detectors, Binary Counters, ALUs, Multiplication, Shifters, Memory Elements. Programmable logic elements and AND-OR arrays, FPGAs programming methods.

MODULE V TRANSISTOR THEORY 7

Introduction to MOS Transistors-NMOS & PMOS Characteristics, Current Equations, Complementary CMOS Inverter-DC Characteristics, Static Load MOS Inverters.

MODULE VI BASICS OF DIGITAL CMOS DESIGN 8

NMOS & PMOS Logic Gate, CMOS Logic Gate, Basic layout design of simple gate-stick diagram, CMOS Logic Structures-full adder, multiplexers.

TOTAL HOURS – 45

REFERENCES:

1. M.Morris Mano "Digital Design", 3rd Edition, Prentice Hall of India Pvt. Ltd New Delhi, 2003.
2. Michael D. Ciletti"Advanced Digital Design with the Verilog HDL" (2nd Edition) Hardcover – January 31, 2010.
3. J.Bhasker: Verilog HDL primer, BS publication, 2001.
4. J. P. Uyemura, "Introduction to VLSI Circuits and System", Wiley, 2002
5. Neil Weste and K. Eshragian, "Principles of CMOS VLSI Design: A System Perspective," 2nd edition, Pearson Education (Asia) Pvt.Ltd., 2000.
6. Douglas A Pucknell& Kamran Eshragian , "Basic VLSI Design" PHI 3rd Edition (original edition – 1994) .

OUTCOMES:

At the end of the course the students will be able to

- Create basic Register Transfer Level (RTL) models for combinational circuits & Sequential circuits using Verilog HDL.
- Create basic behavioral models for combinational circuits & Sequential circuits using Verilog HDL.
- Describe the usage of Programmable Logic Devices and FPGAs.
- Describe MOS devices theory and inverter circuit DC characteristics
- Design the basic digital building blocks using MOS circuit.
- Apply VLSI design concepts based on the requirements to conduct experiments or projects

GECX108	PLANT ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide in depth knowledge on Plant Engineering
- To introduce detail engineering and P&ID
- To learn about the support to Instrumentation from other disciplines
- To study about the Installation and commissioning

MODULE I INTRODUCTION OF PLANTS 7

General Project Cycle – Feed – Sales - Plant Description, Component / Areas of Plant, Plant Layout, Plant Interfaces, Plant Location

MODULE II ELEMENTS OF PLANT 8

Main Elements of a Plant, Process Flow Scheme (PFD – Process Flow Diagram) P&ID's, Plant Legend Finalization.

MODULE III DETAIL ENGINEERING 10

P& ID Development with PFD's, Major Discipline Involvement & Inter discipline Interaction, Major Instrumentation & Control Systems - Development Phase – Instrument List , I/O Count, Specification Sheets, Instrument Installation (Hook ups) , Control Philosophy – Detail Engineering.

MODULE IV SUPPORT FROM OTHER DISCIPLINE 8

Other Discipline Supports to Instrumentation – Plot Plan, Piping / Equipment Plan, Electrical Area Classification, Fire Hazardous Classification Telecommunication Systems - Control Network architecture.

MODULE V INSTALLATION AND COMMISSIONING 7

Plant Construction - Key Drawings for Construction Support Construction Activities, System Testing, Startup / Commissioning, Production.

MODULE VI CASE STUDIES 5

Case studies of Water Treatment Plant - Paper Industry – Power Plant etc

TOTAL HOURS – 45

REFERENCES:

1. Duncan C Richardson, Plant Equipment and Maintenance Engineering Handbook, McGraw-Hill Education: New York, Chicago, San Francisco, Athens, London, Madrid, Mexico City, Milan, New Delhi, Singapore, Sydney, Toronto, 2014 McGraw-Hill Education
2. Gabriel Salvendy, Handbook of Industrial Engineering – Technology and operations Management, John Wiley & Sons, 2001.
3. Robert C Rosaler , Standard Handbook of Plant Engineering, Mc Graw Hill third Edition, 2004
4. R. Keith Mobley, Plant Engineer's Handbook, Technology and Engineering, 2001.

OUTCOMES:

At the end of the course, the student will be able to

- Review and correct P&IDs
- Do installation and commissioning of new plants
- Apply plant engineering in design and maintenance of water treatment plant / power plant etc

GECX109	NETWORK SECURITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

The students should be able to

- Discuss the basic concepts of computer security, model and attacks.
- Examine the major types of threats and the associated attacks.
- Identify the encryption techniques in real time applications.
- Understand the special requirements for wireless security and how authentication is implemented in wireless systems.
- Understand the functions of Network Security Device Firewall and its types.
- Interpret the various network intrusion such as computer viruses, network worms etc.

MODULE I INTRODUCTION 6

Computer Security Concepts - The OSI Security Architecture - Security Attacks - Security Services - Security Mechanisms - A Model for Network Security - Standards – classical encryption techniques.

MODULE II SYMMETRIC ENCRYPTION AND MESSAGE CONFIDENTIALITY 7

Symmetric Encryption Principles - Symmetric Block Encryption Algorithms - Random and Pseudorandom Numbers - Stream Ciphers and RC4 - Cipher Block Modes of Operation

MODULE III PUBLIC KEY CRYPTOGRAPHY AND MESSAGE AUTHENTICATION 8

Approaches to Message Authentication - Secure Hash Functions - Message Authentication Codes - Public-Key Cryptography Principles - Public-Key Cryptography Algorithms - Digital Signatures

MODULE IV KEY DISTRIBUTION ,USER AUTHENTICATION AND TRANSPORT-LEVEL SECURITY 8

Symmetric Key Distribution Using Symmetric Encryption - Kerberos - Key Distribution Using Asymmetric Encryption - X.509 Certificates - Public-Key

Infrastructure -Federated Identity Management - Web Security Considerations - Secure Socket Layer and Transport Layer Security - Transport Layer Security

MODULE V WIRELESS NETWORK SECURITY, ELECTRONIC MAIL SECURITY AND IP SECURITY 8

IEEE 802.11 Wireless LAN Overview -IEEE 802.11i Wireless LAN Security - Wireless Application Protocol Overview - Wireless Transport Layer Security - WAP End-to-End Security - Pretty Good Privacy - S/MIME – Domain Keys Identified Mail- IP Security Overview -IP Security Policy - Encapsulating Security Payload - Combining Security Associations - Internet Key Exchange - Cryptographic Suites

MODULE VI SYSTEM SECURITY 8

Intruders -Intrusion Detection -Password Management - Types of Malicious Software - Viruses Virus Countermeasures – Worms - Distributed Denial of Service Attacks- The Need for Firewalls - Firewall Characteristics - Types of Firewalls - Firewall Basing - Firewall Location and Configurations

TOTAL HOURS – 45

REFERENCES:

1. William Stallings,"Network security Essentials:Applications and standards“, Prentice Hall, Fifth Edition , ISBN-13: 978-0134527338, 2013
2. William Stallings, “Cryptography and Network Security: Principles and Practice”, Pearson, ISBN-13:978-0-273-79335-9,2013
3. Behrouz Forouzan, Debdeep Mukhopadhyay,Cryptography and network security (sie) 2nd edition, ISBN-13: 978-0070702080, 2016
4. Wikipedia, “Network Security and Management” , https://en.wikipedia.org/wiki/Book:Network Security and Management, 2014.
5. Nitesh Dhanjani, Justin Clarke, “Network Security Tools”, O'Reilly Media, ISBN-13: 9780596007942, 2005.

OUTCOMES:

Students who complete this course will be able to

- Recognize the computer security concepts, architecture attacks and model
- Distinguish the symmetric and asymmetric encryption techniques
- Apply the cryptographic algorithms in different applications

- Express the network security designs using available secure solutions such as PGP,SSL, IPSec, etc.
- Describe the firewalls principles and different types of firewalls applied in organization
- Identify abnormalities within the network caused by worms, viruses and Network related security treats.

GECX110 KNOWLEDGE MANAGEMENT

	L	T	P	C
	3	0	0	3

OBJECTIVES:

The course

- Focuses on positioning knowledge as a valuable commodity, embedded in products and in the tacit knowledge of highly mobile individual employees.
- Presents KM as a deliberate and systematic approach to cultivating and sharing an organization's knowledge base.
- Brings out the paradigm in terms of information technology and intellectual capital.

MODULE I KNOWLEDGE MANAGEMENT 6

KM Myths – KM Life Cycle – Understanding Knowledge – Knowledge, intelligence – Experience – Common Sense – Cognition and KM – Types of Knowledge – History of Knowledge Management - From Physical assets to Knowledge Assets – Expert knowledge – Human Thinking and Learning.

MODULE II KNOWLEDGE MANAGEMENT SYSTEMS AND MODELS 9

Challenges in Building KM Systems – Conventional Vs KM System Life Cycle (KMSLS) – Knowledge Creation and Knowledge Architecture – KM cycle - Different variants of KM cycle - KM models - Implications and practical implementations.

MODULE III CAPTURING KNOWLEDGE AND SHARING 9

Tacit knowledge capture - Explicit knowledge codification – Knowledge taxonomies - Knowledge sharing - Communities - Obstacles to knowledge capture and sharing.

MODULE IV KNOWLEDGE MANAGEMENT TOOLS 9

KM System tools – Neural Network – Association Rules – Classification Trees – Data Mining and Business Intelligence – Knowledge capture and creation tools - Content creation tools - Data mining and knowledge discovery – Content management tools - Knowledge sharing and dissemination tools – Group ware and Collaboration tools - Intelligent filtering tools.

MODULE V KNOWLEDGE APPLICATION 6

KM at individual level - Knowledge workers - Task analysis and modeling - Knowledge application at group and organizational levels – Knowledge repositories - Knowledge reuse -Case study: e-learning.

MODULE VI VALUE OF KNOWLEDGE MANAGEMENT 6

KM return on investment and metrics - Benchmarking method – Balanced scorecard method - House of quality method - Results based assessment method - Measuring success - Future challenges for KM.

TOTAL HOURS – 45

REFERENCES:

1. Elias M. Awad, Hassan M. Ghaziri, “Knowledge Management”, Prentice Hall, 2nd Edition, 2010.
2. Jay Liebowitz, “Handbooks on Knowledge Management”, 2nd Edition, 2012.
3. Irma Becerra-Fernandez, Rajiv Sabherwal, ”Knowledge Management: Systems and Processes”, 2010.

OUTCOMES:

Students who complete this course will be able to

- Describe the fundamental concepts in the study of knowledge and its creation, acquisition, representation, dissemination, use and re-use, and management.
- Explains the core concepts, methods, techniques, and tools for computer support of knowledge management.
- Critically evaluate current trends in knowledge management and apply it for e-learning.

GECX111 CYBER SECURITY

	L	T	P	C
	3	0	0	3

OBJECTIVES:

- To understand the basics of Cyber Security Standards and Policies.
- To know the legal, ethical and professional issues in Cyber security.
- To understand Cyber Frauds and Abuse and its Security Measures.
- To know the technological aspects of Cyber Security.

MODULE I FUNDAMENTALS OF CYBER SECURITY 7

Security problem in computing – Cryptography Basics – History of Encryption – Modern Methods – Legitimate versus Fraudulent Encryption methods – Encryption used in Internet.

MODULE II CYBERCRIME AND CYBEROFFENSES 8

Cybercrime and Information Security – Cybercriminals – Classifications of Cybercrimes – Email Spoofing – Spamming – Cyber defamation – Internet Time Theft – Forgery – Web jacking – Hacking – Online Frauds – Software Piracy – Mail Bombs – Password Sniffing – Cyberoffenses – Categories – Planning the attacks – Cyberstalking – Cybercafe and Cybercrimes – Botnets.

MODULE III CYBERCRIME: MOBILE AND WIRELESS DEVICES 8

Proliferation of Mobile and Wireless Devices – Trends in Mobility – Credit card frauds in Mobile and Wireless Computing – Security Challenges – Authentication Service Security – Attacks on Mobile Phones.

MODULE IV TOOLS AND METHODS USED IN CYBERCRIME 8

Proxy Servers and Anonymizers – Phishing – Password Cracking – Keyloggers and Spywares – Virus and Worms – Trojan Horses and Backdoors – Steganography – DoS and DDoS Attacks.

MODULE V SECURITY POLICIES 7

Introduction - Defining User Policies – Passwords – Internet Use – Email Usage – Installing/ Uninstalling Software – Instant Messaging – Defining System Administrative Policies – Defining Access Control Developmental Policies Standards, Guidelines and Procedures – Basics of assessing a system

MODULE VI COMPUTER FORENSICS 7

General Guidelines – Finding Evidence on the PC - Finding Evidence in System Logs – Windows Logs – Linux Logs – Getting Back Deleted Files – Operating System Utilities – The Windows Registry.

TOTAL HOURS – 45

REFERENCES:

1. Nina Godbole, Sunit Belapure, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley, 2011.

2. Chuck Easttom, "Computer Security Fundamentals", 2nd Edition, Pearson Education, 2012.

3.Charles B. Pfleeger, Shari Lawrence Pfleeger, "Security in Computing", 3rd Edition, Pearson Education, 2003.

4. William Stallings, "Cryptography and Network Security – Principles and Practices", 3rd Edition, Pearson Education, 2003.

5. Atul Kahate, "Cryptography and Network Security", Tata McGraw Hill, 2000.

OUTCOMES:

Upon completion of this course, students will be able to

- Explain the general security issues.
- Discuss various cybercrimes and offenses.
- Outline the occurrence of Cybercrime in mobile and wireless environment.
- Use relevant tools and methods in cybercrime.
- Apply security policies in cyber forensics.
- Outline the strategies adopted in computer forensics.

GECX112	GENETIC ENGINEERING	L	T	P	C
		3	1	0	4

OBJECTIVES:

The course aims to provide an advanced understanding of the core principles and topics of Cell and Organism reproduction and the Principles of heredity and their experimental basis, and to enable students to be able to apply these principles in assessment of pedigrees to identify genotypes and predict the mating outcomes.

MODULE I GENETICS AND ORGANISM 10

Genetics and human affairs, Genetics and Biology, Genes and Environment, Techniques of genetic analysis, The chromosome theory of heredity, Sex chromosomes, Sex linkage, The parallel behaviour of autosomal genes and chromosomes.

MODULE II MENDELISM AND LINKAGE 12

Mendel's laws of inheritance, Interaction of genes, Variations on dominance, Multiple alleles, Lethal alleles, Several genes affecting the same character, Penetrance and expressivity, Linkage- Basic eukaryotic chromosome mapping, The discovery of linkage, Recombination linkage symbolism, Linkage of genes on X chromosomes, Linkage maps, Examples of linkage maps.

MODULE III FINE STRUCTURE OF GENES 10

The concept of promoter, Coding sequence, Terminator, Induction of gene for expression. The concept of extranuclear genome in higher plants and animals, Overview of mitochondrial genome, Chloroplast genome.

MODULE IV RECOMBINATION IN BACTERIA AND VIRUSES 10

Conjugation recombination and mapping the E.coli chromosomes, Transformation, Transduction, Chromosome mapping. Population genetics: Darwin's revolution, Variation and its modulation, The effect of sexual reproduction on variation, The sources of variation, Selection quantitative genetics

MODULE V PRINCIPLES OF PLANT BREEDING 9

Objectives, Selfing and crossing techniques, Male sterility, Incompatability, Hybrid vigour.

MODULE VI HUMAN GENOME PROJECT 9

Genetic diseases in humans, Genetics and society

L – 45; T – 15; TOTAL HOURS – 60

REFERENCES:

1. Introduction to genetic analysis, Griffiths, Miller, Suzuki, Lewontin and Gelbart, Freeman and Company.
2. Genetics, A.V.S.S. Sambamurty, Narosa Publishing House.
3. Concepts of Genetics, Klug & Cummings, Prientice Hall.
4. Molecular Cloning, Moniatisetal, Cold Spring Harbor Laboratory.

OUTCOMES:

At the end of the course students will be able to

- Describe the structure, function and replication of DNA as the genetic material.
- Describe gene structure, expression and regulation.
- Describe the chromosomal basis of inheritance and how alterations in chromosome number or structure may arise during mitosis and meiosis.

GECX113	FUNDAMENTALS OF PROJECT MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

The students would gain knowledge on

- Technicalities attached to Project Management and Significance of Quality Consideration
- Project management methodologies – tools and techniques, supplemented with examples from case studies
- The importance of Efficient HR team and role of Communication in executing Projects.
- Managing Risks in Project Management

MODULE I INTRODUCTION TO PROJECT MANAGEMENT 9

Introduction to Project and Project Management-Project Management as a Career-Project Management Skill Sets-Project Scope Management: Project Charter, Scope Creep, Scope Validation, Scope Change Control-Type of Organization: Organization Structure-Influence of Organization Structure on Project, Project Stakeholders and Organizational Productivity.

MODULE II PROJECT MANAGEMENT PROCESS, TOOLS AND TECHNIQUES 8

Project life cycle-Initiation, Planning, Execution, Monitoring and Closing Phase; - Link between project management process, process groups and knowledge areas; Project management tools and techniques- Project Stakeholders description and mapping - Stakeholder Management Process

MODULE III PROJECT QUALITY, COST AND SCHEDULE MANAGEMENT 10

Triple constraints of project-quality, cost and schedule-Quality Planning, Quality Assurance and Quality Control, Process Control, Cost of Quality, Seven Tools of Quality Control- Cost Management: Cost Estimating Methods, Estimating Completion Cost, Earned Value Management, Budgeting, Life-Cycle Cost analysis- Project Time Management: Duration Estimation Method, FS/FF/SS/SF Relations, Lead/Lag, Arrow Diagram Method and Precedence Diagram Method for Scheduling-Resource Allocation

MODULE IV PROJECT HR MANAGEMENT 5

Organizational Goals- (MBO/MBE/MBP)-Responsibility Assignment Matrix (RAM)-Types of Powers- Manage or Lead-Conflict management Techniques-Performance Evaluation Process-Motivation Theories and its Application for execution of Projects-Leadership Styles-Project Team Building-Project Staffing Constraints/Policies

MODULE V COMMUNICATION MANAGEMENT 5

Communication Management: Understanding Body languages of Project Personnel-Effective Communications- Interpersonal Skills for project Managers-PMIS-Communicating with the Customer-Communicating with Management-Formal vs. Informal Communications-Written, Verbal and Non-Verbal Communications.

MODULE VI PROJECT PROCUREMENT & RISK MANAGEMENT 8

Introduction to Project Procure Management: Soliciting RFQ/RFP-Contract Proposals-Contract Negotiation-Contract Closure-Risk Management: Defining risks-Risk management process-Risk identification-Qualitative and Quantitative Risk-Probability and Decision trees-Risk Response strategies / methods-Expected monetary value-Risk vs. life cycle phases

TOTAL HOURS – 45

REFERENCES:

1. Jack. R. Meredith, Samuel. J. Mantel & Scott. M. Shafer, Project Management in Practice, Fifth Edition, Bangalore: Wiley, 2015 .
2. Bob Hughes, Mike Cotterrel “Software Project Management”, Tata McGraw-Hill, 2009.

OUTCOMES:

- Learners will be able to identify the Key Knowledge Areas and apply PM process in hypothetical project assignments given as continuous assessment.
- They would be able to suitably recognize tools and techniques required for various phases included in a project.
- They would also be able to manage scope, time, cost and other major components that would help them to execute the project efficiently.

GECX114	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To acquire knowledge and training in optimization techniques.
- To get knowledge about optimization in utilization of resources.
- To understand and apply operations research techniques to industrial operations

MODULE I LINEAR PROGRAMMING PROBLEM 8

Linear programming – formulation of the problem - graphical interpretation of optimality - Simplex method – to obtain basic feasible solution – types of linear programming solution – complications and their resolution.

MODULE II ARTIFICIAL VARIABLE AND TWO PHASE METHOD, DUALITY 6

Artificial variable - Big M method – Two phase method – alternative optimal solution – unbounded solution - Duality – primal dual relationships - rules of constructing the dual from primal.

MODULE III TRANSPORTATION PROBLEM & ASSIGNMENT PROBLE 8

Transportation problems – Initial basic feasible solutions, MODI method, Unbalance in transportation, Degeneracy in transportation models, Assignment problem – Minimization and Maximization type of problems by Hungarian method.

MODULE IV NETWORK AND SEQUENCING PROBLEMS 8

PERT and CPM – Network diagram – Fulkerson's rule - CPM Probability of achieving completion date – Crash time – Cost analysis. Sequencing N jobs through 2 machines and 3 machines.

MODULE V QUEUING THEORY & SIMULATION 7

Poisson arrivals and exponential service times – characteristics of Queuing models – single channel – Introduction to multi channel models – Random number generation – Monte Carlo Simulation.

MODULE VI INVENTORY CONTROL, REPLACEMENT MODELS AND GAME THEORY 8

Types of inventory- Inventory cost - EOQ - Deterministic inventory problems – Introduction to probabilistic models & system level inventory control - Replacement models – Replacement of items that deteriorate with time – value of money changing with time – not changing with time – Individual and group replacement policy - Game theory – simple games.

TOTAL HOURS – 45

REFERENCES:

1. Hamdy ATaha, “Operations Research an introduction”, 8th edition, Phil Pearson, 2007.
2. Winston.W.L., “Operations Research”, 4th edition, Thompson-Brooks/Cole, 2003.
3. Wayne.L. Winston, “Operations Research applications and algorithms”, 4th edition, Thomson learning, 2007.
4. Frederick. S. Hiller and Gerald.J.Lieberman, “Operations Research concepts and cases”, 8th edition (SIE), Tata McGraw – Hill Pub. Co. Ltd., New Delhi, 2006.
5. A. Ravindran, D. T. Phillips and J. J. Solberg, "Operations Research:Principles and Practice", 2nd edition, John Wiley & Sons, New York, 1992.
6. Robertazzi. T.G., “Computer networks and systems-Queuing theory and performance evaluation”, 3rd edition, Springer, 2002.

OUTCOMES:

At the end of the course students will be able to

- solve linear programming problems
- solve transportation and assignment problems.
- solve network and sequencing problems.
- apply the operations research techniques to solve industrial problems.

GECX115	**NANO TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To introduce the basic concepts of Nanoscience relevant to the field of engineering.
- To provide an exposure about the importance of various synthesis method.
- To enrich the knowledge of students in various characterisation techniques.

MODULE I — INTRODUCTION & CLASSIFICATION OF NANO MATERIALS — 9

Definition - Origin of nanotechnology - Difference between bulk and nanomaterials- Top-down and bottom-up processes - Size dependent properties (magnetic, electronic,transport and optical), Classification based on dimensional property - 0D, 1D, 2D and 3D nanostructures – Kubo gap.

MODULE II — TYPES OF NANO MATERIALS — 9

Metal oxides and metal nano particles - Ceramic nano particles - Semi conducting quantum dots - Core-shell quantum dots - Nanocomposites - Micellar nanoparticles.

MODULE III — PRODUCTION OF NANO PARTICLES — 7

Sol-gel, hydrothermal, solvothermal, Plasma Arcing, Electro deposition, RF sputtering, Pulsed laser deposition, Chemical vapour, deposition.

MODULE IV — CARBON BASED NANO MATERIALS — 6

Carbon nanotubes: Single wall nanotubes (SWNT), Multiwall nanotubes (MWNT) - structures-carbon nanofibre, Fullerenes-Application of carbon nanotubes and Fullerenes.

MODULE V — NANO PHOTONICS — 7

Light and nanotechnology, Interaction of light and nanotechnology, Nanoholes and photons, nanoparticles and nanostructures; Nanostructured polymers, Photonic Crystals, Solar cells.

MODULE VI — CHARACTERISATION TECHNIQUES — 7

Basic principles of scanning Electron Microscopy (SEM), Atomic force microscopy (AFM), Scanning tunneling microscopy (STM), Scanning probe microscopy (SPM) and Transmission electron microscopy (TEM), Particle size analyzer, Luminescence techniques.

TOTAL HOURS – 45

REFERENCES:

1. Hari Singh Nalwa, "Handbook of Nanostructured Materials and Nanotechnology", Academic Press, 2000.
2. Guozhong Cao, "Nanostructures and Nano materials-Synthesis, Properties and Applications", Imperial College Press (2011).
3. Zhong Lin Wang, "Handbook of Nanophase and Nanomaterials (Vol 1 and II)", Springer, 2002.
4. Mick Wilson, Kamali Kannangara, Geoff smith, "Nanotechnology: Basic Science and Emerging Technologies", Overseas press, 2005.
5. A. Nabok, "Organic and Inorganic Nanostructures", Artech House, 2005.
6. C.Dupas, P.Houdy, M.Lahmani, Nanoscience: "Nanotechnologies and Nanophysics", Springer-Verlag Berlin Heidelberg, 2007.
7. Mick Wilson, Kamali Kannangara, Michells Simmons and Burkhard Raguse, "Nano Technology – Basic Science and Emerging Technologies", 1st Edition, Overseas Press, New Delhi,2005.
8. M.S. Ramachandra Rao, Shubra SinghH, "Nanoscience and Nanotechnology: Fundamentals to Frontiers", Wiley, 2013.

OUTCOMES:

At the end of this course, the students will be able to:

- Apply the knowledge of different types of nanomaterials for various engineering applications.
- Acquire the knowledge of various methods of production of nanomaterials.
- Familiarize with various characterization techniques.

GECX116	VEHICLE MAINTENANCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know about the various methods of maintaining procedure, vehicle insurance and basic problems in a vehicle.
- The student able to impart knowledge in maintaining of engine components and subsystems.
- The student able to impart knowledge in maintaining of transmission, driveline, steering, suspension, braking and wheels.
- The student able to impart **carefully maintaining their vehicle and can increase driving safety.**

MODULE I MAINTENANCE, WORKSHOP PRACTICES, SAFETY AND TOOLS 7

Maintenance – Need, importance, primary and secondary functions, policies - classification of maintenance work - vehicle insurance - basic problem diagnosis. Automotive service procedures – workshop operations – workshop manual - vehicle identification. Safety – Personnel, machines and equipment, vehicles, fire safety - First aid. Basic tools – special service tools – measuring instruments – condition checking of seals, gaskets and sealants. Scheduled maintenance services – service intervals - Towing and recovering.

MODULE II ENGINE AND ENGINE SUBSYSTEM MAINTENANCE 8

General Engine service- Dismantling of Engine components- Engine repair- working on the underside, front, top, ancillaries- Service of basic engine parts, cooling and lubricating system, fuel system, Intake and Exhaust system, electrical system - Electronic fuel injection and engine management service - fault diagnosis- servicing emission controls.

MODULE III TRANSMISSION AND DRIVELINE MAINTENANCE 8

Clutch- general checks, adjustment and service- Dismantling, identifying, checking and reassembling transmission, transaxle- road testing- Removing and replacing propeller shaft, servicing of cross and yoke joint and constant velocity joints- Rear axle service points- removing axle shaft and bearings- servicing differential assemblies- fault diagnosis.

MODULE IV STEERING AND SUSPENSION MAINTENANCE 7

Maintenance and Service of Mc person strut, coil spring, leaf spring, shock absorbers. Dismantling and assembly procedures. Inspection, Maintenance and Service of steering linkage, steering column, Rack and pinion steering, Recirculating ball steering service- Worm type steering, and power steering system.

MODULE V BRAKE AND WHEEL MAINTENANCE 7

Inspection, Maintenance and Service of Hydraulic brake, Drum brake, Disc brake, parking brake. Bleeding of brakes. Wheel alignment and balance, removing and fitting of tyres, tyre wear and tyre rotation.

MODULE VI AUTO ELECTRICAL AND AIR CONDITIOING MAINTENANCE 8

Maintenance of batteries, starting system, charging system and body electrical -Fault diagnosis using Scan tools. Maintenance of air conditioning parts like compressor, condenser, expansion valve, evaporator - Replacement of hoses- Leak detection- AC Charging- Fault diagnosis Vehicle body repair like panel beating, tinkering, soldering, polishing, painting.

TOTAL HOURS – 45

REFERENCES:

1. Ed May, "Automotive Mechanics Volume One" , Mc Graw Hill Publications, 2003
2. Ed May, "Automotive Mechanics Volume Two" , Mc Graw Hill Publications, 2003
3. Vehicle Service Manuals of reputed manufacturers
4. Vehicle maintenance and garage practice by Jigar A.Doshi Dhru U.Panchal,Jayesh P.Maniar. 2014
5. A Practical Approach to Motor Vehicle Engineering and Maintenance 3rd Edition by Allan Bonnick.
6. Bosch Automotive Handbook, Sixth Edition, 2004.
7. Advanced Automotive Fault Diagnosis by Tom Denton 2011.
8. Nissan Patrol Automotive Repair Manual: 1998-2014 by Haynes Manuals Inc.
9. Automobile electrical manual a comprehensive guide by Haynes manual car repair.

OUTCOMES:

On completion of the course student should be able to

- Prepare maintenance schedules and procedures with appropriate tools.
- Demonstrate the procedure and methods to repair and calibrate the engine.
- Analyze the causes and remedies for fault in transmission and drive line systems.
- Analyze the causes and remedies of steering and suspension systems.
- Analyze the causes and remedies of brake system.
- Demonstrate the procedure for wheel alignment and wheel balanced.

GECX117 FUNDAMENTALS OF DIGITAL IMAGE PROCESSING L T P C

3 0 0 3

OBJECTIVES:

- Describe and explain basic principles of digital image processing
- Design and implement algorithms that perform basic image processing
- Design and implement algorithms for advanced image analysis
- Assess the performance of image processing algorithms and systems

PRE-REQUISITES:

- Basic knowledge of transforms in Mathematics

MODULE I DIGITAL IMAGE FUNDAMENTALS 8

Elements of Image Processing System, Fundamentals steps in Digital Image Processing, Image Sampling & Quantization, Spatial and Gray Level Resolution.

MODULE II COLOR IMAGE PROCESSING 8

Fundamental of color image processing, color models- RGB, CMY, HIS, Pseudo color image processing.

MODULE III IMAGE ENHANCEMENT 7

Basic gray level Transformations, Histogram Processing, Spatial Filtering .

MODULE IV IMAGE TRANSFORMS 7

2D-DFT, DCT, Haar Transform, Fundamentals of 2D-wavelet transform, sub-band coding.

MODULE V IMAGE SEGMENTATION AND RESTORATION 8

Point, line and edge detection methods ,Image Segmentation and its types, Restoration: Noise model, Inverse filter and Wiener filter.

MODULE VI IMAGE COMPRESSION 7

Fundamentals of redundancies, Basic Compression Methods: Huffman coding, Arithmetic coding, JPEG and MPEG Compression standards.

TOTAL HOURS - 45

REFERENCES:

1. Gonzalez and Woods, "Digital Image Processing", 3rd Edition, Pearson Education, 2016.
2. Anil. K. Jain, "Fundamentals of Digital Image Processing"; 4th Edition, PHI, 2007.
3. Pratt William, "Digital Image Processing", John Wiley & Sons, 2007.
4. Arthur Weeks Jr., "Fundamentals of Digital Image Processing", PHI, 2006.

OUTCOMES:

On completion of the course, students will be able to

- Explain the fundamental concepts of digital image processing.
- Discuss about color image processing
- Recognize & apply various image enhancement techniques.
- Apply various transforms for image processing.
- Apply various techniques for image segmentation and restoration.
- Identify and use appropriate image compression techniques

Group II courses
(To be offered in VII Semester)

		L	T	P	C
GECX201	**GREEN DESIGN AND SUSTAINABILITY**	**3**	**0**	**0**	**3**

OBJECTIVES:

- To impart knowledge to face challenges, the technology poses for water, energy, and climate change by implementing sustainable design.

MODULE I CONCEPTS OF SUSTAINABLE DEVELOPMENT 7

Objectives of Sustainable Development - Need for sustainable development- Environment and development linkages - Globalisation and environment- Population, poverty and pollution- global, regional and local environment issues- Green house gases and climate change.

MODULE II SUSTAINABLE DEVELOPMENT OF SOCIO ECONOMIC SYSTEMS 8

Demographic dynamics of sustainability- Policies for socio economic development- Sustainable Development through trade- Economic growth-Action Plan for implementing sustainable development- Sustainable Energy and Agriculture.

MODULE III FRAME WORK FOR ACHIEVING SUSTAINBAILITY 7

Sustainability indicators- Hurdles to sustainability- Business and Industry – Science and Technology for Sustainable Development- Performance indicators of sustainability and assessment mechanism- Constraints and barriers of Sustainable Development.

MODULE IV GREEN BUILDINGS 8

Introduction to Green Building- Energy- Water- Materials and Resources - Sustainable Sites and Land Use - Indoor Environmental Quality- Life Cycle Assessment- Energy, water and materials efficiency.

MODULE V ENERGY CONSERVATION AND EFFICIENCY 7

Energy savings- Energy Audit- Requirements- Benefits of Energy conservation- Energy conservation measures for buildings- Energy wastage- impact to the environment.

MODULE VI GREEN BUILDINGS DESIGN 8

Elements of Green Buildings Design- Foundation, Electrical, Plumbing, flooring, Decking, roofing, insulation, wall coverings, windows, siding, doors and finishing, LEED certification for Green Buildings, Green Buildings for sustainability.

TOTAL HOURS – 45

REFERENCES:

1. Kirby, J., Okeefe, P., and Timber lake, "Sustainable Development", Earthscan Publication, London, 1995.
2. Charles Kibert, J., "Sustainable Construction: Green Building Design and Delivery", 2^{nd} Edition, John Wiley and sons, 2007.

OUTCOMES:

At the end of the course, the students will be able to

- Explain the relationship between sustainability and emergence of green building practices.
- Address the economic, environmental, and social concerns.

GECX202	APPROPRIATE TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart students knowledge about the basics and applications of various appropriate technologies in the field of civil engineering.

MODULE I BASICS CONCEPTS 7

Back ground, Tools, Choices and Implications, Appropriate Technology Movement (an overview) - Basic design process, basic financial analysis-discounted cash flow, and energy fundamentals.

MODULE II APPROPRIATE TECHNOLOGY WITH REFERENCE TO BUILDING DESIGN 7

Appropriate Building Materials, Appropriate Energy Saving Techniques, Water Conservation (Indoor), Rain Water Harvesting.

MODULE III WATER, HEALTH AND SANITATION MANAGEMENT 7

Water Storage: Designing Dams and Pipelines, Appropriate Selection for Sanitation Technique, Sewerage, Communal Health and Waste Water Recycling.

MODULE IV WASTE MANAGEMENT 8

Types of Waste - Sources - Collections and On-Site Processing -Transferring Stations - Disposal Systems - Recycling.

MODULE V ENERGY EFFICIENT TECHNIQUES 8

Green building concepts-renewable energy sources- Solar – Steam and wind-Biofuels - Biogas – Electricity.

MODULE VI TECHNOLOGY POLICY 8

Government Policies- Energy Policy-Appropriate technology Development Centre-its function and responsibilities-Building policies-Case Studies.

TOTAL HOURS – 45

REFERENCES:

1. Barrett Hazeltine and Christopher Bull, “Appropriate Technology: Tools Choices and Implications”, Academic Press, Orlando, USA, 1998.
2. Ken Darrow and Mike Saxenian, “Appropriate Technology Source Book : A Guide to Practical Books for Village and Small Community Technology”, Stanford, 1986.
3. Richard Heeks, “Technology and Developing Countries: Practical Applications Theoretical Issues”, 1995.
4. John Pickford, “The Worth of Water : Technical Briefs on Health, Water and Sanitation”, Intermediate Technology Publications, 1998.

OUTCOMES:

- At the end of the course, the students will be able to use suitable technologies for various conditions for sustainable development.

GECX203 ENGINEERING SYSTEM MODELLING AND SIMULATION

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn the concepts, techniques, tools for modeling and simulation systems and environments through the use of computers.
- To study the various aspects of discrete dynamic, stochastic systems modeling and conducting experiments with those models on a computer.

MODULE I INTRODUCTION 6

Systems – Modelling – types – systems components – Steps in model building-Simulation Algorithms and Heuristics; Simulation Languages.

MODULE II RANDOM NUMBERS / VARIATES 7

Random numbers – methods of generation – random variates for standard distributions like uniform, exponential, Poisson, binomial, normal etc. – Testing of Random variates – Monte Carlo Simulation.

MODULE III MODELLING PROCESS 7

Primitive Models : Establishing relationships via physical laws; Establishing relationships via curve fitting; Parameters estimation problems; Elementary state transition models.

MODULE IV DESIGN OF SIMULATION EXPERIMENTS 9

Steps on Design of Simulation Experiments – Development of models using of Highlevel language for systems like Queuing, Inventory, Replacement, Production etc., – Model validation and verification, Output analysis.

MODULE V SIMULATION LANGUAGES 10

Need for simulation Languages – Comparisons & Selection of Languages – GPSSARENA- EXTEND – Study of any one of the languages.

MODULE VI CASE STUDIES USING SIMULATION LANGUAGES 6

Case Study using simulation languages

TOTAL HOURS – 45

REFERENCES:

1. Law, A.M., & W.D. Kelton, “Simulation Modelling and Analysis”, McGraw Hill, Singapore, 2000.
2. Harrel, C.R., et. al., “System Improvement Using Simulation”, 3rd Edition, JMI Consulting Group and ProModel Corporation, 1995.
3. Harrel, C.R. & T. Kerim, “Simulation Made Easy, A Manager’s Guide”, IIE Press, 1995.
4. Geoffrey Gordon, “Systems Simulation”, Prentice Hall, 2002.
5. David Kelton, Rondall P Sadowski, David T Sturrock, “Simulation with Arena”, Mc Graw Hill, 2004.

OUTCOMES:

The student should be able to

- Model and simulate systems and environments through the use of computers.
- Conduct experiments with discrete dynamic, stochastic system models on a computer.

GECX204	VALUE ANALYSIS AND ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To get acquainted with value analysis and engineering tool for productivity improvement.
- To understand and analyze the theory and methodology of Value Engineering.

MODULE I VALUE ENGINEERING BASICS 8

Origin of Value Engineering, Meaning of value, Definition of Value Engineering and Value analysis, Difference between Value analysis and Value Engineering, Types of Value, function - Basic and Secondary functions, concept of cost and worth, creativity In Value Engineering.

MODULE II VALUE ENGINEERING JOB PLAN AND PROCESS 6

Seven phases of job plan, FAST Diagram as Value Engineering Tool, Behavioural and organizational aspects of Value Engineering, Ten principles of Value analysis, Benefits of Value Engineering.

MODULE III ORIENTATION AND INFORMATION PHASES 8

Launching Value Engineering project work - Objectives and Targets - VE Project work: a time-bound programme - Projects and Teams - Time Schedule - Co-ordination - Consultant. Technical data - Marketing related information - Competition profile - Cost data - Materials Management related information - Quality related information - Manufacturing data.

MODULE IV FUNCTION ANALYSIS AND CREATIVE PHASES 9

Objectives - Function definition - Classification of functions - Higher level functions – Function – Cost – Function – Worth - Value Gap - Value index - How to carry out Function Analysis? – Fast Diagraming - Cost Modelling. Creativity - How to improve creativity of an individual? – How to promote creativity in the organisation? - Obstacles to Creativity - Mental road blocks - Creativity killer phrases. Positive thinking - Ideas stimulators - Creativity techniques - Brainstorming.

MODULE V EVALUATION, INVESTIGATION AND RECOMMENDATION 6

Paired comparison and Evaluation Matrix techniques - Criteria for selection of VE solutions. Design – Materials – Quality – Marketing – Manufacturing - Preview session. The report - presentation.

MODULE VI IMPLEMENTATION PHASE AND CASE STUDIES 8

Design department - Materials department - Production Planning & Control - Quality Control – Manufacturing – Marketing - Need for co-ordinated teams - The Action Plan. Value Engineering case studies.

TOTAL HOURS – 45

REFERENCES:

1. Mudge, Arthur E. "Value Engineering- A systematic approach", McGraw Hill, New York, 2000.
2. Kumar S, Singh R K and Jha J K (Ed), "Value Engineering", Narosa Publishing House, 2005.
3. Park RJ, "Value Engineering: A Plan for Invention", St.Lucie Press, New York, 1999.
4. Lawrence, D.M., "Techniques of Value Analysis and Engineering", McGraw Hill 1988.
5. George, E.D., "Engineering Design: a Material and Processing Approach", McGraw Hill, 1991.
6. Heller, D.E., "Value Management, Value Engineering and Cost Reduction", Addison Wesley, 1988.

OUTCOMES:

- The student will be able to realize the value of products, processes and implement value analysis to achieve productivity improvement.

GECX205 INDUSTRIAL SAFETY

	L	T	P	C
	3	0	0	3

OBJECTIVES:

- To understand the various safety measures to be taken in different industrial environments.

MODULE I SAFETY MANAGEMENT 7

Evolution of modern safety concept- Safety policy - Safety Organization - line and staff functions for safety- Safety Committee- budgeting for safety. safety education and training.

MODULE II SAFETY IN MANUFACTURING 7

Safety in metal working-Machine guarding -Safety in welding and gas cutting - Safety in cold forming and hot working of metals -Safety in finishing, inspection and testing -Regulation.

MODULE III SAFETY IN CONSTRUCTION 8

General safety consideration in Excavation, foundation and utilities – Cordoning – Demolition – Dismantling –Clearing debris – Types of foundations – Open footings.

Safety in Erection and closing operation - Safety in typical civil structures – Dams-bridges-water Tanks-Retaining walls-Critical factors for failure-Regular Inspection and monitoring.

MODULE IV ELECTRICAL SAFETY 8

Electrical Hazards – Energy leakage – Clearance and insulation – Excess energy – Current surges – Electrical causes of fire and explosion – National electrical Safety code.

Selection of Environment, Protection and Interlock – Discharge rods and earthing device – Safety in the use of portable tools - Preventive maintenance.

MODULE V SAFETY IN MATERIAL HANDLING 8

General safety consideration in material handling devices - Ropes, Chains, Sling, Hoops, Clamps, Arresting gears – Prime movers.

Ergonomic consideration in material handling, design, installation, operation and maintenance of Conveying equipments, hoisting, traveling and slewing mechanisms.

Storage and Retrieval of common goods of shapes and sizes in a general store of a big industry.

MODULE VI SAFETY EDUCATION AND TRAINING 7

Importance of training-identification of training needs-training methods – programme, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training.

TOTAL HOURS – 45

REFERENCES:

1. Krishnan N.V, “Safety Management in Industry”, Jaico Publishing House, Bombay, 1997.
2. Blake R.B., “Industrial Safety”, Prentice Hall, Inc., New Jersey, 1973.
3. Fulman J.B., “Construction Safety, Security, and Loss Prevention”, John Wiley and Sons, 1979.
4. Fordham Cooper W., “Electrical Safety Engineering”, Butterworths, London, 1986.
5. Alexandrov M.P., “Material Handling Equipment”, Mir Publishers, Moscow, 1981.

OUTCOMES:

Students would be able to

- Acquire knowledge on various safety Hazards.
- Carry out safety measures for different industrial environments.

GECX206	ADVANCED OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the various advanced optimization tools.
- To provide an understanding to deal with ill identified and fuzzy problems.

MODULE I INTRODUCTION 7

Review of conventional optimization techniques - limitations - limitation of exhaustive search - need for artificial intelligence - bio mimicking methods

MODULE II HEURISTICS METHODS 8

Introduction – Advanced methods of algorithm design: Greedy method, Backtracking method, Divide and Conquer method – Dynamic programming– Heuristics exploration algorithms – Greedy search - Local search – Hill climbing – Tabu search – Gradient search – Beam search – Simulated Annealing.

MODULE III GENETIC ALGORITHM 7

Introduction - Basics of GA – Population – Reproduction – Cross over – Mutation -genetic algorithms in search, optimization and machine learning-practical genetic algorithms.

MODULE IV ANT COLONY OPTIMIZATION 8

Introduction: Ant Colony Optimization – Meta-heuristic Optimization – History – The ACO Meta-heuristic – ACO Algorithms: Main ACO – Ant system – Ant colony system – Max-Min Ant system – Applications: Routing in telecommunication networks – Travelling salesmen – Graph Coloring – Advantages & Disadvantages.

MODULE V FUZZY LOGIC AND ANN 8

Fuzzy logic, knowledge representation and inference mechanism – Fuzzy and expert control – standard Takagi-Sugeno mathematical characterizations – Design example – Biological foundations to intelligent systems: Artificial neural networks, Back-propagation networks, Radial basis function networks, and recurrent networks.

MODULE VI IMPLEMENTATIONS & APPLICATIONS 7

Reduction of size of an optimization problem – multilevel optimization – parallel processing – multi objective optimization – Job shop scheduling – Vehicle scheduling – Line balancing – Sensor integration.

TOTAL HOURS – 45

REFERENCES:

1. Singiresu S. Rao, "Engineering optimization – Theory and practices", John Wiley and Sons, 1996.
2. Ravindran – Phillips –Solberg, "Operations Research – Principles and Practice, John Wiley and Sons, 1987.
3. Fredrick S.Hillier and G.J.Liberman, "Introduction to Operations Research", McGraw Hill Inc. 1995.
4. Kalymanoy Deb, "Optimization for Engineering Design", PHI, 2003
5. Christos H. Papadimitriou, Kenneth Steiglitz, Combinatorial Optimization, PHI 2006

OUTCOMES:

At the end of the course student will be able to

- Formulate a real life situation as an optimization the problem.
- Identify the appropriate solution methodology and provide a solution

GECX207 MATLAB SIMULATION

L	T	P	C
3	0	0	3

OBJECTIVES:

- To mathematically model engineering systems
- To use computer tools to solve the mathematical models.
- To develop and solve problems in engineering fields.

MODULE I INTRODUCTION TO MATLAB DATA REPRESENTATION 7

Vectors, Matrices -Vector/Matrix Operations & Manipulation- Functions vs scripts- Making clear and compelling plots-Solving systems of linear equations numerically and symbolically- Least squares regression -Curve fitting.

MODULE II MATLAB PLOT FUNCTION 7

Introduction- Plot Function – Animation- 3D Plots-Customizing Plots – Plot Applications- Saving &Painting Plots.

MODULE III LINEARIZATION AND REPRESENTATION OF NUMBERS 7

Linearization and solving non-linear systems of equations- The Newton-Rapson method- Integers and rational numbers in different bases- Floating point numbers- Round off and errors in basic arithmetic-Significant digits when reporting results.

MODULE IV ORDINARY DIFFERENTIAL EQUATIONS 8

Numerical integration and solving 1st order, ordinary differential equations (Euler's method and Runge-Kutta)- Use of ODE function in MATLAB

MODULE V NON-LINEAR DIFFERENTIAL EQUATIONS 8

Converting 2nd order and higher ODEs to systems of 1st order ODEs- Solving systems of ODEs via Euler's method and Runge-Kutta)- Solving single and systems of non-linear differential equations by linearization-Use of the function ODE in MATLAB to solve differential equations.

MODULE VI INTRODUCTION TO SIMULINK 8

Simulink & its relations to MATLAB – Modeling of Electrical Circuits- Modeling fourth order differential equations - Modeling of multiple equations with multiple unknowns - Representing a model as a subsystem-Simulink demos.

Total Hours – 45

REFERENCES:

1. Griffiths D V and Smith I M, Numerical Methods for Engineers, Blackwell, 1991.
2. Laurene Fausett, Applied Numerical Analysis Using MATLAB, Pearson 2008.
3. Moin P, Fundamentals of Engineering Numerical Analysis, Cambridge University Press, 2001.
4. Wilson HB, Turcotte LH, Advanced mathematics and mechanics applications using MATLAB. CRC Press, 1997
5. Ke Chen, Peter Giblin and Alan Irving , Mathematical Exploration with MATLAB, Cambridge University Press, 1999.

OUTCOMES:

At the end of this unit students will be able to:

- Use Matlab as a convenient tool for solving a broad range of practical problems in engineering from simple models to real examples.
- Write programs using first principles without automatic use of built-in ones.
- Write programs for solving linear and nonlinear systems, including those arising from boundary value problems and integral equations, and for root-finding and interpolation, including piecewise approximations.
- Be fluent in exploring Matlab's capabilities, such as using matrices as the fundamental data-storage unit, array manipulation, control flow, script and function m-files, function handles, graphical output.
- Make use of Maltab visual capabilities for all engineering applications.
- An ability to identify, formulate, and solve engineering problems. This will be accomplished by using MATLAB to simulate the solution to various problems in engineering fields

		L	T	P	C
GECX208	**EMBEDDED SYSTEM AND ITS APPLICATIONS**	**3**	**0**	**0**	**3**

OBJECTIVES:

- To provide a detailed overview of embedded system.
- To equip students with the software development skills necessary for practitioners in the embedded systems field.
- To understand entire software development lifecycle and examine the various issues involved in developing software for embedded systems.

MODULE I OVERVIEW OF EMBEDDED SYSTEM 8

Introduction –Embedded Systems vs. General computing systems- Fundamental Components of embedded systems- Characteristics- Challenges-Examples- Embedded System design process.

MODULE II EMBEDDED COMPUTING PLATFORM 8

Overview of Processors and hardware units in an embedded system-CPU buses – Memory devices –Memory types- I/O devices – Designing with computing platforms- Consumer electronics architecture-Design example: Alarm clock.

MODULE III REAL TIME EMBEDDED SYSTEMS 8

Programming embedded systems in assembly and C – Real time systems – Hard and Soft real time systems- Need for RTOS in Embedded Systems- Multiple tasks and processes –Context switching-Scheduling policies- Interprocess communication and synchronization.

MODULE IV EMBEDDED SOFTWARE DEVELOPMENT PROCESS and TOOLS 8

Development process of an embedded system-software modules and tools for implementation of an embedded system- Integrated development environment- Host and target machines-cross compiler-cross assembler-Choosing right platform.

MODULE V PROGRAM MODELING IN EMBEDDED SYSTEMS 8

Program Models – Data Flow Graph model-control DFG model-Synchronous DFG model- Finite state machines- UML modeling – UML Diagrams.

MODULE VI EMBEDDED SYSTEM APPLICATIONS 5

Application specific embedded system – case study: digital camera hardware and software architecture, embedded systems in automobile, embedded system for a smart card.

TOTAL HOURS – 45

REFERENCES:

1. Marilyn Wolf , "Computers as components", Elsevier 2012.
2. Shibu. K.V, "Introduction to Embedded Systems", Tata Mcgraw Hill, 2009.
3. Rajkamal, "Embedded Systems Architecture, Programming and Design",1st Reprint,Tata McGraw-Hill, 2003
4. Frank Vahid and Tony Gwargie, "Embedded System Design", John Wiley & sons, 2002.
5. Sriram V Iyer and PankajGupta ,"Embedded Realtime Systems Programming "TataMcGraw-Hill,2008
6. Qing Li and Carolyn Yao," Real-Time Concepts for Embedded Systems", CMPBooks,2003
7. David E.Simon, "An Embedded Software Primer", Pearson Education, 2003.

OUTCOMES:

On completion of this course, the students will be able to

- Identify the suitable processor and peripherals in embedded applications
- Develop embedded programs in assembly and c
- Choose the right platform for designing an embedded system
- Explore different scheduling mechanism in rtos
- Design the program model for embedded applications.
- Analyze different domain specific applications in embedded systems.

GECX209 USABILITY ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

The objectives of this course are

- To understand the emerging concept of usability, requirements gathering and analysis.
- To learn about human computer interaction with the help of interfaces that has high usability.

MODULE I INTRODUCTION 6

Cost Savings – Usability Now – Usability Slogans – Discount Usability Engineering – Usability – Definition – Example – Trade-offs – Categories – Interaction Design – Understanding & Conceptualizing Interaction – Cognitive Aspects.

MODULE II USER INTERFACES 8

Generation of User Interfaces – Batch Systems, Line Oriented Interfaces, Full Screen Interfaces, Graphical User Interfaces, Next Generation Interfaces, Long Term Trends – Usability Engineering Life Cycle – Interfaces – Data Gathering – Data Analysis Interpretation and Presentation.

MODULE III INTERACTION DESIGN 8

Process of Interaction Design - Establishing Requirements – Design, Prototyping and Construction - Evaluation and Framework.

MODULE IV USABILITY TESTING 8

Usability Heuristics – Simple and Natural Dialogue, Users' Language, Memory Load, Consistency, Feedback, Clearly Marked Exits, Shortcuts, Error Messages, Prevent Errors, Documentation, Heuristic Evaluation – Usability Testing - Test Goals and Test Plans, Getting Test Users, Choosing Experimenters, Ethical Aspects, Test Tasks, Stages of a Test, Performance Measurement, Thinking Aloud, Usability Laboratories.

MODULE V USABILITY ASSESSMENT METHODS 8

Observation, Questionnaires and Interviews, Focus Groups, Logging Actual Use, User Feedback, Usability Methods – Interface Standards - National, International and Vendor Standards, Producing Usable In-House Standards.

MODULE VI USER INTERFACES 7

International Graphical Interfaces, International Usability Engineering, Guidelines for Internationalization, Resource Separation, Multilocale Interfaces – Future Developments – Case Study.

TOTAL HOURS – 45

REFERENCES:

1. Yvonne Rogers, Helen Sharp, Jenny Preece, “Interaction Design: Beyond Human - Computer Interaction”, John Wiley & Sons, 3rd Edition, 2011 (Module I, II, III).
2. Jakob Nielsen, “Usability Engineering”, Morgan Kaufmann Academic Press, 1994. (Module I – VI).
3. Ben Shneiderman, Plaisant, Cohen, Jacobs, “Designing the User Interface: Strategies for Effective Human Interaction”, Pearson Education, 5th Edition, 2010.
4. Laura M. Leventhal, Julie A. Barnes, “Usability Engineering: Process, Products, and Examples”, Pearson/Prentice Hall, 2008

OUTCOMES:

Students who complete this course will be able to

- build effective, flexible and robust user interfaces.
- translate system requirements into appropriate human/computer interaction sequences.
- choose mode, media and device for the application requirements.

GECX210	SUPPLY CHAIN MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the various decision phases in a supply chain
- To be aware of the Supply Chain and its drivers
- To design Supply Chain Network
- To build a aggregate plan in supply chain
- To understand Sourcing Decisions in Supply Chain
- To comprehend the influence of Information technology in Supply Chain

MODULE I INTRODUCTION TO SUPPLY CHAIN 7

Understanding Supply Chain - Decision phases - Supply chain performance - Competitive and supply chain strategies - Achieving strategic fit - Expanding strategic scope

MODULE II SUPPLY CHAIN DRIVERS AND DESIGN 7

Drivers of supply chain performance – Designing distribution network - Network Design in the Supply Chain - Network design in Uncertain Environment

MODULE III AGGREGATE PLANNING AND MANAGING SUPPLY, DEMAND AND INVENTORY 8

Aggregate Planning in a Supply chain: role - Managing Supply - Managing Demand in Supply Chain – Cycle and Safety inventory in supply chain – Level of product availability.

MODULE IV MANAGING INVENTORY IN SUPPLY CHAIN 8

Managing Economies of Scale in a Supply Chain : Cycle Inventory- Managing uncertainty in a Supply Chain Safety Inventory- Determining optimal level of Product Availability

MODULE V SOURCING AND TRANSPORTATION 8

Sourcing decision in supply chain - Third and Fourth – Party Logistics providers - Supplier scoring and assessment - Transportation in a Supply Chain – Risk and Trade-offs in transportation design.

MODULE VI INFORMATION TECHNOLOGY IN A SUPPLY CHAIN 7

Information technology in a supply chain – CRM, ISCM, SRM in supply chain - Over view of recent trends in Supply Chain: e-SRM, e-LRM, e-SCM.

TOTAL HOURS – 45

REFERENCES:

1. Sunil Chopra and Peter Meindl, "Supply Chain Management-Strategy Planning and Operation", Pearson Education, 5th Indian Reprint, 2013.
2. Jananth Shah "Supply Chain Management – Text and Cases", Pearson Education, 2008.
3. Altekar Rahul V, "Supply Chain Management-Concept and Cases", Prentice Hall India, 2005.
4. Monczka et al., "Purchasing and Supply Chain Management", Thomson Learning, 2nd Edition, 2nd Reprint, 2002.

OUTCOMES:

- After taking up the course the student will be able to brighten his prospects of taking up a career on supply chain management.
- The student decision making capability specific to supply chain issues in an industry is improved.
- The student can plan a well defined execution of supply chain strategy in companies.
- The student will be able to design a optimal distribution network as per the demands of the industry.
- The student can also determine the most favorable transportation plan for a company.
- The student will also be able to bring in company from paper environment to paperless environment.

GECX211 SYSTEM ANALYSIS AND DESIGN

L	T	P	C
3	0	0	3

OBJECTIVES:

- To describe the phases of the system development life cycle.
- To teach the automated tools for system development.
- To develop and evaluate system requirements.
- To explain the organizational issues in system implementation.
- To teach the usability testing and electronic data interchange.
- To elucidate the importance of system analysis and design in electronic commerce.

MODULE I FUNDAMENTALS OF SYSTEM DEVELOPMENT 8

System Concept – Characteristics – Elements of System – Types of System – Modern Approach to System Analysis and Design – System Development Life Cycle – Approaches to Improving Development – Tools for System Development – Succeeding as a System Analyst – Skills – Managing the Project.

MODULE II AUTOMATED TOOLS FOR SYSTEMS DEVELOPMENT 7

What is requirements determination? Fact finding techniques, Tools for documenting procedure and decision-CASE Tools-Need for CASE tools-Reverse engineering and reengineering- phases of the software life cycle-Ranking projects-Value Chain Analysis- Corporate Strategic Planning vs. Information Systems Planning.

MODULE III SYSTEM ANALYSIS 8

Determining System Requirements – Traditional Methods - Modern Methods – Radical Methods – Structuring System Requirements – Process Modeling – Data Flow Diagramming – Logic Modeling – Conceptual Data Modeling – E-R Modeling.

MODULE IV SYSTEM DESIGN 8

System Implementation – Software Application Testing – Installation – Documentation – Training and Support – Organizational Issues in Systems Implementation – Maintaining Information System – Conducting System

Maintenance.

MODULE V USABILITY AND MEASURING USER SATISFACTION 7

Usability Testing-User satisfaction test- A tool for analyzing user satisfaction – Unified Modeling Language(UML)- Case study: System Design: Application in Human Resource-Financial Applications

MODULE VI SAD IN E-COMMERCE 7

Systems analysis and design in the era of electronic commerce: B2B, B2C and C2C e-commerce -advantages and disadvantages of e-commerce. E-commerce system architecture – physical networks, logical network, World Wide Web, web-services - HTML, XML - case studies-El electronic data interchange: EDI standards - virtual private networks - XML and EDI

TOTAL HOURS – 45

REFERENCES:

1. Jeffrey A. Hoffer, Joey F. George, Joseph S. Valacich, “Modern Systems Analysis and Design”,Fifth Edition, Prentice Hall,March 2007.
2.Ned Kock, “Systems Analysis & Design Fundamentals” Sage South Asia, May 2008.
3. Joseph S. Valacich, Jeffrey A. Hoffer, Joey F. George, “Essentials Of System Analysis And Design” Prentice Hall , August 2005.
4. Rumbaugh et al, “Succeeding with Booch and Rambaugh Methods”, Addisson Wesley, second Edition, 1998.
5.Larman, C.,” Applying UML and Patterns. An introduction to Object-Oriented Analysis and Design”. Prentice-Hall PTR, 2002.

OUTCOMES:

- List the characteristics of the system and specify the approaches in the development of the system.
- Summarize the phases of the software life cycle
- Differentiate Corporate Strategic Planning and Information Systems Planning.
- Illustrate the system requirements through various modeling diagrams.
- Use tools and techniques for process and data modeling.
- Solve realistic systems analysis problems and perform user satisfaction test.

GECX212	ADVANCED MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the student conversant with

- Dielectric materials
- Magnetic materials
- Energy materials
- Nano materials
- Semi conductors
- Smart materials

MODULE I DIELECTRIC MATERIALS 8

Dielectric Materials- Polarization and Mechanism-Internal or local field-Clausius-Mossotti relation- Dielectric loss- Temperature and Frequency effect- Measurement of Dielectric constant and loss using Scherring bridge- electric break down- ferro, piezo, pyroelectric materials and its application.

MODULE II MAGNETIC MATERIALS 8

Magnetic Materials - Terminology and classification of magnetic materials (Dia, Para, Ferro & Ferri) – Magnetic moments due to electrospin – Domain theory of Hysteresis – Heisenberg theory of Exchange Interaction (without derivation)- Structure and properties of Ferrites- Properties of Soft and Hard Magnetic Materials- Application: floppy disk, CD ROM, Magneto optical recording.

MODULE III ENERGY MATERIALS 8

Energy Materials (Nuclear) - Introduction to nuclear materials- Materials for nuclear fuel in fission and fusion reactors, Fissile and fertile materials- Control & Construction Materials for Nuclear reactors, Moderators, Heat Exchangers- Radiation proof materials- Brief discussion of safety and radioactive waste disposal.

MODULE IV NANO MATERIALS 7

Nano Materials- The nanosize range- classification of nanomaterials- processing of nanomaterials-properties of nanomaterials- mechanical, electrical, magnetic properties- other properties- carbon based nanomaterials- other nanomaterials and its application.

MODULE V SEMICONDUCTORS 7

Semiconductors- The energy gap in solids-Extrinsic Semiconductors- Intrinsic Semiconductors- Hall Effect in semiconductors- Application of Hall Effect- Basic ideas of compound semiconductors -Semiconductor materials- Fabrication of Integrated Circuits- Some semiconductor Devices

MODULE VI SMART MATERIALS 7

Smart materials- aerospace materials Ni and Co based super alloys, Special steels, Titanium alloys, Intermetallics, ceramics and their composites, New High strength material, Properties of Materials, Materials in Medical Applications, Stainless steel alloys,Cobalt based alloys, titanium based alloys, polymers

TOTAL HOURS – 45

REFERENCES:

1. Materials science and Engineering: A first course by V. RAGHAVAN, 6th ed., Eastern Economy edition,Prentice Hall of India,2015
2. Materials science and Engineering: An Introduction by William D. Callister Jr., 7th ed. John Wiley & Sons Inc. 2007
3. Material science by Dr.M.Arumugam, Anurasha agencies ,third revised edition ,2002

OUTCOMES:

Students will be able to know the

- significance of dielectric materials
- types and applications of magnetic materials
- applications of nuclear materials for energy harvesting
- applications of nano materials
- significance of semi conductor devices
- applications of smart materials

GECX213	NATIONAL SERVICE SCHEME	L	T	P	C
		2	0	0	2

OBJECTIVES:

Primary Objective: Personality development through community service.
To achieve the above objective, the following should be adhered:

- To provide an understanding about the aims, structure and programmes and activities of National Service Scheme in terms of Nation Building.
- To develop certain basic skills for personality development through community development.
- Understand the community in which they work and their relation.
- Identify the needs and problems of the community and involve them in problem-solving.
- Practice national integration and social harmony.

MODULE I INTRODUCTION TO NSS 8

Orientation and structure of NSS - Aims and objectives of National Service Scheme- The history of NSS- Symbol and meaning- NSS hierarchy from national to college level – Role and responsibilities of various NSS functionaries.

MODULE II PERSONALITY AND COMMUNITY DEVELOPMENT SKILLS 8

Importance of youth Leadership, Traits of Good Leadership and Personality Development. Role of youth in creating awareness through NSS Programmes on Health & Hygiene; Environmental Conservation and Enrichment for Sustainable Development; Sanitation and Swachh Bharat.

MODULE III UNDERSTANDING YOUTH 7

Definition and Profiles of youth categories, Youth Issues, Challenges and Opportunities for Youth, Youth as agent of social change & Community Mobilization .Role of Youth in Nation Building. National Youth Policy.

MODULE IV SOCIAL HARMONY AND NATIONAL INTEGRATION 7

National Integration, Various obstacles in the way of National Integration; such as caste, religion, language and provisional problems etc. Role of youth in Peace building and conflict resolution- Globalization and its Economic Social Political and Cultural impacts.

TOTAL HOURS – 30

REFERENCES:

1. National Service Scheme – A Youth Volunteers Programme for Under Graduate students as per UGC guidelines J.D.S.Panwar et al. Astral International. New Delhi.
2. National Service Scheme Revised Manual, 2006.Govt. of India. Ministry of Youth Affairs & Sports. New Delhi.
3. Social Problems in India, *Ram Ahuja.*
4. National Youth Policy-2014. Ministry of Youth Affairs & Sports. .Govt. of India

OUTCOMES:

On successful completion of this course

- Students will have exposure to the the aims, structure and programmes and activities of National Service scheme in terms of Nation Building
- Students will be trained to skills for personality development through community development.
- Students will gain knowledge about national integration and social harmony.
- Students will be exposed to the role of youths in Nation building.

GECX214 AUTOMOTIVE POLLUTION AND CONTROL

L	T	P	C
3	0	0	3

OBJECTIVES:

- To have a fair knowledge in automotive pollution control.
- To understand the concept of formation and control techniques of pollutants like UBHC, CO, NOx, particulate matter and smoke for both SI and CI engine will be taught to the students.
- To know about the instruments for measurement of pollutants.
- To get introduced about emission standards.

MODULE I EMISSION FROM AUTOMOBILES 8

Sources of Air Pollution. Various emissions from Automobiles — Formation — Effects of ollutants on environment and human beings. Emission control techniques – Modification of fuel, after treatment devices. Emission standards. Automotive waste management, old vehicle disposal, recycling, tyre recycling

MODULE II SI ENGINE EMISSIONS AND CONTROL 9

Emission formation in SI Engines- Carbon monoxide & Carbon di oxide - Unburned hydrocarbon, NOx, Smoke — Effects of design and operating variables on emission formation – controlling of pollutants - Catalytic converters, Charcoal Canister, Positive Crank case ventilation system, Secondary air injection, thermal reactor

MODULE III CI ENGINE EMISSION AND CONTROL 8

Formation of White, Blue, and Black Smokes, NOx, soot, Effect of Operating variables on Emission formation — Fumigation, Split injection, Catalytic Coating, EGR, Particulate Traps, SCR, Fuel additives — Cetane number Effect.

MODULE IV NOISE POLLUTION FROM AUTOMOBILES 8

Sources of Noise — Engine Noise, Transmission Noise, vehicle structural Noise, aerodynamics noise, Exhaust Noise. Noise reduction in Automobiles — Encapsulation technique for noise reduction —Silencer Design.

MODULE V TEST PROCEDURES 6

Constant Volume Sampling I and 3 (CVSI &CVS3) Systems- Sampling

Procedures — Chassis dynamometers - Seven modes and thirteen mode cycles for Emission Sampling.

MODULE VI EMISSION MEASUREMENTS 6

Emission analysers —NDIR, FID, Chemiluminesecent, Smoke meters, Dilution Tunnel, SHED Test, Sound level meters.

TOTAL HOURS – 45

REFERENCES:

1. V.Ganesan, ‘Internal combustion Engines’, Tata McGraw Hill Book Co, Eighth Reprint, 2005.
2. Crouse and Anglin, ‘Automotive Emission Control’, McGraw Hill company., Newyork 1993.
3. G.P.Springer ad D.J.Patterson, Engine Emissions, Pollutant formation, Plenum Press, New York. 1986.
4. D.J.Patterson and N.A.Henin, ‘Emission from Combustion Engine and their control’, Anna Arbor Science Publication,1985.
5. L.Lberanek, ‘Noise Reduction’, Mcgrawhill Company., Newyork1993.
6. C.Duerson, ‘Noise Abatment’, Butterworths ltd., London1990.
7. A.Alexander, J.P.Barde, C.lomure and F.J. Langdan, ‘Road traffic noise’,
8. Applied science publisher ltd., London, 1987.

OUTCOMES:

On completion of the course student should be able to

- Identify the sources of emission from vehicles.
- Analyse the causes and effects of emissions.
- Analyse causes and effects of noise pollution
- Bring out solutions for control of emissions.
- Demonstrate the test procedures and emission norms.
- Select suitable instruments for measurement of emissions.

GECX215 MOTOR VEHICLE ACT, INSURANCE & POLICY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn about basic act and regulation followed for road vehicle
- To learn about systematic steps involved to get licence and registration of motor vehicle
- To learn arbour various types of motor vehicle polices and insurances

MODULE I BASIC RULES FOR ROAD VEHICLE 8

Display and Use of Number Plates- Attachment of number plates- Number plates in horizontal position- Removal of number plates on transfer- Hours prescribed for lighted lamps- Mounting of lamps and reflectors- Multiple beam headlamps- Daytime running lamps- Auxiliary driving lamps- Parking lamps- Brakes- Stopping distances- Emergency or parking brakes- Horn- Muffler- Mirrors- Inspection of motor vehicles- Standards of safety and repair

MODULE II LICENSING OF DRIVERS OF MOTOR VEHICLES 8

Necessity of driving licence- Age limit in connection with driving of motor vehicle-Responsibility of owners of motor vehicles-Restriction on the holding of driving licence-Grant of learner's licence-Grant of driving licence-Addition to driving licence- Renewal of driving licence-Revocation of driving licence on grounds of disease or disability-Driving licence to drive motor vehicle belonging to the central government- power of court to disqualify- suspension of driving licence in certain cases- suspension or cancellation of driving licence on convection- Endorsement.

MODULE III REGISTRATION OF MOTOR VEHICLE 7

Necessity for registration – Registration Where and how to be made- Special provision for registration of motor vehicle of diplomatic officers-Temporary registration- Production of vehicle at the time of registration- Refusal of registration- renewal of certificate of registration- effectiveness in India of registration- Change of residence or place of business-transfer of ownership- Suspension of registration – cancellation of registration suspended under section 53- certificate of fitness of transport vehicle-cancellation of registration.

MODULE IV INSURANCE OF MOTOR VEHICLE 8

Necessity for insurance against third party – Requirements of policies and limits of liability- - Duty of insurers to satisfy judgements and awards against person insured in respect of third party risks-Duty to give information as to insurance-Settlement between insurers and insured persons- transfer of certificate of insurance-production of certain certificates, licences and permit in certain cases-Special provisions as to compensation in case of hit and run motor accident – Types of motor polices

MODULE V CONTROL OF TRANSPORT VEHICLES 7

Power to State Government to control road transport- Transport authorities- General provision as to applications for permits- Application for stage carriage permit- Procedure of Regional Transport Authority in considering application for stage carriage permit- Scheme for renting of motor cabs- Application for private service vehicle permit- Procedure in applying for and granting permits- Duration and renewal of permits- Transfer of permit- Replacement of vehicles- Temporary permits

MODULE VI OFFENCES AND PUNISHMENT 7

Driving without holding an effective driving licence- Driving by an under-aged person (Minor driving vehicle)- Holding of a driving licence permitting it to be used by other person.- Driving a vehicle at an excessive speed- Driving or permitting to drive a vehicle carrying excess load- Driving dangerously / its Abetment Driving an uninsured vehicle Rider and pillion rider failing to wear protective head gear (Helmet) -Violation of Mandatory Signs -.e-challan and spot challan

TOTAL HOURS – 45

REFEERENCES:

1. The motor vehicle act 1988, Universal law publishing co.cpvt ltd. New Delhi 2011
2. A Commentary On The Motor Vehicles Act, 1988 by SUKHDEV AGGARWAL The Bright Law House, New Delhi.
3. The Motor Vehicles Act, 1988 Along with Latest Case Law, Notifications & Table of Offences and Punishments Asia Law House; 15th edition (2014).

4. Assessment of Compensation in Accidents under Motor Vehicles Act by Karkara Delhi Law House (2013)

OUTCOMES:

On completion of the course students should be able to

- Explain the analysis of rules and regulations for road vehicles
- Analyze the procedure for getting driving license for vehicles at national and international level
- Analyze the procedure for registration of vehicles.
- Analyze the procedure for Insurance of vehicles and claims.
- Analyze the procedure for obtaining Government Permits and renewal
- Analyze the consequences of not following the rules and regulations

GECX216	**PRINCIPLES OF COMMUNICATION SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To introduce the analog and digital modulation techniques.
- To elaborate the working of communication receivers in the presence of noise.
- To give an overview of various communication systems.

MODULE I LINEAR MODULATION 8

Baseband signals, Amplitude Modulation – Modulation Index, Power Transmitted, Double Side Band and Single Side Band AM, AM Modulators and AM Receivers, AM Radio systems, Frequency Division Multiplexing.

MODULE II ANGLE MODULATION 8

Frequency Modulation and Phase Modulation, Frequency deviation and modulation index, Bandwidth of FM, FM Modulators and FM receivers, FM Radio and FM Stereo Systems

MODULE III SAMPLING AND PULSE MODULATION 7

Sampling, Nyquist's Sampling Theorem, Pulse Modulations - PAM, PPM and PWM, Time Division Multiplexing, Bandwidth of TDM systems.

MODULE IV DIGITAL COMMUNICATION 7

Digital baseband data, Digital Modulations – ASK, FSK, PSK and QPSK. Digital Communication Transmitters and Receivers.

MODULE V NOISE 8

Sources of Noise, Thermal Noise, shot noise, White noise, Narrow band Noise, Effect of noise in communication, SNR, Receiver Noise Temperature and Noise Equivalent Bandwidth.

MODULE VI COMMUNICATION SYSTEMS & NETWORK 7

FM Radio Systems, Cellular Mobile network, Satellite Communications, Optical Fiber Communication.

TOTAL HOURS – 45

REFERENCES:

1. A. Bruce Carlson, Paul B. Crilly, “Communication Systems”, 5th Edition, McGraw Hill Int., 2011.
2. B.P. Lathi, Zhi Ding, Hari M. Gupta, “Modern Digital and Analog Communication Systems”, 4th Edition, Oxford University Press, 2017.
3. Herbert Taub, Donald L. Schilling, Goutam Saha, “Principles of Communication Systems” 4th Edition, McGraw Hill Int. 2013.
4. Simon Haykin, “An Introduction To Analog And Digital Communications”, 1st Edition, Wiley India, 2010.
5. Simon Haykin , “Communications Systems” 4th Edition, Wiley India, 2006.
6. Hwei P. Hsu, “Analog and Digital Communications” 3rd Edition,

OUTCOMES:

On completion of the course students will be able to

- Identify various communication systems and the corresponding modulation schemes.
- Predict the characteristics of various analog and digital modulation schemes.
- Interpret the effect of noise and bandwidth in a communication systems
- Apply the Nyquist criteria for a given baseband signals.
- Evaluate the performance of communication receivers.
- Demonstrate the applications of common communication systems.

GECX217 **LEAN MANAGEMENT**

L	T	P	C
3	1	0	4

OBJECTIVES:

The objective of the Course to make the student know about

- the basics of lean production management,
- how Lean principles are applied to the Construction industry to improve the operation management and product development.

MODULE I **8**

Lean production – Introduction, background, and lean thinking. Importance of philosophy, strategy, culture, alignment, focus and systems view. Discussion of Toyota Production System.

MODULE II **8**

Manufacturing systems – an overview of manufacturing strategies. Job shops, batch flow, and flexible manufacturing systems Flow production and lean production systems

MODULE III **7**

Value stream mapping in process design and product development Waste reduction - lead time reduction

Process cycle time and value-added vs. non-value added activities Optimum lot sizing

MODULE IV **8**

Lean production processes, approaches and techniques.—Importance of focusing upon flow. Tools -. Workplace organization – 5S. - Stability. - Just-In-Time – One piece flow – Pull. - . Cellular systems. - . Quick change and set-up reduction methods. f. Total productive maintenance. -. Poka-Yoke – mistake proofing, quality improvement. Standards. - . Leveling. - . Visual management. Just-in-time techniques – SMED and Takt Times - Standard work processes and line balancing Poka-yoke and pull systems material handling reduction and facilities planning

MODULE V **8**

Managing change in the lean organization Human resource management and the lean enterprise Employee involvement – Teams – Training – Supporting and encouraging involvement – Involving people in the change process -- communication -

- Importance of culture. Startup of lean processes and examples of applications. Sustaining improvement and change, auditing, follow-up actions.

7

MODULE VI

The lean enterprise and supply chain management Costs and risks of lean initiatives - Measuring lean initiatives

TOTAL HOURS – 45

REFERENCES:

1. The Toyota Way Fieldbook, Jeffrey Liker and David Meier, McGraw-Hill, 2006. Lean Production Simplified, Pascal Dennis, Productivity Press, 2007.
2. Womack, James P., and Daniel T. Jones. Lean Thinking. New York, NY: Simon and Schuster, 2003. ISBN: 0743249275.
3. Murman, Earll. Lean Enterprise Value. New York, NY: Palgrave Macmillan, 2002. ISBN: 0333976975.
4. http://www.leanconstruction.org/readings.htm
5. Hopp, W. J., and Spearman, M. L. (2011). Factory Physics, Third Edition, Waveland Press, Long Grove, Il. 720 pp.

OUTCOMES:

The student will be able to

- Describe the manufacturing approaches employed and the background and philosophy of lean production.
- Illustrate the concept of waste reduction.
- Apply evaluation techniques that can be used in preparation for and use in learn production activities.
- Select the tools that can be used implementing lean production in production operations.
- Discuss the importance of workplace organization, pull production, cellular arrangement and employee involvement, need for employee creativity.
- Describe about the Methods for promoting success in implementing lean transformations.

GECX218 GEOSPATIAL MODELING & ANALYSIS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To equip the students with fundamental representation and analysis of geospatial phenomena and provides foundations in methods and algorithms used in GIS analysis.
- To focus is on terrain modeling, geomorphometry, watershed analysis and introductory GIS-based modeling of landscape processes (water, sediment). The course includes analysis from lidar data, coastal change assessment and 3D visualization.

MODULE I INTRODUCTION TO GEOSPATIAL DATA 7

Mapping natural phenomena –Concept of continuous fields and discrete sampling – Units, projections, coordinate transformation – Georeferencing, geospatial formats, conversions, geospatial data abstraction library – Raster and vector representation, raster and vector conversions and resampling.

MODULE II DATA DISPLAY AND VISUALIZATION 7

Display of continuous and discrete data, use of color, shading, symbols, to extract the spatial pattern and relationships – 3D visualization: multiple surfaces and volumes, 3D vector objects – visualization for data analysis (lighting, scaling, transparency, cutting planes, animations) – view/create maps/post your data on-line (Google Earth/Maps, GPS visualizer)

MODULE III GEO SPATIAL ANALYSIS 7

Foundations for analysis of continuous and discrete phenomena – neighborhood operations and buffers – analysis and modeling with map algebra – cost surfaces and least cost path – spatial interpolation and approximation (gridding)

MODULE IV TERRAIN MODELING AND ANALYSIS 9

Terrain and bathymetry mapping – mathematical and digital representations (point clouds, contour, raster, TIN) – DEM and DSM, working with multiple return lidar data – spatial interpolation of elevation data and topographic analysis, line of sight, view shed analysis – solar irradiation, photovoltaic energy potential, time series of elevation data, analysis of coastal change.

MODULE V FLOW TRACING, WATERSHED ANALYSIS AND LANDFORMS 8

Methods for flow routing and flow accumulation – Extraction of stream networks – Extraction of watershed boundaries and building watershed hierarchies – feature extraction, types of landforms.

MODULE VI MODELING OF GEOSPATIAL PROCESSES 7

Model formulation, input data processing – introduction to GIS-based hydrologic, erosion and environmental modeling – Geocomputational methods, including agent-based modeling, artificial neural networks and evolutionary computing.

TOTAL HOURS – 45

REFERENCES:

1. Hassan A, Karimi (2017), Geospatial Data Science Techniques and Applications, CRS Press & Co.
2. Sudipto Banerjee, Bradley P, Carlin, Alan E. Gelfand (2014), Hierarchical Modeling and Analysis for Spatial Data, CRS Press & Co.
3. Maguire, D., M. Batty, and M. Goodchild. 2015. GIS, Spatial analysis, and modeling. ESRI Press (G70.212 .G584 2005)
4. Zeiler, M. 2010. Modeling Our World: The ESRI Guide to Geodatabase Design. Second Ed. ESRI Press, Redlands, California

OUTCOMES:

On successful completion of this course,

- Students will be able to apply the basic concepts of conceptualize models as representations of real life systems with inputs, outputs, and processes.
- Students will have gained knowledge in spatial tools to make simulations and predictions of real life phenomena.
- Students will have synthesized knowledge about Apply, integrate, and develop models with geospatial data through a GIS.
- Students will have an overview of evaluate models in terms of accuracy, sensitivity, and uncertainty.
- Students will have use of a system-based approach for problem solving, with an emphasis on sustainability.