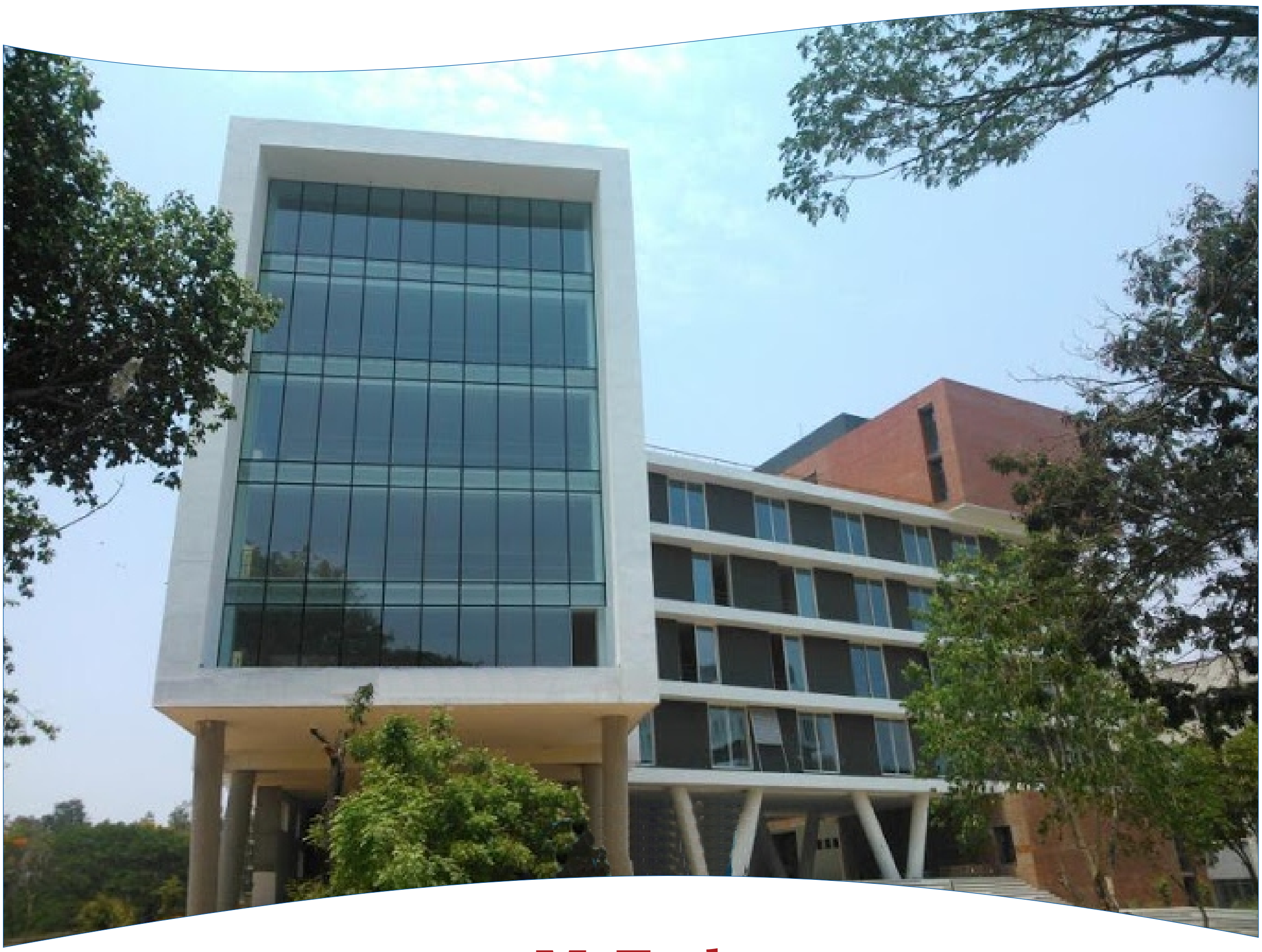
CURRICULUM AND SYLLABI

REGULATIONS - 2016

(As approved by the 9th Academic Council)



M. Tech.

POWER SYSTEMS ENGINEERING

B.S.ABDUR RAHMAN UNIVERSITY

B.S. ABDUR RAHMAN INSTITUTE OF SCIENCE & TECHNOLOGY
(Estd. u/s 3 of the UGC Act, 1956)

(FORMERLY B.S. ABDUR RAHMAN CRESCENT ENGINEERING COLLEGE)
Rated with A Grade by National Assessment and Accreditation Council
Seethakathi Estate, G.S.T. Road, Vandalur, Chennai - 600 048
www.bsauniv.ac.in

REGULATIONS, CURRICULUM AND SYLLABI

M. Tech.
POWER SYSTEMS ENGINEERING

(As approved by the 9th Academic Council)

JULY 2016

B.S.ABDUR RAHMAN
UNIVERSITY
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UNIVERSITY VISION AND MISSION

VISION

B.S. Abdur Rahman 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 University
- 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

VISION AND MISSION OF THE DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

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 AND OUTCOMES

PROGRAMME EDUCATIONAL OBJECTIVES

- To develop competent and skilled power system engineers to meet the national and international industrial requirements.
- To meet the day to day challenges faced by the power sector due to deregulation and to equip the students in power system software applications.
- To meet the challenges of today's clean energy sector and to contribute to the environmental social concerns.
- To train the students to realistic industrial environment, meeting the modern engineering practices.

PROGRAMME OUTCOMES

1. **Engineering knowledge**:
   Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**:
   Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**:
   Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**:
   Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**:
   Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**:
   Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**:
   Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**:
   Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**:
   Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**:
    Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**:
    Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**:
    Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES

(i) Ability to provide solutions for power system problems to meet global requirements

(ii) Have ability to apply various industrial power system software packages in the areas of planning and operation of power systems.

(iii) To have a substantial knowledge, in emerging areas such as deregulation of power system, smart grid and clean energy

REGULATIONS – 2016
FOR
M. Tech. / MCA / M.Sc. DEGREE PROGRAMMES

1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires

i. **"Programme"** means a Post Graduate Degree Programme (M. Tech. / MCA / M.Sc.)

ii. **"Course"** means a theory or practical subject that is normally studied in a semester, like Applied Mathematics, Structural Dynamics, Computer Aided Design, etc.

iii. **"University"** means B.S. Abdur Rahman University, Chennai, 600048.

iv. **"Institution"** unless otherwise specifically mentioned as an autonomous or off campus institution means B.S. Abdur Rahman University.

v. **"Academic Council"** means the Academic Council, which is the apex body on all academic matters of this University

vi. **"Dean (Academic Affairs)"** means Dean (Academic Affairs) of B.S. Abdur Rahman University, who administers the academic matters.

vii. **"Dean (P.G. Studies)"** means Dean (P.G. Studies) of B.S. Abdur Rahman University who administers all P.G Programmes of the University in coordination with Dean (Academic Affairs)

viii. **"Dean (Student Affairs)"** means Dean (Student Affairs) of B.S. Abdur Rahman University, who looks after the welfare and discipline of the students.

ix. **"Controller of Examinations"** means the Controller of Examinations of B.S. Abdur Rahman University who is responsible for conduct of examinations and declaration of results.

2.0 PROGRAMMES OFFERED, MODE OF STUDY AND ADMISSION REQUIREMENTS

2.1 P.G. Programmes Offered

The various P.G. Programmes and their modes of study are as follows:

Degree	Mode of Study
M. Tech. /M.C.A. / M.Sc.	Full Time & Part Time – Day / Evening / Weekends

2.2 Modes of Study

2.2.1 Full-time

Students admitted under "Full-Time" shall be available in the Institution during the complete working hours for curricular, co-curricular and extra-curricular activities assigned to them.

2.2.2 A full time student, who has completed all non-project courses desiring to do the Project work in part-time mode for valid reasons, shall apply to the Dean (Academic Affairs) through the Head of the Department. Permission may be granted based on merits of the case. Such conversion is not permitted in the middle of a semester.

2.2.3 Part-time

In this mode of study, the students are required to attend classes for the courses in the time slots selected by them, during the daytime (or) evenings (or) weekends.

2.3 Admission Requirements

2.3.1 Students for admission to the first semester of the Master's Degree Programme shall be required to have passed the appropriate degree examination of this University as specified in the Table shown for eligible entry qualifications for admission to P.G. programmes or any other degree examination of any University or authority accepted by this University as equivalent thereto.

2.3.2 Eligibility conditions for admission such as class obtained, number of attempts in the qualifying examination and physical fitness will be as prescribed by this Institution from time to time.

2.3.3 All part-time students should satisfy other conditions regarding experience, sponsorship etc., which may be prescribed by this Institution from time to time.

2.3.4 Student eligible for admission to M.C.A under lateral entry scheme shall be required to have passed three year degree in B.Sc (Computer Science) / B.C.A / B.Sc (Information Technology)

3.0 DURATION AND STRUCTURE OF THE P.G. PROGRAMME

3.1 The minimum and maximum period for completion of the P.G. Programmes are given below:

Programme	Min. No. of Semesters	Max. No. of Semesters
M. Tech. (Full Time)	4	8
M. Tech. (Part Time)	6	12
M.C.A. (Full Time)	6	12
M.C.A. (Part Time)	9	18
M.C.A. (Full Time) – (Lateral Entry)	4	8
M.C.A. (Part Time) – (Lateral Entry)	6	12
M.Sc. (Full Time)	4	8
M. Sc. (Part Time)	6	12

3.2 The PG. programmes consist of the following components as prescribed in the respective curriculum

i. Core courses
ii. General Elective courses
iii. Professional Elective courses
iv. Project work / thesis / dissertation
v. Laboratory Courses
vi. Case studies
vii. Seminars
viii. Mini Project
ix. Industrial Internship

3.3 The curriculum and syllabi of all PG. programmes shall be approved by the Academic Council of this University.

3.4 The minimum number of credits to be earned for the successful completion of the programme shall be specified in the curriculum of the respective specialization of the P.G. programme.

3.5 Each academic semester shall normally comprise of 80 working days. Semester-end examinations will follow immediately after the last working day.

ELIGIBLE ENTRY QUALIFICATIONS FOR ADMISSION TO P.G. PROGRAMMES

Sl. No.	Name of the Department	P.G. Programmes offered	Qualifications for admission
01	Civil Engineering	M. Tech. (Structural Engineering)	B.E / B. Tech. (Civil Engineering) / (Structural Engineering)
		M. Tech. (Construction Engineering and Project Management)	
02	Mechanical Engineering	M. Tech. (Manufacturing Engineering)	B.E. / B. Tech. (Mechanical / Auto / Manufacturing / Production / Industrial / Mechatronics / Metallurgy / Aerospace /Aeronautical / Material Science / Marine Engineering)
		M. Tech. (CAD/CAM)	
03	Polymer Engineering	M. Tech. (Polymer Technology)	B. E. / B. Tech. Mechanical / Production /Polymer Science or Engg or Tech / Rubber Tech / M.Sc (Polymer Sc./ Chemistry Appl. Chemistry)
04	Electrical and Electronics Engineering	M. Tech. (Power Systems Engg)	B.E / B.Tech (EEE / ECE / E&I / I&C / Electronics / Instrumentation)
		M. Tech. (Power Electronics & Drives)	B.E / B.Tech (EEE / ECE / E&I / I&C / Electronics / Instrumentation)
05	Electronics and Communication Engineering	M. Tech. (Communication Systems)	B.E / B.Tech (EEE/ ECE / E&I / I&C / Electronics / Instrumentation)
		M. Tech. (VLSI and Embedded Systems)	B.E. / B. Tech. (ECE / Electronics / E&I / I&C / EEE)
06	ECE Department jointly with Physics Dept.	M. Tech. (Optoelectronics and Laser Technology)	B.E. / B. Tech. (ECE / EEE / Electronics / EIE / ICE) M.Sc (Physics / Materials Science / Electronics / Photonics)
07	Electronics and Instrumentation Engineering	M. Tech. (Electronics and Instrumentation Engineering)	B.E. / B. Tech. (EIE / ICE / Electronics / ECE / EEE)

Sl. No.	Name of the Department	P.G. Programmes offered	Qualifications for admission
08	Computer Science and Engineering	M. Tech. (Computer Science and Engineering)	B.E. / B. Tech. (CSE / IT / ECE / EEE / EIE / ICE / Electronics / MCA)
		M. Tech. (Software Engineering)	B.E. / B. Tech. (CSE / IT) MCA
		M. Tech. (Network Security)	B.E. / B. Tech. (CSE / IT / ECE / EEE / EIE / ICE / Electronics / MCA)
		M. Tech. (Computer Science and Engineering with specialization in Big Data Analytics)	B.E. / B. Tech. (CSE / IT / ECE / EEE / EIE / ICE / Electronics / MCA)
09	Information Technology	M. Tech. (Information Technology)	B.E / B. Tech. (IT / CSE / ECE / EEE / EIE / ICE / Electronics) MCA
		M. Tech. (Information Security & Digital Forensics)	B.E / B. Tech. (IT / CSE / ECE / EEE / EIE / ICE / Electronics) MCA
10	Computer Applications	M.C.A.	Bachelor Degree in any discipline with Mathematics as one of the subjects (or) Mathematics at +2 level
		M.C.A. – (Lateral Entry)	B.Sc Computer Science / B.Sc Information Technology / B.C.A
		M. Tech. (Systems Engineering and Operations Research)	BE / B. Tech. (Any Branch) or M.Sc., (Maths / Physics / Statistics / CS / IT / SE) or M.C.A.
		M. Tech. (Data & Storage Management	BE / B. Tech. (Any Branch) or M.Sc., (Maths / Physics / Statistics / CS / IT / SE) or M.C.A.
11	Mathematics	M.Sc. (Actuarial Science)	Any Degree with Mathematics / Statistics as one of the subjects of study.
		M.Sc. Mathematics	B.Sc. (Mathematics)
12	Physics	M.Sc.(Physics)	B.Sc.(Physics / Applied Science / Electronics / Electronics Science / Electronics & Instrumentation)
		M.Sc. (Material Science)	B.Sc.(Physics / Applied Science / Electronics / Electronics

Sl. No.	Name of the Department	P.G. Programmes offered	Qualifications for admission
			Science / Electronics & Instrumentation)
13	Chemistry	M.Sc.(Chemistry)	B.Sc (Chemistry / Applied Science)
14	Life Sciences	M.Sc. Molecular Biology & Biochemistry	B.Sc. in any branch of Life Sciences
		M.Sc. Genetics	B.Sc. in any branch of Life Sciences
		M.Sc. Biotechnology	B.Sc. in any branch of Life Sciences
		M.Sc. Microbiology	B.Sc. in any branch of Life Sciences
		M.Sc. Bioscience	B.Sc. in any branch of Life Sciences
		M. Tech. Biotechnology	B. Tech. (Biotechnology / Chemical Engineering) / M.Sc. in any branch of Life Sciences

3.6 The curriculum of PG programmes shall be so designed that the minimum prescribed credits required for the award of the degree shall be within the limits specified below:

Programme	Minimum prescribed credits
M. Tech.	73
M.C.A.	120
M.Sc.	72

3.7 Credits will be assigned to the courses for all P.G. programmes as given below:

- One credit for one lecture period per week (or) 15 periods per semester
- One credit for one tutorial period per week
- One credit each for seminar/practical session/project of two or three periods per week
- One credit for two weeks of industrial internship
- One credit for 15 periods of lecture (can even be spread over a short span of time)

3.8 The number of credits registered by a student in non-project semester and project semester should be within the range specified below:

P.G. Programme	Full Time		Part Time	
	Non-project Semester	Project semester	Non-project Semester	Project semester
M. Tech.	9 to 28	12 to 28	6 to 12	12 to 28
M.C.A.	9 to 29	12 to 29	6 to 12	12 to 29
M.Sc.	9 to 25	12 to 20	6 to 12	12 to 20

3.9 The student may choose a course prescribed in the curriculum from any department depending on his / her convenient time slot. All attendance will be maintained course-wise only.

3.10 The electives from the curriculum are to be chosen with the approval of the Head of the Department.

3.11 A student may be permitted by the Head of the Department to choose electives from other PG programmes either within the Department or from other Departments up to a maximum of nine credits during the period of his/her study, with the approval of the Head of the Departments offering such courses.

3.12 To help the students to take up special research areas in their project work and to enable the department to introduce courses in latest/emerging areas in the curriculum, "Special Electives" may be offered. A student may be permitted to register for a "Special Elective" up to a maximum of three credits during the period of his/her study, provided the syllabus of this course is recommended by the Head of the Department and approved by the Chairman, Academic Council before the commencement of the semester, in which the special elective course is offered. Subsequently, such course shall be ratified by the Board of Studies and Academic Council.

3.13 The medium of instruction, examination, seminar and project/thesis/ dissertation reports will be English.

3.14 Industrial internship, if specified in the curriculum shall be of not less than two weeks duration and shall be organized by the Head of the Department.

3.15 Project Work / Thesis / Dissertation

3.15.1 Project work / Thesis / Dissertation shall be carried out under the supervision of a Faculty member in the concerned Department.

3.15.2 A student may however, in certain cases, be permitted to work for the project in an Industrial/Research Organization, on the recommendation of the Head of the Department. In such cases, the project work shall be jointly supervised by a faculty of the Department and an Engineer / Scientist from the organization and the student shall be instructed to meet the faculty periodically and to attend the review committee meetings for evaluating the progress.

3.15.3 Project work / Thesis / Dissertation (Phase - II in the case of M. Tech.) shall be pursued for a minimum of 16 weeks during the final semester, following the preliminary work carried out in Phase-1 during the previous semester.

3.15.4 The Project Report/Thesis / Dissertation report / Drawings prepared according to approved guidelines and duly signed by the supervisor(s) and the Head of the Department shall be submitted to the concerned department.

3.15.5 The deadline for submission of final Project Report / Thesis / Dissertation is within 30 calendar days from the last working day of the semester in which Project / Thesis / Dissertation is done.

3.15.6 If a student fails to submit the Project Report / Thesis / Dissertation on or before the specified deadline he / she is deemed to have not completed the Project Work / Thesis / dissertation and shall re-register the same in a subsequent semester.

4.0 CLASS ADVISOR AND FACULTY ADVISOR

4.1 Class Advisor

A faculty member will be nominated by the HOD as Class Advisor for the whole class.

He / she is responsible for maintaining the academic, curricular and co-curricular records of all students throughout their period of study.

4.2 Faculty Advisor

To help the students in planning their courses of study and for general counseling on the academic programme, the Head of the Department of the students will attach a certain number of 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 offer advice to the students on academic and personal matters and guide the students in taking up courses for registration and enrolment every semester.

5.0 CLASS COMMITTEE

5.1 Every class of the PG Programme will have a Class Committee constituted by the Head of the Department as follows:

i. Teachers of all courses of the programme

ii. One senior faculty preferably not offering courses for the class, as

Chairperson.

iii. Minimum two students of the class, nominated by the Head of the Department.

iv. Class Advisor / Faculty Advisor of the class - Ex-Officio Member

v. Professor in-charge of the PG Programme - Ex-Officio Member.

5.2 The Class Committee shall be constituted by the respective Head of the Department of the students.

5.3 The basic responsibilities of the Class Committee are to review periodically the progress of the classes to discuss problems concerning curriculum and syllabi and the conduct of classes. The type of assessment for the course will be decided by the teacher in consultation with the Class Committee and will be announced to the students at the beginning of the semester. Each Class Committee will communicate its recommendations to the Head of the Department and Dean (Academic Affairs). The class committee, **without the student members,** will also be responsible for finalization of the semester results and award of grades.

5.4 The Class Committee is required to meet at least thrice in a semester, first within a week of the commencement of the semester, second, after the first assessment and the third, after the semester-end examination to finalize the grades.

6.0 COURSE COMMITTEE

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).

7.0 REGISTRATION AND ENROLMENT

7.1 For the first semester every student has to register for the courses within one week from the commencement of the semester

7.2 For the subsequent semesters registration for the courses will be done by the student one week before the last working day of the previous semester. The curriculum gives details of the core and elective courses, project and seminar to be taken in different semester with the number of credits. The student should consult his/her Faculty Advisor for the choice of courses. The Registration form shall be filled in and signed by the student and the Faculty Advisor.

7.3 From the second semester onwards all students shall pay the prescribed fees and enroll on a specified day at the beginning of a semester.

7.4 A student will become eligible for enrolment only if he/she satisfies clause 9 and in addition he/she is not debarred from enrolment by a disciplinary action of the Institution. At the time of enrolment a student can drop a course registered earlier and also substitute it by another course for valid reasons with the consent of the Faculty Advisor. Late enrolment will be permitted on payment of a prescribed fine up to two weeks from the date of commencement of the semester.

7.5 Withdrawal from a course registered is permitted up to one week from the date of the completion of the first assessment test.

7.6 Change of a course within a period of 15 days from the commencement of the course, with the approval of Dean (Academic Affairs), on the recommendation of the HOD, is permitted.

7.7 Courses withdrawn will have to be taken when they are offered next if they belong to the list of core courses.

7.8 A student undergoing a full time PG Programme should have enrolled for all preceding semesters before registering for a particular semester

7.9 A student undergoing the P.G. programme in Part Time mode can choose not to register for any course in a particular semester with written approval from the head of the department. However the total duration for the completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 3.1)

8.0 TEMPORARY BREAK OF STUDY FROM THE 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. Such student has to rejoin only in the same semester from where he left. However the total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 3.1).

9.0 MINIMUM REQUIREMENTS TO REGISTER FOR PROJECT / THESIS / DISSERTATION

9.1 A student is permitted to register for project semester, if he/she has earned the minimum number of credits specified below:

Programme	Minimum No. of credits to be earned to enroll for project semester
M. Tech. (Full time / Part time)	18
M.C.A. (Full time / Part time)	45
M.C.A. (Full time / Part time) – (Lateral Entry)	22
M.Sc.(Full time / Part time)	18

9.2 If the student has not earned minimum number of credits specified, he/she has to earn the required credits, at least to the extent of minimum credits specified in clause 9.1 and then register for the project semester.

10.0 DISCIPLINE

10.1 Every student is required to observe discipline and decorous behavior both inside and outside the campus and not to indulge in any activity, which will tend to bring down the prestige of the Institution.

10.2 Any act of indiscipline of a student reported to the Head of the Institution will be referred to a Discipline and Welfare Committee for taking appropriate action.

11.0 ATTENDANCE

11.1 Attendance rules for all Full Time Programme and Part time Programmes are given in the following sub-clause.

11.2 Ideally every student is expected to attend all classes and earn 100% attendance in the contact periods of every course, subject to a maximum relaxation of 25% for genuine reasons like on medical grounds, representing the University 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. If the course is a core course, the student should register for and repeat the course when it is offered next. If the course is an elective, either he/she can register and repeat the same elective or can register for a new elective.

11.3 The students of Full Time mode of study, who have not attended a single hour in all courses in a semester and awarded 'I' grade are not permitted to write the examination and also not permitted move to next higher semester. Such students should repeat all the courses of the semester in the next Academic year.

12.0 SUMMER TERM COURSES

12.1 Summer term courses may be offered by a department on the recommendation of the Departmental Consultative Committee and approved by the Dean (Academic Affairs). No student should register for more than three courses during a summer term.

12.2 Summer term courses will be announced by the Head of the department at the end of the even semester before the commencement of the end semester examinations. A student will have to register within the time stipulated in the announcement. A student has to pay the fees as stipulated in the announcement.

12.3 The number of contact hours and the assessment procedure for any course during summer term will be the same as those during regular semesters.

Students with U grades will have the option either to write semester end arrears exam or to redo the courses during summer / regular semesters, if they wish to improve their continuous assessment marks subject to the approval of the Head of the department.

12.4 Withdrawal from a summer term course is not permitted. No substitute examination will be conducted for the summer term courses.

12.5 The summer term courses are not applicable for the students of Part Time mode.

13.0 ASSESSMENTS AND EXAMINATIONS

13.1 The following rule shall apply to all the PG programmes (M. Tech. / M.C.A. / M.Sc.)

For lecture-based courses, normally a minimum of two assessments will be made during the semester. The assessments may be combination of tests and assignments. The assessment procedure as decided in the Class Committee will be announced to the students right from the beginning of the semester by the course teacher.

13.2 There shall be one examination of three hours duration, at the end of the semester.

13.3 In one (or) two credit courses that are not spread over the entire semester, the evaluation will be conducted at the completion of the course itself. Anyhow approval for the same is to be obtained from the HoD and the Dean of Academic Affairs.

13.4 The evaluation of the Project work will be based on the project report and a Viva-Voce Examination by a team consisting of the supervisor concerned, an Internal Examiner and External Examiner to be appointed by the Controller of Examinations.

13.5 At the end of industrial internship, the student shall submit a certificate from the organization and also a brief report. The evaluation will be made based on this report and a Viva-Voce Examination, conducted internally by a Departmental Committee constituted by the Head of the Department.

14.0 WEIGHTAGES

14.1 The following shall be the weightages for different courses:

i) Lecture based course

Two continuous assessments	50%
Semester-end examination	50%

ii) Laboratory based courses

Laboratory work assessment	75%
Semester-end examination	25%

iii) Project work

Periodic reviews	50%
Evaluation of Project Report by External Examiner	20%
Viva-Voce Examination	30%

14.2 Appearing for semester end examination for each course (Theory and Practical) is mandatory and a student should secure a minimum of 40% marks in semester end examination for the successful completion of the course.

14.3 The markings for all tests, tutorial, assignments (if any), laboratory work and examinations will be on absolute basis. The final percentage of marks is calculated in each course as per the weightages given in clause 13.1.

15.0 SUBSTITUTE EXAMINATION

15.1 A student who has missed for genuine reasons any one of the three assessments including semester-end examination of a course may be permitted to write a substitute examination. However, permission to take up a substitute examination will be given under exceptional circumstances, such as accident or admissions to a hospital due to illness, etc.

15.2 A student who misses any assessment in a course shall apply in a prescribed form to the Dean (Academic Affairs) through the Head of the department within a week from the date of missed assessment. However the substitute tests and examination for a course will be conducted within two weeks after the last day of the semester-end examinations.

16.0 COURSEWISE GRADING OF STUDENTS AND LETTER GRADES

16.1 Based on the semester performance, each student is awarded a final letter grade at the end of the semester in each course. The letter grades and the corresponding grade points are as follows, but grading has to be relative grading

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

- Flexible range grading system will be adopted
- **“W”** denotes withdrawal from the course.
- **"I"** denotes inadequate attendance and hence prevention from semester-end examination
- **"U"** denotes unsuccessful performance in a course.
- **“AB”** denotes absent for the semester end examination

16.2 A student is considered to have completed a course successfully if he / she secure five grade points or higher. A letter grade ‘U’ in any course implies unsuccessful performance in that course.

16.3 A course successfully completed cannot be repeated for any reason.

17.0 AWARD OF LETTER GRADE

17.1 A final meeting of the Class Committee without the student member(s) will be convened within ten days after the last day of the semester end examination. The letter grades to be awarded to the students for different courses will be finalized at the meeting.

17.2 After finalization of the grades at the class committee meeting the Chairman will forward the results to the Controller of Examinations, with copies to Head of the Department and Dean (Academic Affairs).

18.0 DECLARATION OF RESULTS

18.1 After finalization by the Class Committee as per clause 16.1 the Letter grades awarded to the students in the each course shall be announced on the departmental notice board after duly approved by the Controller of Examinations.

18.2 In case any student feels aggrieved about the results, he/she can apply for revaluation after paying the prescribed fee for the purpose, within one week from the announcement of results.

A committee will be constituted by the concerned Head of the Department comprising of the Chairperson of the concerned Class Committee (Convener), the teacher concerned and a teacher of the department who is knowledgeable in the concerned course. If the Committee finds that the case is genuine, it may jointly revalue the answer script and forward the revised marks to the Controller of Examinations with full justification for the revision, if any.

18.3 The “U” and “AB” grade once awarded stays in the grade sheet of the students and is not deleted when he/she completes the course successfully later. The grade acquired by the student later will be indicated in the grade sheet of the appropriate semester.

19.0 COURSE REPETITION AND ARREARS EXAMINATION

19.1 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.

19.2 A student who is awarded “U” or “AB” grade in a course shall write the semester-end examination as arrear examination, at the end of the next semester, along with the regular examinations of next semester courses.

19.3 A student who is awarded “U” or “AB” grade in a course will have the option of either to write semester end arrear examination at the end of the subsequent semesters, or to redo the course whenever the course is offered. Marks earned during the redo period in the continuous assessment for the course, will be used for grading along with the marks earned in the end-semester (re-do) examination.

19.4 If any student obtained "U" or "AB" grade, the marks earned during the redo period for the continuous assessment for that course will be considered for further appearance as arrears.

19.5 If a student with "U" or "AB" grade 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.

20.0 GRADE SHEET

20.1 The grade sheet issued at the end of the semester to each student will contain the following:

(i) the credits for each course registered for that semester.

(ii) the performance in each course by the letter grade obtained.

(iii) the total credits earned in that semester.

(iv) the Grade Point Average (GPA) of all the courses registered for that semester and the Cumulative Grade Point Average (CGPA) of all the courses taken up to that semester.

20.2 The GPA will be calculated according to the formula

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

where n = number of courses

where C_i is the number of credits assigned for i^{th} course

GP_i - Grade point obtained in the i^{th} course

for the cumulative grade point average (CGPA) a similar formula is used except that the sum is over all the courses taken in all the semesters completed up to the point of time.

'I' and 'W' grades will be excluded for GPA calculations.

'U', 'AB' 'I' and 'W' grades will be excluded for CGPA calculations.

20.3 Classification of the award of degree will be as follows:

20.3.1 For students under full time mode of study

CGPA	Classification
8.50 and above, having completed all courses in first appearance	First class with Distinction
6.50 and above, having completed within a period of 2 semesters beyond the programme period	First Class
All others	Second Class

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 PG Programme within a minimum period covered by the minimum duration (clause 3.1) plus authorized break of study, if any (clause 8). To be eligible for First Class, a student should have passed the examination in all courses within the specified minimum number of semesters reckoned from his/her commencement of study plus two semesters. 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.

20.3.2 For students under part time mode of study

CGPA	Classification
8.50 and above, having completed all courses in first appearance	First class with Distinction
6.50 and above	First Class
All others	Second Class

For the purpose of classification, the CGPA will be rounded to two decimal places.

21.0 ELIGIBILITY FOR THE AWARD OF THE MASTERS DEGREE

21.1 A student shall be declared to be eligible for the award of the Masters Degree, if he/she has:

i) successfully acquired the required credits as specified in the Curriculum corresponding to his/her programme within the stipulated time,

ii) no disciplinary action is pending against him/her.

21.2 The award of the degree must be approved by the University.

22.0 POWER TO MODIFY

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

CURRICULUM & SYLLABI FOR
M. Tech (Power Systems Engineering)

CURRICULUM
(FOUR SEMESTERS / FULL TIME)

Sl. No.	Course Code	Course Title	L	T	P	C
		Semester I				
1	MAC6184	Probability, Matrix Theory and Linear Programming	**3**	**1**	**0**	**4**
2	EEC6101	System Theory	**3**	**0**	**0**	**3**
3	EEC6102	Advanced Power System Analysis	**3**	**1**	**0**	**4**
4	EEC6103	Power Distribution Systems	**3**	**0**	**0**	**3**
5	EEC6104	Power System Protection	**3**	**0**	**0**	**3**
6		Professional Elective#				**3#**
7	EEC6105	Power System Analysis & Protection Lab	**0**	**0**	**2**	**1**
8	EEC6106	Design / Simulation Project	**0**	**0**	**2**	**1**
		Total Credits				**22**

Minimum of 3 credits

Sl. No.	Course Code	Course Title	L	T	P	C
		Semester II				
1	EEC6211	Advanced Power system Operation and Control	**3**	**0**	**0**	**3**
2	EEC6212	Restructured Power Systems	**3**	**0**	**0**	**3**
3	CSB6101	Research Methodology for Engineers	**3**	**1**	**0**	**4**
4		Professional Elective##				**9##**
5	EEC6213	Power System Dynamics Control & Operation Laboratory	**0**	**0**	**2**	**1**
6	EEC6214	Self Learning	**0**	**2**	**0**	**2**
7	EEC6215	Industrial Internship	**0**	**0**	*****	******
		Total Credits				**22**

Minimum of 9 credits

* Minimum of 30 days Industrial Internship

** Industrial internship will be undertaken during first year summer vacation. The credit will be awarded in the 3rd semester.

Sl. No.	Course Code	Course Title	L	T	P	C
		Semester III				
1		General Elective #				**3#**
2		Professional Elective #				**3#**
2	EEC6215	Industrial Internship	**0**	**0**	*****	**2**
3	EEC7101	Project Phase I ##	**0**	**0**	**12**	**6##**
		Total Credits				**8**

* Minimum of 30 days Industrial Internship

Minimum of 3 credits

Sl. No.	Course Code	Course Title	L	T	P	C
		Semester IV				
1	EEC7101	Project Phase II##	**0**	**0**	**36**	**18##**
		Total Credits	**18+6 = 24**			

Credits for Project Work Phase I to be accounted along with Project Work Phase II in IV Semester.

Grand Total of Credits 76

PROFESSIONAL ELECTIVE

Sl. No.	Course Code	Course Title	L	T	P	C
1	EECY001	Electro Magnetic Field Computation and Modelling	3	0	0	3
2	EECY002	Power System Dynamics	3	0	0	3
3	EECY003	EHV Power Transmission	3	0	0	3
4	EECY004	Power Quality	3	0	0	3
5	EECY005	Power System Planning and Reliability	3	0	0	3
6	EECY006	Advanced Digital Signal Processing	3	0	0	3
7	EECY007	Control System Design	3	0	0	3
8	EECY008	High Voltage Switch Gear	3	0	0	3
9	EECY009	Optimal Control and Filtering	3	0	0	3
10	EECY010	Industrial Power System Analysis and Design	3	0	0	3
11	EECY011	High Voltage Direct Current Transmission	3	0	0	3
12	EECY012	Wind Energy Conversion Systems	3	0	0	3
13	EECY013	Application of MEMS Technology	3	0	0	3
14	EECY014	Outdoor Insulators	3	0	0	3
15	EECY015	Flexible AC Transmission Systems	3	0	0	3
16	EECY016	Electrical Transients in Power Systems	3	0	0	3
17	EECY017	High Voltage Pulse Generation, Measurement and Testing for Life Sciences	3	0	0	3
18	EECY018	Smart Power Grid	3	0	0	3
19	EECY019	Distributed Generation and Micro-grid	3	0	0	3
20	EECY020	Reactive Power Management in Power Systems	3	0	0	3
21	EECY021	State Estimation and Contingency Analysis in Smart-grid	3	0	0	3
22	EECY022	Power Electronics Applications to Power Systems	3	0	0	3
23	EECY043	SCADA and DCS	3	0	0	3
24	EECY047	Special Electrical Machines and Controllers	3	0	0	3
25	EECY049	Solar and Energy Storage System	3	0	0	3
26	EECY050	Fundamentals of Grid Connected Photo Voltaic Power Electronic Converter Design	3	0	0	3
27	EECY051	Solar Power System Design	3	0	0	3

Sl. No.	Course Code	Course Title	L	T	P	C
28	EEC6125	Modeling and Analysis of Electrical Machines	**3**	**0**	**0**	**3**
29	EEC6126	Advanced Power Semiconductor Devices	**3**	**0**	**0**	**3**
30	EEC6127	Analysis of Power converters	**3**	**0**	**0**	**3**
31	EEC6235	Solid State AC & DC Drives	**3**	**0**	**0**	**3**
32	EECY023	Electrical Insulation in Power Apparatus and Systems	**2**	**0**	**0**	**2**
33	EECY024	Energy Auditing	**2**	**0**	**0**	**2**
34	EECY025	Wide Area Measurement Systems	**2**	**0**	**0**	**2**
35	EECY026	Power System Simulation Software	**0**	**0**	**2**	**1**
36	EECY027	Simulation of Power Electronic Circuits	**0**	**0**	**2**	**1**
37	EECY028	Electric Vehicles	**1**	**0**	**0**	**1**

GENERAL ELECTIVES FOR M.TECH PROGRAMMES

Sl. No.	Course Code	Course Title	L	T	P	C
1	GECY101	Project Management	3	0	0	3
2	GECY102	Society, Technology & Sustainability	3	0	0	3
3	GECY103	Artificial Intelligence	3	0	0	3
4	GECY104	Green Computing	3	0	0	3
5	GECY105	Gaming Design	3	0	0	3
6	GECY106	Social Computing	3	0	0	3
7	GECY107	Soft Computing	3	0	0	3
8	GECY108	Embedded System Programming	3	0	0	3
9	GECY109	Principles of Sustainable Development	3	0	0	3
10	GECY110	Quantitative Techniques in Management	3	0	0	3
11	GECY111	Programming using MATLAB & SIMULINK	1	0	2	2
12	GECY112	JAVA Programming	1	0	2	2
13	GECY113	PYTHON Programming	1	0	2	2
14	GECY114	Intellectual Property Rights	1	0	0	1

SEMESTER I

MAC6184	**PROBABILITY, MATRIX THEORY AND LINEAR PROGRAMMING**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

OBJECTIVE:

The aim of this course is to

- provide a comprehensive introduction to the probability distributions used in engineering.
- familiarize students with advanced matrix theory and variation problems.
- expose the students to Operations Research using concepts of linear programming.

MODULE I PROBABILITY DISTRIBUTIONS 10

Axioms of probability – addition and multiplication theorem – conditional probability – total probability – random variables - moments – moments generating functions and their properties- Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

MODULE II TWO DIMENSIONAL RANDOM VARIABLES 08

Joint distributions - marginal and conditional distributions - functions of random variables - covariance - correlation and regression - Central limit theorem.

MODULE III ADVANCED MATRIX THEORY 09

Matrix norms - singular value decomposition - QR algorithm - pseudo inverse - least square approximations.

MODULE IV LINEAR PROGRAMMING 10

Formation - graphical method - simplex method - Big-M method - Two Phase method - transportation and assignment problems.

MODULE V CALCULUS OF VARIATIONS 08

Variation and its properties – Euler’s equation – functional dependant on first and higher order derivatives – functional dependant on functions of several independent variables – variational problems with moving boundaries – isoperimetric problems – Ritz and Kantorovich methods.

L – 45; T – 15; Total – 60

TEXT BOOKS:

1. S.M.Ross, “A First Course in Probability”, 9th edition, Pearson Education, 2013.
2. Lewis.D.W., “Matrix Theory”, Allied Publishers, Chennai, 1995.
3. Taha, H.A., “Operations Research - An Introduction ", 10th edition, Pearson Prentice Hall, 2016.
4. A.S. Gupta, “Calculus of variations with applications”, PHI Pvt. Ltd, New Delhi, 2011.

REFERENCES:

1. H. Cramer., “Random Variables and Probability Distributions”, Cambridge University Press (2004).
2. Roger A. Horn, Charles R. Johnson, “Matrix Analysis”, Cambridge University Press; 2nd edition (2012).
3. Robert.J.Vanderbei., “Linear Programming: Foundations and Extensions”, Springer US(2014).
4. David. J. Rader., “Deterministic Operations Research”, Wiley (2010).
5. Elsgolts, “Differential Equations and Calculus of Variations", University Press of the Pacific (2003).

OUTCOME:

At the end of the course students will be able to

- Solve problems using concept of standard, discrete and continuous distributions.
- Solve problems using one dimensional and two dimensional random variables.
- Find Eigen values and Eigen vectors of a higher order matrix.
- Solve problems of linear programming.
- Solve problems of calculus of variations by direct methods and using Euler’s formulae.

EEC6101 SYSTEM THEORY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To provide knowledge on state space approach, state feedback controllers and observers for different processes.
- To enhance knowledge on stability analysis of multivariable processes.
- To introduce nonlinear systems and its linearization methods.
- To evaluate Stability of Linear and Non Linear Systems.

MODULE I STATE SPACE APPROACH 08

Introduction to State Space Approach - System representation in state variable form – State transition equation – Methods of computing the state transition matrix.

MODULE II STATE FEEDBACK CONTROL AND STATE ESTIMATOR 08

Stability analysis - Controllability and Observability of linear time invariant systems - State Feedback – Output Feedback – Pole placement technique – Full order and Reduced Order Observers.

MODULE III STABILITY FOR LINEAR SYSTEMS 08

Introduction – Equilibrium points – Stability in the sense of Lyapunov - BIBO Stability – Stability of LTI systems – The direct method of Lyapunov and the Linear continuous time autonomous systems – Popov Stability Criterion.

MODULE IV NON-LINEAR SYSTEMS 06

Types of Non-Linearity – Typical Examples – Phase plane analysis (analytical and graphical methods) – Limit cycles – Equivalent Linearization.

MODULE V STABILITY FOR NON-LINEAR SYSTEMS 08

Equilibrium stability of non linear continuous time autonomous systems – Finding Lyapunov functions for nonlinear continuous time autonomous systems – Krasovskii and variable gradient method.

MODULE VI STABILITY FOR NON-LINEAR SYSTEMS USING DESCRIBING 07

Describing Function Analysis for Non Linear Systems, Describing Functions for different non-linear elements- backlash, deadzone, saturation and hysteresis.

Total Hours: 45

REFERENCES:

1. M.Gopal, "Modern Control System Theory", New Age International, 2005.
2. K.Ogata, "Modern Control Engineering", Prentice Hall of India, 2002.
3. John .S.Bay, "Fundamentals of Linear State Space Systems", Tata McGraw– Hill, 1999.
4. Z.Bubnicki, "Modern Control Theory", Springer, 2005.

OUTCOMES:

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

- Implement state space approach for the process and obtain the solution.
- Design state feedback controller and observers.
- Perform stability analyses of the system using conventional mathematical approach
- Ability to analyze complex systems using mathematical models.
- Ability to analyze the stability of Linear Systems using Lyapnov and Popov Stability Criterions
- Ability to analyze the stability of Non-Linear Systems using novel techniques.

EEC6102 ADVANCED POWER SYSTEM ANALYSIS

L	T	P	C
3	1	0	4

OBJECTIVES:

- To provide the student the knowledge to use efficient numerical techniques suitable for computer application which are required for planning and operation of power system.
- To provide the student the knowledge and computational skills required to model and analyze large-scale power system under normal and abnormal operating conditions.

MODULE I SPARSE MATRICES IN POWER SYSTEMS 08

Sparse Matrix techniques for large scale power systems: Optimal ordering schemes for preserving sparsity. Flexible packed storage scheme for storing matrix as compact arrays - Factorization by Bifactorization and Gauss elimination methods; Repeat solution using Left and Right factors and L and U matrices.

MODULE II POWER FLOW ANALYSIS 08

Power flow equation in real and polar forms; Review of Newton's method for solution; Adjustment of P-V buses; Review of Fast Decoupled Power Flow method; Sensitivity factors for P-V bus adjustment; DC Power Flow,; Net Interchange power control in Multi-area power flow analysis.

MODULE III OPTIMAL POWER FLOW 07

Problem statement; Solution of Optimal Power Flow (OPF) - The gradient method, Newton's method, Linear Sensitivity Analysis; LP methods - With real power variables only - LP method with AC power flow variables and detailed cost functions; Security constrained Optimal Power Flow; Interior point algorithm; Bus Incremental costs. DC Optimal Power Flow (DCOPF)

MODULE IV SHORT CIRCUIT ANALYSIS 08

Fault calculations using sequence networks for different types of faults. Bus impedance matrix (ZBUS) construction using Building Algorithm for lines with mutual coupling; Simple numerical problems. Computer method for fault analysis using ZBUS and sequence components. Derivation of equations for bus voltages, fault current and line currents, both in sequence and phase domain using Thevenin's equivalent and ZBUS matrix for different faults.

MODULE V CONTINGENCY ANALYSIS 07

Introduction and concept of linear sensitivity factors– Generation outage and line outage Sensitivity factors - Analysis of multiple contingencies - Contingency ranking methods – Numerical examples

MODULE VI STABILITY ANALYSIS 07

Introduction, Numerical Integration Methods: Euler and Fourth Order Runge-Kutta methods, Algorithm for simulation with classical synchronous machine model; Factors influencing transient stability, implicit Integration methods and numerical stability. Small Signal Stability – Eigen value and participation factors for SMIB systems

Total Hours: 60

REFERENCES:

1. G W Stagg, A.H El. Abiad, “Computer Methods in Power System Analysis”, McGraw Hill, 1968.
2. P.Kundur, “Power System Stability and Control”, McGraw Hill, 1994.
3. A.J.Wood and B.F.Wollenberg, “Power Generation Operation and Control”, John Wiley and sons, New York, 1996.
4. W.F.Tinney and W.S.Meyer, “Solution of Large Sparse System by Ordered Triangular Factorization”, IEEE Trans. on Automatic Control, Vol:18, pp:333-346, Aug 1973.
5. K.Zollenkopf, “Bi-Factorization: Basic Computational Algorithm and Programming Techniques; pp: 75-96; Book on “Large Sparse Set of Linear Systems” Editor: J.K.Rerd, Academic Press, 1971.
6. Mariesa L. Crow, “Computational Methods for Electric Power Systems’, Second Edition CRC Press, 2009.
7. John Grainger, William Stevenson Jr., ‘’Power System Analysis’’ First Edition, McGraw-Hill, 1994
8. L.P. Singh, “Advanced Power System: Analysis and Dynamics”, Sixth Revised Edition, New Age International Pvt. Ltd., 2014.

OUTCOMES:

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

- Use the right solution technique to handle the solution technique while encountering sparse matrices in power system analysis.
- Perform load flow study and interpret the result effectively for power system

operational problems.

- Suggest optimal settings for power system operation by performing optimal power flow analysis.
- Perform short circuit studies and interpret the result for designing the circuit breaker and protection system in long term planning problem.
- Assess the steady state security of the power system for different contingencies.
- Perform transient stability study and interpret the result effectively for long term planning problem.

EEC6103 POWER DISTRIBUTION SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To provide knowledge about basics of distribution systems
- To provide knowledge about distribution feeders and substations
- To provide knowledge about analysis of distribution system
- To understand the protection devices and practices followed in distribution system
- To understand the concepts of reactive power compensation and voltage control in distribution system.

MODULE I INTRODUCTION TO DISTRIBUTION SYSTEMS 08

General, 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 AND SUBSTATIONS 08

Design consideration of Distribution feeders: Radial and loop types of primary feeders- voltage levels- feeder loading. Design practice of the secondary distribution system-Location of Substations: Rating of a Distribution Substation service area with primary feeder - benefits derived through optimal location of substations.

MODULE III SYSTEM ANALYSIS 08

Voltage drop and power loss calculations : Derivation forvolt-drop and power loss in lines- manual methods of solution for radial networks - three-phase balanced primary lines- non-three-phase primary lines.

MODULE IV PROTECTIVE DEVICES AND COORDINATION 08

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 V CAPACITIVE COMPENSATION FOR POWER FACTOR CONTROL 08

Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and switched) - power factor correction, capacitor location. Economic justification - Procedure to determine the best capacitor location.

MODULE VI VOLTAGE CONTROL 05

Equipment for voltage control - effect of series capacitors - effect of AVR- line drop compensation.

Total Hours: 45

REFERENCES:

1. Turan Gonen, "Electric Power Distribution System Engineering", Mc.GrawHill Book Company, 1986.
2. A.S.Pabla, "Electric Power Distribution", Tata Mc Graw-Hill Publishing Company, 4th edition, 1997.
3. V.Kamaraju, "Electrical Power Distribution Systems", Tata Mc Graw Hill publication, 2009

OUTCOMES:

At the end of the course, the student is expected to achieve the following:

- Better understanding of basics of power distribution system
- Ability to design distribution feeders and substations
- Ability to perform voltage drop and power loss calculations
- Ability to do distribution system planning
- Ability to carry out reactive power compensation and voltage control in distribution system.
- Ability to perform fault calculations.

EEC6104 POWER SYSTEM PROTECTION

L	T	P	C
3	0	0	3

OBJECTIVES:

A protection scheme for Power System is designed to continuously monitor the Power System to ensure maximum continuity of Electrical Supply, with minimum damage to Life, Equipment and Property. Hence, the course on Power System Protection aims at the following:

- Fault Characteristics of individual Power System elements
- Tripping characteristics of various protective relays and matching them
- Various schemes of protection employed in Generator and Transformer protection
- Significance of Over Current Protective Schemes
- Relays used for protection of Transmission lines.
- Protection of bus bars.

MODULE I GENERATOR PROTECTION 05

Introduction to Equipment Protection - Electrical circuit of the generator -Various faults and abnormal operating conditions - Rotor faults -Abnormal operating conditions; Numerical examples for typical generator protection schemes

MODULE II TRANSFORMER PROTECTION 08

Types of transformers - Phasor diagram for a three Phase transformer -Equivalent circuit of transformer - Types of faults in transformers - Over current protection - Percentage Differential Protection of Transformers - Inrush phenomenon - High resistance Ground Faults in Transformers – Inter turn faults in transformers - Incipient faults in transformers - Phenomenon of overfluxing in transformers - Transformer protection application chart - Numerical examples for typical transformer protection schemes

MODULE III BUSBAR PROTECTION 08

Introduction – Differential protection of busbars - External and internal fault - Actual behaviors of a protective CT - Circuit model of a saturated CT - External fault with one CT saturated :need for high impedance Busbar protection – Minimum internal fault that can be detected – Stability ratio of high impedance busbar differential scheme - Supervisory relay - Protection of three Phase busbars - Numerical example on design of high impedance bus bar differential scheme.

MODULE IV OVER CURRENT PROTECTION 08

Time - Current characteristics - Current setting - Time setting - Over current protective schemes - Reverse power or directional relay - Protection of parallel feeders - Protection of ring feeders - Earth fault and phase fault protection - Combined Earth fault and phase fault protection scheme - Phase fault protective scheme - Directional earth fault relays.

MODULE V DISTANCE PROTECTION OF TRANSMISSION LINES 08

Drawbacks of over Current protection – Introduction to distance Protection – Simple impedance relay – Reactance relay – Mho relay - comparison between distances relays.

Need for carrier aided protection – Various options for a carrier – Coupling and trapping the carrier into the desired line section – Unit type carrier aided directional comparison relaying – Carrier aided distance schemes – Phase comparison relaying.

MODULE VI NUMERICAL PROTECTION 08

Introduction – Block diagram of numerical relay - Sampling theorem - Correlation with a reference wave - Digital filtering - Numerical over Current protection – Numerical transformer differential protection. Numerical distance protection of transmission line.

Case study of a simulation software for solving a protection problem.

Total Hours: 45

REFERENCES:

1. Y.G. Paithankar and S.R Bhide, “Fundamentals of Power System Protection”, Prentice-Hall of India, 2010
2. Badri Ram and D.N. Vishwakarma, “Power System Protection and Switchgear”, Tata McGraw- Hill Publishing Company, 2011
3. Bhavesh Bhalja, R. P. Maheswari and Nilesh Ghothani, “Protection and Switchgear,” Oxford University press, 2011
4. J. Lewis Blackburn and Thomas J. Domin “Protection Relaying: Principles and Applications”, CRC press, 2014

OUTCOMES:

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

- Fault Characteristics of Individual Power System elements.

- Various schemes employed in Generator and Transformer protection.
- Design of Busbar differential Scheme.
- Significance of Over Current Protective Schemes.
- Distance and Carrier Protection of Transmission lines.
- Numerical Protection.

		L	T	P	C
EEC6105	**POWER SYSTEM ANALYSIS & PROTECTION LABORATORY**	**0**	**0**	**2**	**1**

OBJECTIVES

- To study and develop programs for steady state analysis of Power systems.
- To study and develop programs for transient analysis of SMIB systems.
- To understand the operation of power system protection relays through simulation.
- To understand the effects of energization of transmission lines and starting of induction motor on power systems.
- To get familiarized with both proprietary and open source power system simulation software such as MATLAB, Octave, Scilab, ETAP, PSCAD, CYME and OpenDSS.

LIST OF EXERCISES

1. Sparse matrix techniques and optimal ordering schemes using C.
2. Development of load flow analysis program by Newton-Raphson method using MATLAB
3. Development of transient stability program for single machine-infinite bus system using classical machine model using MATLAB.
4. Contingency analysis: Calculation of Generator shift factors and line outage distribution factors using MATLAB.
5. Development of Load flow analysis program by FDPF method using GNU OCTAVE.
6. Development of small signal stability program for single machine infinite bus system using classical machine model using Scilab.
7. Co-ordination of over-current and distance relays for radial line protection using ETAP.
8. Simulation of digital differential relay protection using MATLAB Simulink.
9. Analysis of switching surge using PSCAD/EMTDC: Energization of a long distributed parameter line.
10. Induction motor starting analysis using CYME.
11. Modeling of smart distribution networks using OpenDSS.

Total Hours: 30

COURSE OUTCOMES

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

- Handle sparse matrices effectively, while they are encountered in power system programming.
- Develop programs for power system steady state analysis using MATLAB / Octave / Scilab.
- Develop programs for transient simulation of SMIB systems.
- Model over-current, distance and differential relays in simulation software ETAP/Simulink.
- Simulate energization of transmission lines and perform induction motor starting analysis using power system simulation software PSCAD/CYME.
- Model distribution networks using the open source software Open DSS.

EEC6106 DESIGN / SIMULATION PROJECT

L	T	P	C
0	0	2	1

OBJECTIVE:

- To identify the problems existing in power sector and expose the students to the available tools and methodologies for solving a power system problem.

COURSE DESCRIPTION:

Design / Simulation project shall be carried out by each and every individual student under the supervision of a faculty of this department. The student shall meet the faculty periodically and attend the periodic reviews for evaluating the progress. There will be two reviews for continuous assessment and one final review and viva voce at the end of the semester. A report prepared according to approved guidelines and duly signed by the supervisor(s) and the Head of the Department shall be submitted to the course teacher.

Design / Simulation project may be chosen from, but not limited to, the following areas:

1) Distribution system optimization, planning and reliability
2) Flexible AC Transmission Systems
3) Forecasting and Management
4) Generation systems
5) Modeling and simulation
6) Power quality
7) Power system restructuring
8) Power systems protection
9) Smart grid technologies and applications
10) Renewable energy sources and technology
11) Distributed generation and micro grid
12) Power system dynamics and control
13) High voltage engineering
14) HVAC/DC and EHV transmission
15) Reactive power management
16) Micrigrid

Total Hours: 30

OUTCOMES:

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

- Identify a problem existing in the power industry.
- Obtain the mathematical model a power system or components of a power system under study.
- Analyze a problem analytically & practically and to suggest a viable solution.
- Use appropriate software tools for simulation and analysis.
- Critically evaluate and improve a published work.
- Effectively communicate the findings.

SEMESTER II

EEC6211	ADVANCED POWER SYSTEM OPERATION AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To get an overview of system operation and control
- To become familiar with the preparatory work necessary for meeting the next day's operation such as load forecasting, unit commitment and generation scheduling.
- To review the basics of AGC and also study about the security of power systems.
- To understand the concepts of hydro thermal scheduling, SCADA and state estimation

MODULE I LOAD FORECASTING 08

Introduction – Estimation of Average and trend terms – Estimation of periodic components – Estimation of Stochastic components: Time series approach – Auto-Regressive Model, Auto-Regressive Moving – Average Models – Kalman Filtering Approach – On-line techniques for non stationary load prediction.

MODULE II UNIT COMMITMENT 07

Constraints in unit commitment – Spinning reserve – Thermal unit constraints – Other constraints – Solution using Priority List method, Dynamic programming method - Forward DP approach Lagrangian relaxation method – adjusting.

MODULE III GENERATION SCHEDULING 08

The Economic dispatch problem – Thermal system dispatching with network losses considered – The Lambda – iteration method – Gradient method of economic dispatch – Economic dispatch with Piecewise Linear cost functions – Transmission system effects – A two generator system – coordination equations – Incremental losses and penalty factors.

MODULE IV HYDROTHERMAL CO-ORDINATION 08

Introduction- Hydro electric plant models-Scheduling Problems-Short term hydro thermal scheduling problem-Gradient approach-Hydro units in series(Hydraulically coupled)-Pumped storage hydro scheduling with a iteration method – Pumped storage hydro scheduling by a gradient method-Dynamic programming solution to hydro thermal scheduling problem.

MODULE V CONTROL OF POWER SYSTEMS 07

Review of AGC and reactive power control -System operating states by security control functions – Monitoring, evaluation of system state by contingency analysis – Corrective controls (Preventive, emergency and restorative) - Energy control center – SCADA system – Functions – monitoring, Data acquisition and controls – EMS system.

MODULE VI STATE ESTIMATION 07

Maximum likelihood Weighted Least Squares Estimation: - Concepts - Matrix formulation - Example for Weighted Least Squares state estimation; State estimation of an AC network: development of method – Typical results of state estimation on an AC network – State Estimation by Orthogonal Decomposition algorithm.

Total Hours: 45

REFERENCES:

1. O.I.Elgerd, "Electric Energy System Theory - an Introduction", - Tata McGraw Hill, New Delhi, 2002.
2. P.Kundur; "Power System Stability and Control", EPRI Publications, California, 1994.
3. Allen J.Wood and Bruce. F.Wollenberg, "Power Generation Operation and Control', John Wiley & Sons, New York, 1996.
4. A.K.Mahalanabis, D.P.Kothari. and S.I.Ahson., "Computer Aided Power System Analysis and Control", Tata McGraw Hill publishing Ltd, 1984.

OUTCOMES:

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

- Ability to do optimal generation scheduling with and without transmission loss
- Ability to carry out real time unit commitment problem.
- Ability to carry out load forecasting using different techniques
- Better understanding of Automatic Generation Control and security of power systems
- Ability to carry out Hydro thermal co-ordination and state estimation.
- Better understanding of SCADA and Energy Management System

EEC6212 RESTRUCTURED POWER SYSTEMS

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.

MODULE I OVERVIEW OF POWER SYSTEM RESTRUCTURING 08

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 - Stranded costs - Transmission Pricing: Contract Path Method, The MW-Mile Method - Congestion Pricing: Congestion Pricing Methods, Transmission Rights - Management of Inter-Zonal/Intra Zonal Congestion: Solution procedure, Formulation of Inter-Zonal Congestion Sub problem, Formulation of Intra- Zonal Congestion Sub problem.

MODULE II ELECTRIC UTILITY MARKETS IN THE UNITED STATES 08

California Markets: ISO, Generation, Power Exchange, Scheduling Coordinator, UDCs, Retailers and Customers, Day-ahead and Hour-Ahead Markets, Block forwards Market, Transmission Congestion Contracts(TCCs) - New York Market: Market operations - PJM interconnection - Ercot ISO - New England ISO - Midwest ISO: MISO's Functions, Transmission

Management, Transmission System Security, Congestion Management, Ancillary Services Coordination, Maintenance Schedule Coordination - Summary of functions of U.S. ISOs.

MODULE III OASIS: OPEN ACCESS SAME-TIME INFORMATION SYSTEM 08

FERC order 889 - Structure of OASIS: Functionality and Architecture of OASIS Types of information available on OASIS, Information requirement of OASIS, Users of OASIS - Transfer Capability on OASIS: Definitions, Transfer Capability Issues, ATC Calculation, TTC Calculation, TRM Calculation, CBM Calculation - Transmission Services - Methodologies to Calculate ATC - Experiences with OASIS in some Restructuring Models: PJM OASIS, ERCOT OASIS

MODULE IV ELECTRIC ENERGY TRADING 08

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 - Port Folio Management: Effect of Positions on Risk Management - Energy Trading Hubs - Brokers in Electricity Trading – Green Power Trading.

MODULE V SPECIAL COMPUTATIONAL TECHNIQUES 08

Formulation of D.C. Optimal Power Flow (DCOPF) model for- Assessment of Available Transfer Capability (ATC)- Assessment of Simultaneous ATC (SATC)- Congestion Management.-Solution of the above problems using the LP technique-Numerical examples for the above problems.

MODULE VI FREQUENCY RELATED ANCILLARY SERVICES AND ITS MARKET MODELS 05

General Configuration of AGC in a Deregulated Environment - Disco Participation Matrix- State Space Characterization of the Two-Area System in Deregulation - Market Models for Frequency related Ancillary Services - Regulation - Load following - frequency based pricing - Unsheduled Interchange - ABT .

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.
8. Rajesh Joseph Abraham, Automatic Generation Control : Traditional and Deregulated Environments”, LAP Lambert Academic Publishing (1 September 2010).

OUTCOMES:

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

- 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.
- Carry out the various transformation process required for converting our present Indian power system into a restructured power system with competitive energy trading.

		L	T	P	C
CSB6101	**RESEARCH METHODOLOGY FOR ENGINEERS**	**3**	**1**	**0**	**4**

OBJECTIVES:

- To make the students well versed in statistical methods used in engineering.
- To describe the steps involved in research process.
- To explain how to formalize research problems.
- To discuss clearly the approaches for research through some case studies.

MODULE I RESEARCH PROBLEM 08

The research problem – Sources of research problem – Information, how to deal with it – Criteria / characteristics of a good research problem – Errors in selecting a good research problem – Types of research – Nature and use of arguments.

MODULE II ANALYSIS OF VARIANCE 07

Anova – one way – two way classification – Collection of Secondary Latin square design – 2^2 factorial design.

MODULE III DESIGN OF EXPERIMENTS 08

Experimental factors – interaction of factors, Types of experimental design – blocking design – factorial – fractional factorial, Taguchi's orthogonal approach.

MODULE IV REGRESSION, CORRELETION AND CURVE FITTING 10

Regression analysis – simple linear regression – regression coefficient, multiple regression – multiple & partial correlation coefficient, curve fitting – graphical – least square – method testing of goodness of fit.

MODULE V TRANSPORTATION AND ASSIGMENT MODELS 06

Transportation Problem – Assignment Problem – Travelling Sales man. Problem.

MODULE VI CASE STUDIES 06

Presentation by students on their area of research.

Total Hours: 60

REFERENCES:

1. Kothari, C.R., “Research Methodology: Methods and Techniques”, 2nd Edition, New Age International, New Delhi, 2012.
2. Nicholas Walliman, “Your Research Project”, 2nd Edition, Vistaar Publication, New Delhi, 2005.
3. Taha H.A., “Operations Research: An Introduction”, 7th Edition, Pearson Education Edition, Asia, New Delhi, 2002.
4. Richard A. Johnson, “Miller and Freund’s Probability and Statistics for Engineers”, 8th Edition, Pearson Education, Asia, 2011.

OUTCOMES:

Students who complete this course will be able to

- Identify the research problem.
- Become capable of analyzing the data using mathematical techniques.
- Learn to apply the statistical concepts in research.
- Demonstrate the different research methods applicable to a specific problem.

EEC6213	POWER SYSTEM DYNAMICS, CONTROL AND OPERATION LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES

- To model and analyze multi-machine power systems for small signal and transient stability.
- To incorporate models of FACTS devices in the steady state and dynamic analysis of power systems and understand their effects.
- To understand effects of wind energy conversion system in the transient stability of power systems.
- To understand the operation of Automatic Generation Control (AGC) in deregulated environment.
- To study and develop programmes for economic operation of the power systems.
- To develop programs for computation ATC and congestion management in deregulated environment
- To expose the students to simulation software such as Xcos, PSPICE, EUROSTAG and PSAT.

LIST OF EXERCISES

1. Economic Dispatch with line flow constraints using MATLAB.
2. Unit commitment: Dynamic programming using MATLAB.
3. Development of small signal stability program for multi machine power system using classical machine model using MATLAB.
4. Load flow analysis of two-bus system with STATCOM using MATLAB.
5. Small signal stability enhancement with TCSC in a SMIB system using MATLAB.
6. Simulation of Automatic Generation Control (AGC) in a multi-area deregulated power system using Scilab / Xcos.
7. Available Transfer Capability (ATC) calculation and congestion management by DCOPF method using GNU OCTAVE.
8. Transient stability analysis of power system with doubly fed induction generator using EUROSTAG.
9. Computation of harmonic indices generated by a rectifier feeding an R-L load using PSPICE
10. Transient analysis of single machine infinite bus system with STATCOM using MATLAB SIMULINK.
11. Transient stability analysis of multi-machine power system using PSAT.

Total Hours: 30

OUTCOMES

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

- Develop programs for small signal stability analysis of multi-machine systems.
- Prepare data and simulate multi-machines systems for transient stability.
- Incorporate models of FACTS devices in the dynamic simulations and steady state analysis of power systems.
- Use the software EUROSTAG for transient simulation of power systems with induction generators.
- Develop programs for unit commitment, economic dispatch for the economic operation of power systems, congestion management and automatic generation control in deregulated environment
- Simulate power electronic circuits using PSPICE and measure the harmonics generated by non-linear loads.

EEC6214 SELF LEARNING

L	T	P	C
0	2	0	2

OBJECTIVE:

- To provide fundamental and advanced knowledge in the area of final year project work the student intends to do.

COURSE DESCRIPTION:

A student is expected to do the self learning course on his own, relating to the area of Project work. For discussion and interaction with the project supervisor, two hours per week is allocated. The course content and the materials for self learning course shall be decided by the student and the respective supervisor and the same will be approved by the Head of the Department. A broader choice will be given to the student so that a student is permitted to choose a course in the areas of his/her interest.

OUTCOMES:

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

- Narrow down the area of project work to focus on specific topic.
- Acquire sufficient fundamental and advanced knowledge to carry out the project work.

EEC 6125 INDUSTRIAL INTERNSHIP

L	T	P	C
0	0	*	**

* Minimum of 30 days Industrial Internship.

** Industrial internship will be undertaken during first year summer vacation. Two credits will be awarded in the 3rd semester.

OBJECTIVE:

- To provide fundamental and advanced knowledge in the area of final year project work the student intends to do.

COURSE DESCRIPTION:

1. To earn credits for this course, a minimum 30 days of industrial training, in a single slot, is mandatory. The course has to be undertaken during the first year summer vacation and the credits will be awarded in the third semester.
2. If the student is not able to complete the internship during the first year summer vacation, he/she can complete the course in a single slot between 2th and 4th semester vacation.
3. For effective implementation of the course Industry Internship, a teaching faculty is appointed as the coordinator by the Head of the department.
4. The students of EEE will be allowed to undergo training only in reputed companies/research labs/design centres. The co-ordinator identifies the companies related to core engineering for internship during second semester. He/she assists the students in every process of getting into the companies as an intern.
5. To enable the students to focus on the internship, no two students are allowed to be in the same site.
6. Interacting with the respective industries, where the students do their internship, the Coordinator continuously monitors the performance of the students during the internship.
7. After completion of the internship, the students are required to submit a detailed report and present what they had learned through the internship, in the form of posters. The students should submit the industry certificate at the time of giving the presentation.
8. The performance of the student will be evaluated by the industry as well as the University. Both the evaluations will be considered and aggregated to award the final grade. 50% weightage is given to the evaluation by the industry and remaining 50% weightage to the evaluation by the committee appointed by the Head of the Department.

9. The 50 % weightage of evaluation done at the department comprises of (a) 20/50 for viva-voce, (b) 20/50 for the Intern report and (c) 10 /50 for poster presentation.

OUTCOMES:

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

- Solve problems typically encountered by engineers in industry.
- Identify and address social, economic, and safety issues in an engineering problem and develop a solution that addresses this.
- Learn new concepts and apply them to the solution of engineering problems.
- Function effectively on a multidisciplinary team and interface effectively with other areas of the organization.
- Clearly communicate their ideas orally and in writing.
- Prepare for a lifelong productive career as an engineer.

SEMESTER III

		L	T	P	C
EEC7101	**PROJECT WORK**				
	PHASE – I (SEMESTER III)	**0**	**0**	**12**	**6***
	PHASE – II (SEMESTER IV)	**0**	**0**	**36**	**18+6***

* Credits for Project work (Phase-I) of third semester will be accounted along with Project work (Phase-II) of fourth semester

OBJECTIVES:

- To enable a student to do an individual project work which may involve design, modelling, simulation and/or fabrication.
- To analyze a problem both theoretically and practically.
- To motivate the students to involve in research activities leading to innovative solutions for industrial and societal problems.

COURSE DESCRIPTION:

Project work shall be carried out by each and every individual student under the supervision of a faculty of this department. A student may however, in certain cases, be permitted to work for the project in association with other departments or in an Industrial/Research Organization, on the recommendation of the Head of the Department. In such cases, the project work shall be jointly supervised by a faculty of the Department and the faculty of the other department of the University or an Engineer / Scientist from the organization. The student shall meet the faculty periodically and attend the periodic reviews for evaluating the progress.

Project work will be carried out in two phases, Phase-I during the pre-final semester and Phase-2 during the final semester. Phase-I shall be pursued for a minimum of 12 periods per week and Phase – II in 36 periods per week. Credits for Phase I will be accounted along with Phase II in the final semester.

In each phase, there will be three reviews for continuous assessment and one final review and viva voce at the end of the semesters. The Project Report prepared according to approved guidelines and duly signed by the supervisor(s) and the Head of the Department shall be submitted to the concerned department.

OUTCOMES:

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

- Comprehend a problem thoroughly and provide an appropriate solution.
- Do a systematic literature survey.
- Derive a mathematical model for the system under study.
- Get proficiency over the software used for simulation and analysis.
- Present the findings of a research work in conferences and publish in journals.
- Identify and provide solution for the industrial and societal problems.

PROFESSIONAL ELECTIVES

EECY001	**ELECTROMAGNETIC FIELD COMPUTATION AND MODELLING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To impart knowledge on Finite Element Analysis (FEA) of Electric machines and systems.
- To impart knowledge on mathematics of FEA.
- To impart knowledge on FEA software package.

MODULE I INTRODUCTION 06

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 09

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 09

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 07

Computation of electric and magnetic field intensities– Capacitance and Inductance – Force, Torque, Energy for basic configurations.

MODULE V BASIC EXERCISES IN FEA PACKAGES 06

Modeling – Pre-processing – A vector and flux plot calculations – deriving Other quantities in Post-processing.

MODULE VI DESIGN APPLICATIONS 08

Insulators- Bushings – Cylindrical magnetic actuators – Transformers – Rotating machines.

Total Hours: 45

REFERENCES:

1. Silvester and Ferrari, "Finite Elements for Electrical Engineers",Cambridge University press, 1983.
2. K.J.Binns, P.J.Lawrenson, C.W Trowbridge, "The analytical and numerical solution of Electric and magnetic fields", John Wiley & Sons, 1993.
3. Nathan Ida, Joao P.A.Bastos , "Electromagnetics and calculation of fields", Springer-Verlage, 1992.
4. Nicola Biyanchi , "Electrical Machine analysis using Finite Elements", Taylor and Francis Group, CRC Publishers, 2005.
5. S.J Salon, "Finite Element Analysis of Electrical Machines." ,Kluwer Academic Publishers, London, distributed by TBH Publishers & Distributors, Chennai, India, 1995.
6. User manuals of MAGNET, MAXWELL & ANSYS software.

OUTCOMES:

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

- Ability to find solutions for field equations
- Ability to perform field computation for basic configurations
- Ability to model and analyze electrical system through Finite Element techniques.
- Ability to analyze pre-processing and post processing in FEA packages
- Ability to design applications.

EECY002 POWER SYSTEM DYNAMICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To model and analyze the dynamics of power system with its synchronous machines, turbines and various controllers when subjected to small signal and large signal disturbances.
- To model and analyze SMIB for small-signal stability and transient stability with controllers.
- To assess power system stability in large-signal, small-signal sense and to design the system with enhanced stability.

MODULE I INTRODUCTION TO POWER SYSTEM STABILITY 03

Power system stability: Basic Concepts and Definitions - Classification of Power system Stability –Rotor angle stability-Voltage stability and Voltage collapse- Mid term and long term stability-Historical review of stability problem.

MODULE II SYNCHRONOUS MACHINE MODELLING 09

Schematic Diagram, Physical Description: armature and field structure, machines with multiple pole pairs, mmf waveforms, direct and quadrature axes, Mathematical Description of a Synchronous Machine: Basic equations of a synchronous machine: stator circuit equations, stator self, stator mutual and stator to rotor mutual inductances, dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates, electrical power and torque, physical interpretation of dq0 transformation, Per Unit Representations: Lad-reciprocal per unit system and that from power-invariant form of Park's transformation; Equivalent Circuits for direct and quadrature axes, Steady state Analysis: Voltage, current and flux-linkage relationships, Phasor representation, Rotor angle, Steady-state equivalent circuit, Computation of steady-state values, Equations of Motion: Swing Equation, calculation of inertia constant, Representation in system studies, Synchronous Machine Representation in Stability Studies: Simplifications for large-scale studies : Neglect of stator terms and speed variations, Simplified model with amortisseurs neglected: two-axis model with amortisseur windings neglected, classical model.

MODULE III MODELLING OF EXCITATION AND SPEED GOVERNING SYSTEMS 09

Excitation System Requirements; Elements of an Excitation System; Types of Excitation System; Control and protective functions; IEEE (1992) block diagram for simulation of excitation systems. Turbine and Governing System Modeling: Functional Block Diagram of Power Generation and Control, Schematic of a hydroelectric plant, classical transfer function of a hydraulic turbine (no derivation), special characteristic of hydraulic turbine, electrical analogue of hydraulic turbine, Governor for Hydraulic Turbine: Requirement for a transient droop, Block diagram of governor with transient droop compensation, Steam turbine modeling: Single reheat tandem compounded type only and IEEE block diagram for dynamic simulation; generic speed governing system model for normal speed/load control function.

MODULE IV SMALL-SIGNAL STABILITY ANALYSIS WITHOUT CONTROLLERS 08

Rotor angle stability, The Stability Phenomena. Fundamental Concepts of Stability of Dynamic Systems: State-space representation, stability of dynamic system, Linearization, Eigen properties of the state matrix: Eigen values and eigenvectors, modal matrices, Eigen value and stability, mode shape and participation factor. Single-Machine Infinite Bus (SMIB) Configuration: Classical Machine Model stability analysis with numerical example, Effects of Field Circuit Dynamics: synchronous machine, network and linearised system equations, block diagram representation with K-constants; expression for K-constants (no derivation), effect of field flux variation on system stability: analysis with numerical example - Enhancement Of Small Signal Stability and its countermeasures.

MODULE V TRANSIENT STABILITY ANALYSIS 08

Review of numerical integration methods: Euler and Fourth Order Runge Kutta methods, Numerical stability and implicit methods, Simulation of Power System Dynamic response: Structure of Power system Model, Synchronous machine representation: equations of motion, rotor circuit equations, stator voltage equations, Thevenin's and Norton's equivalent circuits, Excitation system representation, Transmission network and load representation, Overall system equations and their solution: Partitioned - Explicit and Simultaneous implicit approaches, treatment of discontinuities, Simplified Transient Stability Simulation using implicit integration method.

MODULE VI VOLTAGE STABILITY ANALYSIS 08

Voltage and frequency controllers - Limiting devices affecting voltage stability - Voltage-reactive power characteristics of synchronous generators - Capability curves - Effect of machine limitation on deliverable power - Load Aspects - Voltage dependence of loads - Load restoration dynamics.

Total Hours: 45

REFERENCES:

1. P. Kundur, “Power System Stability and Control”, McGraw-Hill, 1993.
2. P.M Anderson and A.A Fouad, “Power System Control and Stability”, Iowa State University Press, Ames, Iowa, 1978.
3. IEEE Committee Report, “Dynamic Models for Steam and Hydro Turbines in Power System Studies”, IEEE Trans., Vol.PAS-92, pp:1904-1915, November/ December, 1973. on Turbine- Governor Model.
4. 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:

- detailed model of the electrical and mechanical parts of a three phase synchronous machine, excitation system and turbine 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.
- familiarize with different type of numerical integration algorithms used for transient stability analysis of power systems.
- mathematically model the electromechanical dynamics of a power system, to determine the transient stability limits under fault conditions.
- determine how the voltage profile across a large power network can be controlled to maintain voltage within stipulated limits throughout the network.
- assess power system stability and to design the system with enhanced stability.

EECY003 EHV POWER TRANSMISSION

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the need for long EHV & UHV transmission lines.
- To study calculation procedures to obtain line parameters, conductor voltage gradients and electric field produced in the vicinity of the line
- To study about the audible noise and radio interference caused by corona and methods to regulate them.

MODULE I INTRODUCTION 08

Indian Power Scenario - Power Scenario in Tamil Nadu - Conventional and non conventional methods of power generation details in India - Choice of economic voltage - standard transmission voltages - problems with long EHVAC lines - need for compensation - FACTS devices - HVDC transmission.

MODULE II LINE PARAMETERS 08

Types of conductors - bundled conductors - various line configurations of EHVAC lines - line resistance - Maxwell’s potential coefficient matrix - Inductance and capacitance matrices of multi conductor untransposed / transposed lines - sequence inductances and capacitances - line parameters for modes of propagation in case of travelling wave propagation.

MODULE III LINE LOADINGS 08

Temperature rise of line conductors and current carrying capacity of lines - surge impedance loading - Power handling capacity of long lines - EHVAC and HVDC alternatives - Line loss - mechanical vibrations / oscillations of line conductors and their reduction.

MODULE IV VOLTAGE GRADIENT ON CONDUCTORS 06

Charge - potential relations for multi conductor lines - surface voltage gradients of bundled conductors - gradients factors and their use - distribution of voltage gradient on sub conductors of bundle - voltage gradients on conductors in the presence of ground wires on towers.

MODULE V EFFECTS OF CORONA 08

Corona Power loss and its comparison with leakage loss and line I^2R Loss - Audible noise generation and its characteristics - limits for audible noise - Day - Night equivalent noise level - Radio Interference (RI) due to corona pulse generation and its properties - limits on RI fields.

MODULE VI EFFECT OF ELECTRIC FIELD PRODUCED BY EHV LINES 07

Effects of EHV lines on heavy vehicles - calculation of electric field of EHVAC lines - Effect of high fields on humans, animals and plants - measurement of electric fields - Induced voltages in unenergised circuit of a double circuit line - induced voltages in insulated ground wires - electromagnetic interference.

Total Hours: 45

REFERENCES:

1. Rakosh Das Begamudre, “Extra High Voltage AC Transmission engineering”, Second Edition, New Age International Pvt. Ltd, 2011.
2. Power engineer’s Hand book, Revised and Enlarged 6th Edition, TNEB Engineer’s Association, October 2002.
3. Microtran Power system Analysis Corporation, Microtran Reference Manual Vancouver Canada, (Website: www.microtran.com)

OUTCOMES:

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

- Possess data about power scenario of India and major countries of the world, history of growth of electrical industry and its latest development.
- Ability to obtain line parameters for analysis with symmetrical and unsymmetrical power frequency operation and modes of operation with travelling wave propagation.
- Ability to obtain power carrying capacity of EHVAC and HVDC lines of various lengths.
- Work out voltage gradients od EHVAC and HVDC lines with bundled conductors analytically and by using pre-calculated charts.
- Ability to recognize the occurrence of corona and regulate its effects in the form of audible and radio noises.
- Calculate the voltage induced in neighboring lines and the electric fields produced by the EHVAC / HVDC lines and its effects on human beings , animals and plants.

EECY004 POWER QUALITY

L	T	P	C
3	0	0	3

OBJECTIVES:

- The main objective of the course is to enhance the knowledge of the participants in the emerging area of power quality and several key issues related to its modeling, assessment and mitigation.
- The course will provide a platform to an in-depth discussion on the various challenges and their possible remedies with respect to maintaining power quality in electricity sector, which will benefit participants from academic and R & D institutions, professional engineers from utilities, industries and policy makers

MODULE I INTRODUCTION 06

Power Quality – Significance of power quality, Terms and Definitions (IEC Standards) – Transients, Voltage Imbalance, Waveform distortion, Power frequency variations, DC offset, Electric Noise, Voltage Fluctuation and Flicker
Sources of Sags and Interruptions, Estimating Voltage Sag Performance - Solutions at the End-User Level.

MODULE II DISCRETE FREQUENCY DOMAIN ANALYSIS 08

Harmonics versus Transients -Harmonic Indexes -Harmonic Sources from Commercial Loads -Harmonic Sources from Industrial Loads - Time domain methods and Frequency domain methods: Laplace's, Fourier and Hartley transform – The Walsh Transform – Wavelet Transform- Harmonic Distortion - Voltage versus Current Distortion - Locating Harmonic Sources -System Response Characteristics -Effects of Harmonic

MODULE III FUNDAMENTALS OF HARMONICS 07

Harmonic Distortion Evaluations – End users, utility -Principles for Controlling Harmonics- Where to Control Harmonics - Harmonic Studies – Computer tools for harmonic analysis- Harmonic analyzer - Devices for Controlling Harmonic Distortion -Harmonic Filter Design

MODULE IV DISTRIBUTED GENERATION AND POWER QUALITY 08

Resurgence of DG-DG Technologies – Interfacing DG to the Utility System -Power Quality Issues - Operating Conflicts - DG on Distribution Networks - Sitting DG Distributed Generation - Interconnection Standards (IEC)

MODULE V POWER QUALITY MONITORING AND ANALYSIS 08

Monitoring considerations: Power line disturbance analyzer, power quality measurement equipment, harmonic / spectrum analyzer, flicker meters, disturbance analyzer. Analysis of power outages, Analysis of unbalance: Symmetrical components of phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion: On–line extraction of fundamental sequence components from measured samples

MODULE VI GROUNDING 08

Impact of grounding on power quality- Terms and definitions, Reasons for grounding, problems associated with grounding- Problems with conductors and Connectors, Missing safety ground, Multiple neutral-to-ground connections, additional ground rods, ground loops - Solutions to wiring and grounding- Proper grounding practices, Ground electrode (rod), Service entrance connections, Panel board, Isolated ground, Separately derived systems, Grounding techniques for signal Reference, grounding for sensitive equipment

Total Hours: 45

REFERENCES:

1. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, (2nd edition) 1994.
2. Arindam Ghosh, “Power Quality Enhancement Using Custom Power Devices”, Kluwer Academic Publishers, 2002.
3. R.C. Duggan,” Power Quality “McGraw-Hill, 2003.
4. Arrillaga, j.. Bradley. D.a.. And bodger, P.S.,“Power system harmonics”, Wiley, 1985.
5. Derek A. Paice, “Power electronic converter harmonics : Calculations and multipulse methods”, Paice and Associates -1994.
6. Andreas Eberhard, “Power Quality”, Published by InTech, March 2011.
7. Surajit Chattopadhyay, Madhuchhanda Mitra,Samarjit Sengupta, “Electric Power Quality”, Springer, 2010.

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
- Know the power quality issues caused due to the insertion of DG

- Able to monitor the power quality parameters
- Identify the techniques to mitigate power quality disturbances
- Know the importance of grounding to improve power quality

EECY005	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 INTRODUCTION TO POWER SYSTEMS AND LOAD FORECASTING 08

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

MODULE II INTRODUCTION TO RELIABILITY ANALYSIS 07

Review of probability distribution, binomial distribution and exponential distribution – Network modeling and evaluation of simple and complex systems – System reliability evaluation using probability distributions – Frequency and duration techniques. Reliability concepts: Meantime to failure – Series and parallel systems – MARKOV process – Recursive technique.

MODULE III GENERATION SYSTEM RELIABILITY ANALYSIS 08

Probabilistic generation and load models - Determination of reliability of isolated and interconnected generation systems – Energy transfer and off peak loading.

MODULE IV TRANSMISSION SYSTEM RELIABILITY ANALYSIS 07

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

MODULE V EXPANSION PLANNING 07

Basic concepts on expansion planning - 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 08

Introduction, sub transmission lines and distribution substations - Design primary and secondary systems - Distribution system protection and coordination of protective devices. Distribution system reliability evaluation: Reliability analysis of radial systems with perfect and imperfect switching.

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 will be

- Able to carry out contingency analysis in transmission systems.
- Capable of applying the probabilistic methods for evaluating the reliability of generation and transmission system
- Able to design different model of system components in reliability studies
- Able to analyze advanced concepts of power system planning
- Able to design the expansion planning of power system
- Able to forecast the load using different regression models

EECY006 ADVANCED DIGITAL SIGNAL PROCESSING

L	T	P	C
3	0	0	3

OBJECTIVES:

- Provide the student with a broad, yet strong background in the traditional topics associated with processing of deterministic digital signals, e.g., discrete time transforms, linear filtering, spectrum estimation and linear prediction.
- Introduce the student to some of the more recent developments that promise to have a broad impact on digital signal processing, e.g., nonlinear filtering and adaptive filtering.
- To provide basics of multi rate DSP, Wavelets, multi resolution analysis and their interpretation and use
- To expose the students with basic DSP programming

MODULE I PARAMETRIC METHODS FOR POWER SPECTRUM ESTIMATION 08

Relationship between the auto correlation and the model parameters – The Yule – Walker method for the AR Model Parameters – The Burg Method for the AR Model parameters – unconstrained least-squares method for the AR Model parameters – sequential estimation methods for the AR Model parameters – selection of AR Model order.

MODULE II ADAPTIVE SIGNAL PROCESSING 08

FIR adaptive filters – steepest descent adaptive filter – LMS algorithm – convergence of LMS algorithms – Application: noise cancellation – channel equalization – adaptive recursive filters – recursive least squares.

MODULE III MULTIRATE SIGNAL PROCESSING 08

Decimation by a factor D – Interpolation by a factor I – Filter Design and implementation for sampling rate conversion: Direct form FIR filter structures – Polyphase filter structure.

MODULE IV SPEECH SIGNAL PROCESSING 08

Digital models for speech signal : Mechanism of speech production – model for vocal tract, radiation and excitation – complete model – time domain processing of speech signal:- Pitch period estimation – using autocorrelation function – Linear predictive Coding: Basic Principles – autocorrelation method – Durbin recursive solution.

MODULE V WAVELET TRANSFORMS 05

Fourier Transform : Its power and Limitations – Short Time Fourier Transform – The Gabor Transform - Discrete Time Fourier Transform and filter banks – Continuous Wavelet Transform – Wavelet Transform Ideal Case – Perfect Reconstruction Filter Banks and wavelets – Recursive multi-resolution decomposition – Haar Wavelet – Daubechies Wavelet.

MODULE VI DSP PROCESSORS 08

General and special purpose DSP Processors – Computer Architecture for signal processing – Havard Architecture – Pipelining – Hardware Multiply and Accumulate – Special Instructions – Replication – On-chip Memory Cache – Extended Parallelism – SIMD – VLIW and static super-scalar Processing – Brief study of TMS320C4X and ADSP 2106 processors.

Total Hours: 45

REFERENCES:

1. John G Proakis and Manolakis, “Digital Signal Processing Principles, Algorithms and Applications”, Pearson, Fourth Edition, 2007.
2. Sanjit K.Mitra, “Digital Signal Processing: A computer based approach”, Tata McGraw Hill, second edition, 2004.
3. A.V.Oppenheim and R.W Schafer, Englewood, “ Digital Signal Processing”, Prentice Hall, Inc. 2006.
4. B. Venkatramani & M.Bhaskar, “Digital Signal Procesors architecture, Programming and applications”, Tata McGraw Hill, 2002.
5. Andreas Antoniou, “Digital signal Processing Processing”, Tata McGraw Hill,second edition, 2008.
6. Stewen W. Smith, “Digital signal Processing Processing – A practical guide for Engineers and scientist”, Elsevier Science, 2003.

OUTCOMES:

- Have a more thorough understanding of the relationship between time and frequency domain interpretations and implementations of signal processing algorithms;
- Understand and be able to implement adaptive signal processing algorithms based on second order statistics;
- Students will have the ability to solve various types of practical problems in DSP
- Be familiar with some of the most important advanced signal processing

techniques,

- understand the multi-rate processing wavelet transform and time-frequency analysis techniques to solve real time process.
- Apply the above tools to real-world problems including spectral analysis, filter design, noise cancellation, signal compression, rate conversion, feature extraction, inverse problems.

EECY007 CONTROL SYSTEM DESIGN

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To have an exhaustive exposure to various methods of control system design.
- To study the basic control system design approaches.
- To study the Design in Discrete Domain and effect of sampling.
- To have good knowledge on State variable feedback.
- To study the Non - linear control system design with emphasis to sliding mode control.
- To impart knowledge in control system design through case studies.

MODULE I INTRODUCTION TO CONTROL SYSTEMS 08

Concept of control - Control system terminology, classification of Control Systems. Mathematical Models of Systems - Differential equations of electrical and mechanical system, transfer function of linear systems, block diagram models, signal flow graph.

MODULE II DESIGN OF FEEDBACK CONTROL SYSTEM 08

Approaches to system design - P, PI and PID Controllers - Compensators - Root Locus method - Phase lead, phase lag design using Bode diagram - Design Problems.

MODULE III DESIGN IN DISCRETE DOMAIN 08

Sample and Hold - Digital equivalents - Impulse and step invariant transformations - Methods of discretisation - Effect of sampling - Direct discrete design, Design Problems.

MODULE IV DESIGN USING STATE VARIABLE FEEDBACK 08

Controllability - Observability - Pole placement using state feedback - Ackerman's formula, Limitations of state variable feedback - Observers - Design Problems.

MODULE V NON - LINEAR CONTROL SYSTEM DESIGN 07

Concept of variable structure controller and sliding control - Implementation of switching control laws - Cascade designs - Partial state feedback design - Feedback linearization - Design Problems.

MODULE VI CASE STUDIES 06

Cruise control - Robotic arm - Process control application – Aircraft control- Ball and beam arrangement.

Total Hours: 45

REFERENCES:

1. Gene F Franklin. J David Powell, Michael Workman, “Digital Control of Dynamic Systems”, Pearson Education, Asia, 2000.
2. Graham C. Goodwin, Stefan F. Graebe and Mario E. Salgado, "Control system Design", PHI (Pearson), 2003.
3. Loan D. Landau, GianlucaZito," Digital Control Systems, Design, Identification and Implementation", Springer, 2006
4. M. Gopal, "Modern control system Theory", New Age International, 2005
5. Benjamin C. Kuo, "Digital control systems", Oxford University Press, 2006.
6. Seborg D, Edgar T, Mellichamp, D and Doyle F, Process Dynamics and Control, 3rd Edition, Wiley, 2011.

OUTCOMES:

At the end of the course, the student will have knowledge on:

- The different phases that constitute the process of designing control system using the enumerate methods available.
- The feedback techniques and the choice of selecting the appropriate method for design of feedback control system.
- Establishing a quantitative foundation to the design and analysis of sampled data systems.
- The basis for applying the methods of state space in multivariable systems design.
- Non - linear control system design with emphasis to sliding mode control.
- The working tools and design the system given using the appropriate tools identified.

EECY008	**HIGH VOLTAGE SWITCH GEAR**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

As Switch Gear is an important link in any Power System network, including Transmission and Distribution systems, this course aims to provide a holistic view of all the aspects of Switch Gear, including the following:

- Insulation clearance in the medium like Air, Oil, SF6, Vacuum etc.
- Various characteristics and phenomena of “Arc”
- Various types of Circuit Breakers and their applications
- The testing technique, short circuit calculation and rating of Circuit Breaker

MODULE I INSULATION OF SWITCHGEAR 08

Rated and tested voltage - co-ordination between inner and external insulation - Insulation clearances in air, oil SF6 and vacuum - bushing insulation - solid insulating materials – dielectric and mechanical strength consideration.

MODULE II CIRCUIT INTERRUPTION 08

Switchgear terminology – Arc characteristics – direct and alternating current interruption – arc quenching phenomena – computer simulation of arc models – transient re-striking voltage – RRRV – recovery voltage – current chopping – capacitive current breaking – auto re-closing.

MODULE III SHORT CIRCUIT CALCULATIONS AND RATING OF CIRCUIT BREAKERS 05

Types of faults in Power systems - short circuit current and short circuit MVA calculations for different types of faults-ratings of circuit breakers – symmetrical and asymmetrical ratings.

MODULE IV CIRCUIT BREAKERS 08

Classifications of circuit breakers-design, construction and operating principles of bulk oil, minimum oil, airblast, SF6 and vacuum circuit breakers – comparison of different types of circuit breakers.

MODULE V TESTING OF CIRCUIT BREAKERS 08

Type tests and routine tests – short circuit testing – synthetic testing of circuit breakers – recent advancements in high voltage circuit breakers – diagnosis.

MODULE VI DESIGN OF CIRCUIT BREAKERS 08

Basic data and specifications – Design of Arc extinguishing chamber – insulation design – Design of current carrying system – Thermal calculation.

Total Hours: 45

REFERENCES:

1. Chunikhin A and Zhavoronkov M., "High Voltage Switchgear analysis and Design", Mir Publishers, MOSCOW, 1989.
2. Kuffel E., Zaengl, W.S., and Kuffel J., "High Voltage Enginering Fundamentals, Newness", Second edition , Butterworth – Heinemann publishers, New Delhi, 2000
3. B. Ravindranath and M. Chander "Power System Protection and Switchgear", New Age international (P) Ltd., 2011.
4. B.H.E.L., "Handbook of Switchgear" Tata McGraw Hill, 2007.

OUTCOMES:

At the successful completion of the course, the student is expected to possess knowledge and skill on the following:

- Various insulation medium and their characteristics
- Arc characteristics and arc extinction methods
- Rating of Circuit Breakers.
- Circuit breaks – their types, and applications
- Testing of Circuit Breakers.
- Design of Circuit Breakers

EECY009 OPTIMAL CONTROL AND FILTERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To give students a background in the historical trends in dynamicoptimization.
- To study the optimality problems persisting in control system.
- To impart knowledge in numerical methods for optimal control problems.
- To have a detail understanding on Dynamic programming including LQ control problems.
- To study the filters and estimation methods.

MODULE I OPTIMALITY PROBLEMS IN CONTROL THEORY 08

Concept of optimal control-Statement of optimal control problem - Problem formulation and forms of optimal Control - Selection of performance measures-Necessary conditions of optimal control.

MODULE II PONTRYAGIN'S MINIMUM PRINCIPLE 08

Minimum Time problem - Minimum Fuel problem - Minimum Energy problem - Singular intervals.

MODULE III NUMERICAL TECHNIQUES FOR OPTIMAL CONTROL PROBLEMS 08

Linear optimal regulator problem - Matrix Riccatti equation and solution method - Choiceof weighting matrices - Steady state properties of optimal regulator - Solution of Ricatti equation by negative exponential and interactive Methods - Numerical solution of 2-pointboundary value problem by Steepest Descent and Fletcher Powell Method.

MODULE IV DYNAMIC PROGRAMING AND LQ CONTROL PROBLEMS 08

Linear tracking problem – LQ, LQG and LQR problem - Computational procedureforsolving optimal control problems - Characteristics of dynamic programming solution -Dynamic programming application to discrete and continuous systems - Hamilton Jacobi Bellman equation.

MODULE V FILTERING & ESTIMATION 05

Filtering of Linear system – System noise smoothing and prediction -Gauss Markovdiscrete time model - Estimation criteria – Minimum variance estimation - Least square estimation - Recursive estimation.

MODULE VI KALMAN FILTER 08

Kalman Filter- Linear estimator property of Kalman Filter - Time invariance and asymptotic stability of Kalman filters - Discrete-time Kalman Filter- Implementation-sub-optimal steady-state Kalman Filter - Extended Kalman Filter-practical applications Optimal smoothing.

Total Hours: 45

REFERENCES:

1. Donald E Kirk, "Optimal Control Theory - An Introduction", Prentice-Hall Inc, Englewood Cliffs, New Jersey, 1970.
2. Athans M and P L Falb, “Optimal Control - An Introduction to the Theory and its Applications”, McGraw Hill Inc, New York, 1966.
3. Dimitri P. Bertsekas, “Dynamic Programming and Optimal Control”, Athena Scientific Publisher, 2007.
4. Frank L. Lewis, DragunaVrabie, Vassilis L. Syrmos, “Optimal Control”, Wiley & Sons; IncHobkoken New Jersey, 2012.

OUTCOMES:

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

- Understand the basic background of dynamic optimization.
- Understand the problems persisting in optimal control system.
- Study numerical methods for optimal control problems.
- Detail understanding on Dynamic programming including LQ control problems.
- Understand the various filters and estimation methods.

EECY010	INDUSTRIAL POWER SYSTEM ANALYSIS AND DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study and understand the calculations used with induction motor starting studies.
- To study and calculate the rating of capacitors for power factor correction studies.
- To study and understand and calculate harmonics indices in power quality studies
- To study and understand the phenomenon of Flicker
- To study the grounding grid calculations and to introduce computer analysis methods for ground grid calculations
- To study and understand the operation of recent power systems and smart grids.

MODULE I INDUCTION MOTOR STARTING STUDIES 05

Induction motor classification based on NEMA standards and enclosure – Starting methods – Voltage drop calculations - Calculation of Acceleration time - Evaluation Criteria- Motor starting with limited – capacity generators-Computer Aided Analysis.

MODULE II POWER FACTOR CORRECTION 08

System description and modeling-Acceptance Criteria-Frequency Scan analysis-Voltage Magnification-Sustained Overvoltage-Switching surge analysis-Back-to back switching – Capacitor for EHV applications – Capacitors for motor starting.

MODULE III HARMONICS ANALYSIS 08

Harmonics sources-system response to harmonics-System model for computer Aided analysis-Acceptance criteria-Harmonic Filters-Harmonic evaluation-Case study.

MODULE IV FLICKER ANALYSIS 08

Sources of flicker –Flicker analysis-Flicker Criteria-Data for flicker –Case study Arc Furnace Load-Minimizing the flicker effects.

MODULE V GROUND GRID ANALYSIS 08

Introduction-Acceptance criteria-Ground grid calculations-computer aided analysis –Improving the performance of the grounding grids.

MODULE VI RECENT TRENDS IN INDUSTRIAL POWER SYSTEMS 08

Overview of power system-Layout of power system-Generation, Transmission and Distribution- Comparison between utility & industrial power systems - Introduction to deregulated power system — introduction of smart grid.

Total Hours: 45

REFERENCES:

1. Ramaswamy Natrajan,"Computer –Adided Power system analysis",Marcel Dekker Inc.,2002.
2. Shoiab Khan, Sheeba Khan,"Industrial Power Systems,"CRC press,Taylor & Francis Group,2007
3. Loi Lei Lai, "Power System Resstructuring and Regulation: Trading,Performance and Information Technology", John Wiley &Sons,2001.
4. NPTEL material for deregulation of power system
5. Tony Flick and Justin Morehouse, "Securing the smart Grid-Next Generation Power Grid Security", Elsevier Publications, 2011.

OUTCOMES:

At the end of the course, the student is expected to possess the following.

- Ability to select an induction motor for a particular industrial application
- Capable of designing the rating of capacitor for power factor correction.
- To calculate the harmonics indices in power quality study.
- To be familiar with Flicker analysis
- To be familiar with grounding grids and calculations
- .Able to understand the operation of deregulated power system and smart grids

EECY011	**HIGH VOLTAGE DIRECT CURRENT TRANSMISSION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To identify situations where HVDC is a better alternative
- To acquire knowledge of HVDC converters, system control and development of MTDC systems
- To perform power flow analysis in an integrated EHVAC - HVDC system.

MODULE I COMPARISON OF EHVAC AND HVDC SYSTEMS 07

Technical and economic problems in bulk power transmission over long distances using EHV / UHV AC lines - HVDC alternatives for transmission - Description of HVDC systems - its application - comparison of EHVAC and HVDC systems.

MODULE II ANALYSIS OF HVDC CONVERTERS 08

Planning of HVDC transmission - modern trends in HVDC transmission - DC breakers - U/G cable transmission - VSC based HVDC - pulse number - choice of converter configuration - simplified analysis of Graetz circuit - 6 pulse converter bridge characteristics - generation of harmonics and filtering.

MODULE III ANALYSIS AND CONTROL OF HVDC SYSTEMS 08

Twelve pulse converter characteristics - its advantages - detailed analysis of Converters - Principles of DC link control - converter / inverter control characteristics - system control hierarchy - firing angle control - current and extinction angle control - power control - higher level controllers.

MODULE IV MULTI TERMINAL HVDC SYSTEMS 07

Introduction to MTDC systems – potential applications of MTDC systems – Types of MTDC systems – Control and protection of MTDC systems – Detailed study about developments of MTDC systems.

MODULE V POWER FLOW ANALYSIS 08

Per unit system for DC quantities – modeling of DC links – solution of DC power flow – solution of AC – DC power flow – case studies

MODULE VI SIMULATION 07

System simulation – philosophy and tools – HVDC systems simulation: modeling of HVDC systems for digital simulation – dynamic interaction between DC and AC systems. Application in Wind Power generation.

Total Hours: 45

REFERENCES:

1. K.R. Padiyar, "HVDC Power Transmission Systems", New Age International (P) Ltd., New Delhi, 2002.
2. J. Arrillaga, "High Voltage Direct Current Transmission", Peter Pregrinus, London, 1983.
3. P. Kundur, "Power System stability and Control", Tata McGraw Hill, 1993.
4. Erich Uhlmann, "Power Transmission by Direct Current", BS Publications, 2004.
5. V.K. Sood, "HVDC and FACTS Controllers - Applications of Static Converters in power system", Kluwer Academic Publishers, April 2004.

OUTCOMES:

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

- Identification of situations where HVDC transmission is a better alternative to EHVAC transmission
- The operation and control of converter/Inverter for power control
- The development and applications of MTDC systems
- Power flow analysis used for Integrated EHVAC-HVDC system
- Steady state performance simulation and analysis
- Analysis of HVDC controllers.

EECY012 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 and fundamentals of wind power.
- To study and understand about the wind turbine components, power generation machinery, and its control systems.
- To simulate the wind turbine dynamic behavior when integrated to grid and in standalone operation.

MODULE I INTRODUCTION 08

Introduction-Historical Development and current status of Wind power-Generators and Power Electronics for wind turbines - Power System Impacts of Wind turbines-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 08

Types of Wind Turbine-Rotor design consideration-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 08

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 AND VARIABLE SPEED WIND GENERATORS 08

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 4.3-Doubly Fed Induction Generator(DFIG) modeling - controller modelling -modelling of DFIG in EUROSTAG - transient stability simulation of powersystems with induction generators using EUROSTAG 4.3.

MODULE V POWER ELECTRONICS IN WIND ENERGY CONVERSION SYSTEM 08

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 05

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.

TotalHours: 45

REFERENCES:

1. S.N.Bhadra, D.Kasthra,S.Banerjee, “Wind Electrical Systems”,OxfordHigherEduction, 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 andperformance of fixed-speed induction generators in power system oscillationstability studies", Electric Power System Research Vol. 78,pp: 1416-1424,2008.
5. Andre´s Feijoo, Jose Cidras, Camilo Carrillo, "A third order model for thedoubly-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
9. Ltd., Trowbridge, 1976.
10. 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 component, 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.
- indentify the present and the future energy storage technologies used for standalone operation and grid connected operation .

EECY013 APPLICATION OF MEMS TECHNOLOGY

	L	T	P	C
	3	0	0	3

OBJECTIVES:

- To develop skills in the area of Micro fabrication and Micromachining techniques.
- To study about different types of micro sensors and their applications in various areas.

MODULE I MEMS: MICRO-FABRICATION, MATERIALS AND ELECTROMECHANICALCONCEPTS 08

Introduction to micro fabrication – Silicon and other material based fabrication processes – Concepts: Conductivity of semiconductors - Crystal planes and orientation-stress and strain- flexural beam bending analysis- Torsional deflections- Intrinsic stress - resonant frequency and quality factor.

MODULE II ELECTROSTATIC SENSORS AND ACTUATION 08

Principle, material, design and fabrication of parallel plate capacitors as electrostatic sensors and actuators - Applications.

MODULE III THERMAL SENSING AND ACTUATION 07

Principle, material, design and fabrication of thermal couples, thermal bimorph sensors, thermal resistor sensors-Applications.

MODULE IV PIEZOELECTRIC SENSING AND ACTUATION 07

Piezoelectric effect-cantilever piezo-electric actuator model-properties of piezoelectric materials-Applications.

MODULE V RF APPLICATIONS OF MEMS 09

Introduction – RF based communication system and RF Modules: Tuners, Resonators, Switch, Phase shifter – RF MEMS: Application Areas, Advantages of RF MEMS technology – RF MEMS Design scenarios: MEMS Inductors, Varactors, Tuner/Filter, Resonators, MEMS Switches, Phase Shifters.

MODULE VI CASE STUDIES 06

Piezoresistive sensors, Magnetic actuation, Micro fluidics applications, Medical applications, Optical MEMS.

Total Hours: 45

REFERENCES:

1. Chang Liu, "Foundations of MEMS", Pearson International Edition, 2006.
2. Marc Madou , "Fundamentals of microfabrication", CRC Press, 1997.
3. Boston , "Micromachined Transducers Sourcebook", WCB McGraw Hill, 1998.
4. M.H.Bao "Micromechanical transducers :Pressure sensors, accelerometers and gyroscopes", Elsevier, Newyork, 2000.
5. N.P. Mahalik, "MEMS",Tata McGraw Hill, 2007.
6. Julian W.Gardner, Vijay.K.Varadhan, Osama O. Awadelkarim, "Microsensors, MEMS and Smart Devices", John Wiley and Sons Ltd, 2001.
7. Vijay.K. Varadhan, K.J.Vinoy, K.A.Jose, "RF MEMS and their Applications", John Wiley and Sons Ltd, 2003.

OUTCOMES:

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

- Ability to understand the operation of micro devices, micro systems and their applications.
- Ability to design the micro devices, micro systems using the MEMS fabrication process.
- Working principles of different micro sensors and applications.
- Execute a vibrant analysis on sensing and actuation mechanisms.
- Perform different case studies on various micro sensors.

EECY014 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, including 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
- The testing standards, selection and maintenance of insulators will also be made aware.

MODULE I INTRODUCTION 07

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 07

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 08

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.

Glass Insulators – The Glass Suspension Insulator – Glass Pin-type Insulators – Glass Multicone Post Insulators – Manufacture of Glass Insulators – Glass Insulator Hardware – Glass Insulator Cement – The Glass 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 08

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 DETECTING DEFECTIVE INSULATORS 07

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 08

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., Phoenix, Arizona 85044, USA,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,
5. Definition, Test Methods and Acceptance Criteria”, 1992
6. EPRI, “Transmission Lines Reference Book – 345kV and above”, 1982
7. ANSI C 29.1, “Electrical Power Insulator – Test Methods”, 1992

OUTCOMES:

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

- Various types of outdoor insulators and their characteristics
- Design, testing and maintenance of different types of insulators
- Selection and detection of defective Insulators
- Various standards used in Insulators testing
- Manufacturing Process of Insulators
- Maintenance and selection of Insulators.

EECY015 FLEXIBLE AC TRANSMISSION SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce students to the transmission challenges of modern electrical power systems
- To present the basic concepts, principles and operation of fast high power electronic controllers known as Flexible AC Transmission Systems (FACTS)
- To provide advanced knowledge and understanding of power electronics applications in power transmission systems
- To introduce the operating principles, control systems and modeling of different FACTS devices (SVC, SSSC, SR, TCSC, STATCOM, UPFC, IPFC, etc.)
- To understand the influence of measurement systems, network resonances and harmonic interactions on the performance of FACTS control systems
- To provide the techniques of FACTS controller design for enhancing power transfer, stability and damping, mitigating sub-synchronous resonances, preventing voltage instability, etc.
- To understand the interactions amongst various FACTS Controllers and techniques for their coordination and placement

MODULE I INTRODUCTION 08

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 STATIC VAR COMPENSATOR (SVC) 08

Voltage control by SVC - advantages of slope in dynamic characteristics - influence of svc on system voltage - design of SVC voltage regulator - modelling of SVC for power flow and transient stability.

MODULE III THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) 07

Operation of the TCSC - different modes of operation - modelling of TCSC - variable reactance model - modeling for power flow and stability studies. sub synchronous resonance- torsional interaction,- torsional torque - NGH damping schemes.

MODULE IV VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS 07

Static synchronous compensator (STATCOM) - principle of operation - V-I characteristics. SSSC-operation of SSSC and the control of power flow - modeling of SSSC in load flow and transient stability studies -UPFC and IPFC.

MODULE V CO-ORDINATION OF FACTS CONTROLLERS 07

Controller interactions - SVC - SVC interaction - co-ordination of multiple controllers using linear control techniques - control coordination using genetic algorithms.

MODULE VI APPLICATIONS OF FACTS CONTROLLERS 08

Applications of SVC - enhancement of transient stability - steady state power transfer - enhancement of power system damping - prevention of voltage instability. -applications of TCSC- improvement of the system stability limit - enhancement of system damping. applications of STATCOM- steady state power transfer-enhancement of transient stability - prevention of voltage instability - applications of SSSC – SSR mitigation.

Total Hours: 45

REFERENCES:

1. R.Mohan Mathur, Rajiv K.Varma, “Thyristor - Based FACTS Controllers for Electrical Transmission Systems”, IEEE press and John Wiley & Sons, Inc., 2002.
2. Narain G. Hingorani, “Understanding FACTS -Concepts and Technology of Flexible AC Transmission Systems”, Standard Publishers Distributors, Delhi- 110 006,1999.
3. K.R.Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age International (P) Limited, Publishers, New Delhi, 2008 .
4. A.T.John, “Flexible A.C. Transmission Systems”, Institution of Electrical and Electronic Engineers (IEEE)”, Wiley IEEE Press,1999.
5. 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 achieve skills on the following:

- Identify the needs of power systems and utility networks where installation of FACTS Controllers/Devices becomes essential

- Compute power transmission capability of a transmission system and apply reactive compensation methods for its improvement
- Comprehend the operating principles, control systems and modeling of different FACTS Controllers
- Understand the influence of measurement systems, network resonances and harmonic interactions on the performance of FACTS control systems
- 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.
- Analyze the interactions amongst various FACTS Controllers and Utilize techniques for the coordination of FACTS Devices within power systems

EECY016	ELECTRICAL TRANSIENTS IN POWER SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To model the transmission lines for transient analysis
- To study about the generation of switching and lightning transients, their propagation on the grid.
- To protect the station equipments against over voltages with proper insulation co-ordination

MODULE I LINE MODELLING 08

Line parameters - Bundled Conductors - Maxwell potential coefficient matrices for various line configurations - L and C calculations for lines - resistance and inductance of ground return using Carson's formulae - Line modeling for Power frequency and surge over voltages.

MODULE II POWER FREQUENCY OVER VOLTAGES 07

Symmetrical components for O/H lines and computation of sequence impedance - a, ß, O and Karrenbaur's transformations - over voltages caused by unsymmetrical line faults - over voltages due to Ferranti effect and load rejection.

MODULE III PROPAGATION OF TRAVELLING WAVES 07

Wave equation and its solution - Relation between voltage and current waves - velocity of travelling waves-reflection and refraction - behavior at line terminations - multiple reflections - lattice diagram - attenuation and distortion

MODULE IV MODAL ANALYSIS FOR MULTI CONDUCTOR LINES 07

Wave equation for multi conductor lines - general solution using modal analysis - significance of modal analysis - simple example of modal analysis – modes of propagation for a three conductor system.

MODULE V LIGHTNING AND SWITCHING OVER VOLTAGES 08

Lightning and switching over voltages - their influence on line transients -switching surges in capacitive circuits - switching surges in distributed parameter systems.

MODULE VI PROTECTION AND INSULATOR CO-ORDINATION 08

Protection against over voltages - shielding and non - shielding methods - back flashover - characteristics of surge arrestors - Location of surge arrestors –

substation earthing - Basic Insulation levels - insulation co-ordination in 220kV and 400kV systems - Specific examples - insulation co-ordination in HVDC systems.

Total Hours: 45

REFERENCES:

1. Pritindra Chowdhari, "Electromagnetic transients in Power system", PHILearning. Age International (P) Ltd., Publishers New Delhi, 2008.
2. Allan Greenwood, "Electrical Transients in Power System", Wiley & Sons Inc., New York, 1991.
3. H.W. Dommel, "EMTP Theory Book", Microtran Power System Analysis Corporation, Vancouver B.C.,1992.

OUTCOMES:

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

- Ability to distinguish between power frequency and surge over-voltages and Model the transmission lines accordingly.
- Analyse the propagation characteristics of voltage and current surges in
- Transmission lines and their terminations.
- Design insulation co-ordination schemes for 220kV and 400kV systems.
- Analyse and control power frequency over voltages due to unsymmetrical faults , Ferranti effect and load rectification.
- Analyse propagation in multi-conductor lines using modal analysis.

EECY017	**HIGH VOLTAGE PULSE GENERATION, MEASUREMENT AND TESTING FOR LIFE SCIENCES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- As the application of High voltage electric Pulse in Life Science is getting increased attention among the researchers, this course aims to provide a comprehensive idea.
- By the end of the semester, a student will be able to as certain methods of High Voltage generated measures.
- Appreciate the significance NDT testing techniques.
- Role of Bioelectrics in life science
- Appreciate the significance Electro pulsed and electromagnetic in cancer treatment

MODULE I HIGH VOLTAGE GENERATION & MEASUREMENT 08

Generation of High Alternating Voltages – High Frequency A.C. High Voltages - Generation of Rectangular & Square Current Pulses - Measurements of High Alternating Voltages – Currents – High Power Frequency.

MODULE II NON DESTRUCTIVE TESTING TECHNIQUE 08

Measurement of Direct Current Resistivity – Dielectric constant and Loss Factor – Partial Discharge Measurement – Balance Detection Method – Calibration of Discharge Detectors – Discharge Detection in Power Cables.

MODULE III BIO ELECTRICS 08

Window effect of pulsed Electric field on Biological Cells – Biological Matter due to the Application of Ultra short High Voltage Pulses – Bio response to sub Nano second ultra high voltage pulsing – Effects of Steep pulsed Electric fields on human liver cancer cells – cortical anchoring on the stability of transmembrane Electropores.

MODULE IV CANCER TREATMENT 07

Preliminary procedures – partial – mastectomy and auxiliary dissection – Total mastectomy – Reconstruction and Prosthesis – Radiation Therapy – Systemic Therapy – Complementary and Alternative Treatments.

MODULE V ELECTROPORATION 07

Introduction – Effect of Electroporation – Frequency Response of Cells – Nano electroporation – Nano Second – Electroporation effects – Caspases – Calcium Bursts – Nano pulses – Nano Second pulse Generator.

MODULE VI ELECTROPORATORS 07

Introduction – Design of electroporator including Booster circuit and converter circuit – Design of clinical electroporator.

Total Hours: 45

REFERENCES:

1. E. Kuffl, W.S. Zaengl, “High Voltage Engineering, Fundamentls”, first Edition, PERGAMON Press, OXFORD, New York, 1984.
2. M.S. Naidu, V. Kamaraju, “High Voltage Engineering”, Third Edition, Tata Mc Graw Hill Publishing Company Ltd., New Delhi, 2001.
3. Chenguo Yao, Xiaoqian Hu, Yan Mi, Chengxiang Li and Caixin Sun, “Window effect of pulsed electric field on biological cells”, IEEE Trans. Dielectrics and electrical insulation Vol. 16, No: 5,pp 1259-1266, October 2009.
4. UweF.Pliquett and Karl. H. Schoenbach, “Changes in Electrical Impedance of Biological Matter Due to the Application of Ultrashort High Voltage Pulses”, IEEE Trans. Dielectrics and electrical insulation Vol. 16, No. 5, pp1273-1279, October 2009.
5. R. P. Joshi, J. Song, K. H. Schoenbach and V. Sridhara, “Aspects of Lipid Membrance Bio-responses to Subnanosecond, Ultrahigh Voltage pulsing”, IEEE Trans. Dielectrics and electrical insulation Vol. 16, No. 5, pp1243-1250, October 2009.
6. Yan Mi, Chengxiang Li, Caixin Sun, Liling Tang and Huan Liu, “Apoptosis Induction Effects of Steep Pulsed Electric Fields (SPEF) on Human Liver Cancer Cell SMMC-7721 in vitro”, IEEE Trans. Dielectrics and electrical insulation Vol. 16, No. 5,pp1302-1310, October 2009.
7. S. M. Kennedy, Z. Ji, N. B. Rockweiler, A. R. Hahn, J. H. Booske and S. C.Hagness, “The Role of Plasmalemmal-Cortical Anchoring on the Stability of Transmembrane Electropores”, IEEE Trans. Dielectrics and electrical insulation Vol. 16, No. 5; pp1251-1258., October 2009.
8. RajiSundararajan, “Nano Second Electroporation Another look Mol Biotechnol”, Vol No:41, pp :69-82, 2009.
9. Susan M. Love, Karen Lindsey, “Dr. Susan Love’s Breast Book”, 4th Edition,

First Da Ca Po Press Edition, 2005.

OUTCOMES:

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

- Ability to impart knowledge on generation and measurement of high frequency AC voltages and currents.
- Ability to select an appropriate testing technique for high voltage apparatus.
- Ability to relate bioelectrics with high voltage applications.
- Ability to gain fundamental knowledge on various cancer treatments techniques.
- Application of Electroporation and Electroporators in Cancer Treatment

EECY018 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 09

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

MODULE II COMPONENTS AND STANDARDS 09

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

MODULE III AUTOMATION TECHNOLOGIES 09

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 06

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

MODULE V CASE STUDY I 06

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

MODULE VI RECENT TRENDS IN SMART POWER GRIDS 06

Demand Response – concepts and models.Real time pricing models 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 Intelligence for Electric Power Grid, Wiley IEEE .,2014
5. James Momoh : Smart Grids , Fundamentals of Design and Analysis .,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 possess knowledge and skills on the following :

- Ability to design and implement Smart Power Grid Power Systems
- Ability to apply the concept of demand response in Smart grids.
- Ability to apply Smart grid concepts to real applications.
- Ability to co ordinate between cloud computing and smart grids
- Ability to apply SCADA in smart power grids
- Ability to use PMUs for optimal placement in smart grids.

EECY019	DISTRIBUTED GENERATION AND MICROGRID	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart the importance of renewable based generation system to meet the growing demands
- To locate distributed generation system optimally in the distribution system network and to study its impacts

MODULE I INTRODUCTION 08

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 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 II DISTRIBUTED ENERGY RESOURCES AND STORAGE DEVICES 08

Distributed Energy Resources: solar – wind – CHP – MCHP – Microturbine - Diesel generators –geo thermal –working, characteristics and mathematical modeling, Storage devices-Batteries - fuel cells - super capacitors.

MODULE III DISTRIBUTED SYSTEM EXPANSION 08

Power flow, Short circuit and loss calculations- with and without distributed generation- Distribution system reliability analysis –Distribution system expansion planning – load characteristics – load forecasting – design concepts – optimal location of distributed generation – solution technique.

MODULE IV CONTROLLERS 08

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 (Vf) Control Scheme - generation Control Based on Droop Concept - adaptive droop control, Phase locked loop for synchronization.

MODULE V PROTECTION ISSUES 07

Requirements of protection - issues in protection (LOM, Blinding of protection, unwanted islanding, lack of selectivity, failure of co-ordination between fuse and recloser) - challenges in protection scheme – Solutions for microgrid protection - digital relays- Adaptive protection scheme : centralized, decentralized–Multiagent based protection scheme – protection scheme based on variables

MODULE VI MICROGRID COMPONENTS 06

PMU basic concepts - International Electrotechnical Commission (IEC) 61850, 61850-7-420, 61850-8. Renewable Microgrid controller RMC 600. Microgrid pilots : KERI – CERTS - Intelligent Electronic Device (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 Engineering Stockholm 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

Course Outcomes:

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

- Know the basic concepts with respect to microgrid
- Model the distributed generator for distribution network
- Optimally locate the distributed generator in the distribution system
- Address the Issues involved in microgrid protection
- Model controllers for distributed generator to interface it to the distribution system network

EECY020 REACTIVE POWER MANAGEMENT IN POWER SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To analyze the operation of AC voltage controllers and AC-DC converters.
- To understand the operating principles of power semiconductor devices.
- To understand the fundamental concepts of compensation.
- To understand the concepts of Demand side management.

MODULE I SINGLE-PHASE AND THREE PHASE AC-DC CONVERTERS 08

Single phase Half controlled and Fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current- Three Phase ac-dc Converters- Half controlled and fully controlled Converters with RL load-Continuous and Discontinuous load current -three phase PWM-twelve pulse converters- numerical problems.

MODULE II MULTI LEVEL INVERTERS 08

Introduction, Multilevel Concept - Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter- Principle of Operation, Features of Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying-Capacitors Inverter- Features of Multilevel Inverters.

MODULE III LOAD COMPENSATION AND DEMAND SIDE MANAGEMENT 07

Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks.

MODULE IV REACTIVE POWER COMPENSATION IN TRANSMISSION SYSTEM 07

Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples-Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation – compensation using synchronous condensers – examples- Mathematical modelling.

MODULE V SERIES AND SHUNT COMPENSATION TECHNIQUE 08

Modeling and control of Thyristorised controlled series compensators. Static VAR Compensation - Basic concepts, Thyristor controlled reactor (TCR), Thyristors switched reactor (TSR), Thyristor switched capacitor (TSC)- Variable structure FACTS controllers for Power system transient stability, Non-linear variable structure control, Unified power flow, Unified Power Flow Control - Basics of STATCOM, its applications.

MODULE VI CASE STUDY 07

Reactive power compensation capability of a matrix converter-based FACTS device- Reactive Power Compensation in Single-Phase Operation of Microgrid- Practices of reactive power management and compensation- Transmission system reactive power compensation.

Total Hours: 45

Reference Books:

1. Reactive power control in Electric power systems by T.J.E.Miller, John Wiley and sons, 1982.
2. Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First Indian Reprint- 2008
3. Power Electronics- Ned Mohan, Tore M.Undelan and William P.Robbins – John Wiley & Sons -2nd Edition.
4. R.Mohan Mathur, Rajiv K.Varma, “Thyristor – Based Facts Controllers for Electrical Transmission Systems”, IEEE press and John Wiley & Sons, Inc.
5. A.T.John, “Flexible A.C. Transmission Systems”, Institution of Electrical and Electronic Engineers (IEEE), 1999.
6. Reactive power Management by D.M.Tagare,Tata McGraw Hill, 2004.

OUTCOMES:

After Completion of this course students will be able to

- Analyze the operation of AC voltage controllers and AC-DC converters.
- Design the power factor correction converters.
- Analyze the load compensation in transmission systems.
- Analyze suitable compensation for AC transmission systems.
- To understand the concept of reactive power management and various method of control employed in power systems.
- To understand its performance under static and dynamic conditions.

EECY021	STATE ESTIMATION AND CONTINGENCY ANALYSIS IN SMART GRID	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the model, management and protection of smart grid systems.
- To understand the information systems used in smart grid.
- To grasp the limits of the power system operating states.
- To grasp the contingency analysis made in a transmission grid.
- To model the states in power system for state estimation.
- To analyse the states for observability.

MODULE I SMART GRID SYSTEMS 05

Smart Grid introduction, Major systems in Smart Grid a technical perspective: Smart infrastructure system, Smart management system, Smart protection system, benefits and requirements of smart grid, Microgrid, Grid to vehicle and vehicle to grid.

MODULE II SMART INFORMATION SYSTEMS 08

Smart Metering, Smart Monitoring and Measurement, Information Management, Smart Communication Subsystem, An Overview, Wireless Technologies, wired technologies

MODULE III CONTINGENCY ANALYSIS FOR POWER SYSTEMS 05

Contingency Analysis of Power System, Types of Violations, Low Voltage Violations, Line MVA Limits Violation, Instability Prediction.

MODULE IV CONTINGENCIES STUDY OF NIGERIAN TRANSMISSION GRID 09

Case Study of Nigeria's 330kV Transmission Grid, Power System Security, Algorithm of a typical Contingency Analysis, Line Loadability, Simulation, Phasor and PMU Functions, Phasor Measurement Unit, Typical PMU Applications.

MODULE V STATIC STATE ESTIMATION MODELS 09

Power System Static- State Estimation, Exact Model, Nature of problem, Modeling, General Theory, State Estimation, Detection, Identification, Initial Tests, Approximate Model: State Estimation using P- Delta, Contingency Evaluation: P-Delta, Reactive Power and Voltage Magnitude.

MODULE VI EQUATION FORMULATIONS AND OBSERVABILITY ANALYSIS 09

Use of Loop Equations in Power System Analysis, Loop and Nodal Formulations, Pre- compensation, Post-compensation. Mid-compensation, Load Flow Computation, Network Observability Problem, Conventional Observability Analysis, Linearized Measurement Model, Classification of Measurements, Observability Algorithm.

Total Hours: 45

REFERENCES:

1. Nonyelu, Chibuzo Joseph, Prof. Theophilus C. Madueme, "Power System Contingency Analysis: A Study of Nigeria's 330kV Transmission Grid", Conference of Energy Source for Power Generation, University of Nigeri, Nsukka, Volume: 4, February 2016.
2. Xinyu Tony Jiang, Joe H Chow, Bruce Fardanesh, Deepak Maragal, George Stefopoulos, Michael Raxanousky, " Power System State Estimation using Direct Non-Iterative method", Electrical Power and Energy Systems, Volume 73, Pages 361-368, 2015.
3. Mrs. Veenavati Jagadishprasad Mishra, Prof. Manisha D. Khardenvis, "Contingency Analysis of Power System", IEEE Students' Conference on Electrical, Electronics and Computer Science, 2012.
4. Feng Ding, C.D. Booth, "Protection and Stability Assessment in Future Distribution Networks Using PMUs", 11th International Conference on Developments in Power Systems Protection, 2012.
5. Xi Fand, Satyajayant Misre, Guoliang Xue, Dejun Yang, "Smart Grid - The New and Improved Power Grid: A Survey", Volume: 14, Issue 4, Pages: 944 – 980, 2012.
6. Antonio Gomez ExpBsito and Ali Abur, "Generalized Observability Analysis and Measurement Classification", IEEE Transactions on Power Systems, Volume 13, No3, August 1998.
7. Antonio Gomez ExpBsito and Ali Abur and Esther Rineri Ramos, "On the use of LOOP Equations in Power System Analysis", IEEE International Symposium on Circuits and Systems, ISCAS' 95, 15 Volume 2, 1995.
8. Fred C. Scheweppe, and J.Wildes, "Power System Static-State Estimation, Part 1: Exact Model", Transactions on Power Apparatus and Systems, Volume: PAS-8, No1, January 1970.
9. Fred C. Schweppe, and Douglas B.Rom, "Power System Static-State Estimation, Part 2: Approximate Model", IEEE Transactions on Power

Apparatus and Systems, Volume: PAS-89, Issue 1, 1970.

OUTCOMES:

- The model, management and protection of smart grid systems were understood.
- The information systems used in smart grid was gathered.
- The limits of the power system operating states were understood.
- The contingency analysis made in a transmission grid was understood.
- The state estimation modeling was understood.
- The analysis and observability of the states was done.

EEC0Y22	POWER ELECTRONIC APPLICATIONS TO POWER SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To have a thorough understanding of the construction, theory and characteristics of the Devices like MOSFET, BJT's, IGBT's and SCR.
- To analysis and modeling of Inverters and converters.
- To study in detail about the Reactive power compensation and FACTS devices.
- To study about the definition and issues in power quality.

MODULE I INTRODUCTION 07

Basic Concept of Power Electronics, Different types of Power Electronic Devices - Diodes, Transistors, SCR, MOSFET, IGBT and GTO's.

MODULE II AC TO DC CONVERTERS 09

Single Phase and three phase bridge rectifiers, half controlled and Fully Controlled Converters With R, RL, AND RLE loads. Free Wheeling Diodes, Dual Converter, Sequence Control of Converters - inverter operation, Input Harmonics and Output Ripple, Smoothing Inductance - Power Factor Improvement effect of source impedance, Overlap, Inverter limit.

MODULE III DC TO AC CONVERTERS 09

General Topology of single Phase and three phase voltage source and current source inverters- Need for feedback diodes in anti parallel with switches - Multi Quadrant Chopper viewed as a Single phase inverter- Configuration of Single phase voltage source inverter: Half and Full bridge, Selection of Switching Frequency and Switching Device. Voltage Control and PWM strategies.

MODULE IV STATIC REACTIVE POWER COMPENSATION 08

Shunt Reactive Power Compensation - Fixed Capacitor Banks, Switched Capacitors, Static Reactor Compensator, Thyristor Controlled Shunt Reactors (TCR) - Thyristor Controlled Transformer- FACTS Technology-Applications of static thyristor Controlled Shunt Compensators for load compensation ,Static Var Systems for Voltage Control, Power Factor Control and Harmonic Control of Converter Fed Systems.

MODULE V POWER QUALITY 06

Power Quality - Terms and Definitions - Transients - Impulsive and Oscillatory Transients - Harmonic Distortion - Harmonic Indices - Total Harmonic Distortion - Total Demand Distortion- Locating Harmonic Sources Harmonic s from commercial and industrial Loads -Devices for Controlling Harmonics Passive and Active Filters -Harmonic Filter Design.

MODULE VI VOLTAGE SAGS AND HARMONICS 06

Sources of over voltages - Capacitor switching – lightning- Mitigation of voltage swells - surge arrester. Sources of sags and interruptions, estimating voltage sag performance, motor starting sags mitigation of voltage sags harmonics.

Total Hours: 45

REFERENCES:

1. N.Mohan,T.M.Undeland and W.P.Robbins, Power Electronics : Converter, Applications and Design , John Wiley and Sons , 2000.
2. M.H.Rashid, Power Electronics, Prentice Hall of India,2006.
3. B.K.Bose, Power Electronics and A.C. Drives , Prentice Hall ,2004.
4. Roger C.Dugan , Mark .F. Mc Granaghan, Surya Santaso, H.Wayne Beaty, “Electrical Power Systems Quality”, Second Edition, Mc Graw Hill, 2002.
5. T.J.E. Miller, Static Reactive Power Compensation, John Wiley and Sons, Newyork,1982.
6. Mohan Mathur.R., Rajiv.K.Varma, “Thyristor Based FACTS controllers for Electrical Transmission Systems”, IEEE press .1999.
7. Tripathy, S.C., 'Electric Energy Utilisation and Conservation', Tata McGraw Hill Publishing Company Ltd. New Delhi, 1991.
8. Soni, M.L., P.V. Gupta and Bhatnagar, 'A Course in Electrical Power', Dhanpat Rai Sons, New Delhi, 1983.
9. Roger.C.Dugan, Mark.F.McGranagham, Surya Santoso, H.Wayne Beaty, ‘Electrical Power Systems Quality’ McGraw Hill, 2003.
10. M.H.J Bollen, ‘Understanding Power Quality Problems: Voltage Sags and Interruptions’, (New York: IEEE Press, 1999). (For Chapters 1, 2, 3 and 5)

OUTCOMES:

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

- Ability to model and analyze Inverters & Converters.
- Ability to analyze custom power electronic devices.

- Basic understanding of the semiconductor devices like rectifiers, Thyristors and transistors.
- Understanding the principle of operation of FACTS devices.
- Knowing the issues like sag and harmonics in power quality.

EECY043 SCADA AND DCS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To give an in depth study of SCADA and PLC.
- To acquire knowledge of application of software automation blocks and DCS.
- To expose the students to the Micro SCADA techniques

MODULE I INTRODUCTION 06

Introduction to automation tools PLC, DCS, SCADA, Hybrid DCS/PLC.

MODULE II DCS PROJECT 08

Development of User Requirement Specifications - Functional Design Specifications for automation tool - GAMP, FDA.

MODULE III PROGRAMMABLE LOGIC CONTROLLERS 08

Introduction of Advanced PLC programming, Selection of processor, Input/ output MODULEs - Interfacing of Input/output devices, Operator Interface - OPC- study of SCADA software - Interfacing of PLC with SCADA software.

MODULE IV DCS 09

Introduction to architecture of different makes - DCS Specifications, configuration of DCS blocks for different applications - Interfacing of protocol based sensors - Actuators and PLC systems, Plant wide database management- Security and user access management - MES, ERP Interface.

MODULE V STUDY OF ADVANCE PROCESS CONTROL BLOCKS 09

Statistical Process Control - Model Predictive Control - Fuzzy Logic Based Control - Neural-Network Based Control Higher Level Operations: Control & Instrumentation for process optimization - Applications of the above techniques to the same standard units/processes.

MODULE VI MICRO SCADA FOR POWER ELECTRONICSYSTEMS 05

System concept –Hardware: Base computer - Workstations-Front ends-Peripherals Software Programming-Process Objects – Command Procedures – RTU Integration –Communication to Third Party Systems –Functional description:

process pictures- operation-Alarm handling-Event Handling- reports- Trends

Total Hours: 45

REFERENCES:

- Gary Dunning, “Introduction to Programmable logic Controllers”, Delmar Thomson learning, 2001.
- Webb & Reis, “Programmable logic Controllers”, (Prentice Hall), 2003.
- Jose A. Romagnoli, Ahmet Palazoglu, 'Introduction to process Control' (CRC Taylor and Francis group), 2013.
- “Statistical Process Control” -ISA Handbook.
- B.G. Liptak “Handbook of Instrumentation- Process Control”.
- Installation and user manuals of different DCS, PLC Vendors, 2004.

OUTCOMES:

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

- Basics of SCADA & DCS.
- Appropriate knowledge and skills in Industrial automation systems with the use of DCS, PLCs, and SCADA.
- An ability to apply creativity in design of systems, components or processes appropriate to power electronic circuits.
- Ability to get a grip on micro SCADA for power electronics applications
- Ability to perform programming in SCADA and DCS.

EECY047	SPECIAL ELECTRICAL MACHINES AND CONTROLLERS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To impart knowledge on Construction, principle of operation and performance of switched reluctance motors.
- To understand the Construction, principle of operation and performance of SM.
- To impart knowledge on Construction, principle of operation and performance of AC commutator motors.
- To study about the Construction, principle of operation and performance of permanent magnet brushless D.C. motors and PMSM.
- To impart knowledge on Construction, principle of operation and performance of linear motors.
- To learn the softwares Magnet AND ANSYS for performance analysis of motor.

MODULE I SWITCHED RELUCTANCE MOTORS 07

Constructional features - principle of operation - Torque equation - Power controllers Characteristics and control - Microprocessor based controller.

MODULE II STEPPING MOTORS 07

Constructional features, principle of operation-modes of excitation torque, production in Variable Reluctance (VR) stepping motor- dynamic characteristics, Drive systems - circuit for open loop control- closed loop control of stepping motor.

MODULE III AC COMMUTATOR MOTORS 07

Principle of operation – Equivalent circuit – Phasor diagram – Performance of Repulsion motor and Universal motor

MODULE IV PERMANENT MAGNET MOTORS 07

Principle of operation – types – magnetic circuit analysis – EMF and Torque equations – Power Controllers – Motor characteristics and control of PMSM and BLDC motors.

MODULE V LINEAR MOTORS 07

Linear Induction motor (LIM) classification – construction – Principle of operation – Concept of current sheet – goodness factor – DC Linear motor (DCLM) types –

circuit equation , DCLM control applications ,Linear Synchronous motor(LSM) – Types - Performance equations – Applications.

MODULE VI CASE STUDY 10

Modeling and simulation – Switched Reluctance Machines – Permanent magnet BLDC Motor – PMSM – MAGNET 6.0, ANSYS software.

Total Hours: 45

REFERENCES:

1. Taylor E O, "The performance and design of AC Commutator motors", Sir Issac Pitman & Sons, London, 1998.
2. Kenjo T, "Stepping Motors and their Microprocessor Controls", Clarendon Press London, 1984.
3. Miller T J E, "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989.
4. Naser A and Boldea L,"Linear Electric Motors: Theory Design and Practical Applications", Prentice Hall Inc., New Jersey 1987.

OUTCOMES:

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

- Talent in selection of motor for various application
- A thorough understanding of various special electric machines and their applications.
- Able to analyse any electric machine.
- Ability to model small power rating of motor for real time application
- Software knowledge in Magnet, ANSYS for electrical application.
- Able to present the rudiments of linear machines.

EECY049	SOLAR AND ENERGY STORAGE SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To Study about solar modules and PV systems design and their applications
- To Deal with grid connected PV systems
- To Discuss about different energy storage systems

MODULE I INTRODUCTION 09

Characteristics of sunlight – semiconductors and P-N junctions –behavior of solar cells – cell properties – PV cell interconnection

MODULE II STAND ALONE PV SYSTEMS 09

Solar modules – storage systems – power conditioning and regulation - protection – stand alone PV systems design – sizing

MODULE III GRID CONNECTED PV SYSTEMS 09

PV systems in buildings – design issues for central power stations – safety – Economic aspect – Efficiency and performance - International PV programs

MODULE IV POWER CONDITIONING SCHEMES 08

DC Power conditioning Converters - Maximum Power point tracking algorithms - AC Power conditioners Synchronized operation with grid supply - Harmonic problem – building integrated PV systems.

MODULE V ENERGY STORAGE SYSTEMS 09

Impact of intermittent generation – Battery energy storage – solar thermal energy storage – pumped hydroelectric energy storage

MODULE VI APPLICATIONS 09

Water pumping – battery chargers – solar car – direct-drive applications –Space – Telecommunications.

Total Hours : 45

TEXT BOOKS

1. Eduardo Lorenzo G. Araujo, Solar electricity engineering of photovoltaic systems, Progensa,1994. 2. Stuart R.Wenham, Martin A.Green, Muriel E. Watt and Richard Corkish, Applied Photovoltaics, 2007,Earthscan, UK.

REFERENCES

1. Frank S. Barnes & Jonah G. Levine, Large Energy storage Systems Handbook , CRC Press, 2011.
2. Solar & Wind energy Technologies – McNeils, Frenkel, Desai, Wiley Eastern, 1990
3. Solar Energy – S.P. Sukhatme, Tata McGraw Hill,1987.

OUTCOMES:

Students will develop more understanding on solar energy storage systems:

- Students will develop basic knowledge on standalone PV system
- Students will understand the issues in grid connected PV systems
- Able to develop various power conditioning schemes for solar systems.
- Able to explain the Grid connected PV systems.
- Students will study about the modelling of different energy storage systems and their performances
- Students will attain more on different applications of solar energy

EECY050	**FUNDAMENTALS OF GRID CONNECTED PHOTO-VOLTAIC POWER ELECTRONIC CONVERTER DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To impart knowledge on constructional details and characteristics of solar panel.
- To familiarize theoretical concepts and control strategies, for extraction of maximum power from the solar power and its synchronization with the grid.

MODULE I INTRODUCTION 04

Characteristics of sunlight – semiconductors and P-N junctions –behaviour of solar cells – cell properties – PV cell interconnection

MODULE II OVERVIEW OF PHOTO VOLTAIC SYSTEMS AND CONVERTERS 08

Grid connection standards, Solar Cell Characteristics, Solar panel and converter configurations, Converter topologies, Grid filter topologies, Temporary storage

MODULE III CONTROL OF PHOTO-VOLTAIC CONVERTERS 09

Maximum power utilization of photo voltaic power sources, DC-DC Converter Control, DC-AC Converter control, Harmonic compensation, Grid synchronization, Anti Islanding

MODULE IV POWER CONDITIONING SCHEMES 09

DC Power conditioning Converters - Maximum Power point tracking algorithms - AC Power conditioners Synchronized operation with grid supply - Harmonic problem – building integrated PV systems.

MODULE V SYSTEM DESCRIPTION, MODELLING AND OPTIMIZATION 09

Converter topology and control description, P&O Maximum Power Point Tracker optimization, Phase Locked Loop PI Regulator, Current Regulator, Voltage Controller , Complete control system model.

MODULE VI SIMULATIONS 06

DC-DC Converter, DC-AC Converter- PLL, Current control, Voltage control, The LCL filter.

Total Hours: 45

TEXT BOOK

1. Svein Erik Evju,Fundamentals of Grid Connected Photo-Voltaic Power Electronic Converter Design', Norwegian University of Science and Technology.

REFERENCES

1. Eduardo Lorenzo G. Araujo, Solar electricity engineering of photovoltaic systems, Progensa,1994.
2. Stuart R.Wenham, Martin A.Green, Muriel E. Watt and Richard Corkish, Applied Photovoltaics, 2007,Earthscan, UK.
3. Frank S. Barnes & Jonah G. Levine, Large Energy storage Systems Handbook , CRC Press, 2011.
4. Solar & Wind energy Technologies – McNeils, Frenkel, Desai, Wiley Eastern, 1990
5. Solar Energy – S.P. Sukhatme, Tata McGraw Hill,1987.

OUTCOMES:

- Will become familiar with the operation of the components of PV systems, including solar modules, power control components, and the balance of system components.
- Able to carry out a credible design of a grid-connected PV system.
- Able to model and design MPPT and controllers of grid tied inverters.
- Use of simulation software for energy yield estimation

EECY051 SOLAR POWER SYSTEM DESIGN

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge, analyze and to design the modern semi-conductor devices and their applications in power Electronic controller for rectification, inversion, frequency conversion with improved performance.

MODULE I SOLAR POWER SYSTEM PHYSICS 07

Solar Cell Physics - Solar Cell Electronics - Types of Solar Cells Technologies - Concentrators - Solar Panel Arrays - Solar Power System Components.

MODULE II SOLAR POWER TECHNOLOGIES 08

Solar Power System Components - Crystalline Solar Photovoltaic Module Production - Amonix Megaconcentrators - Film Technologies - Solar Photovoltaic System Power Research and Development.

MODULE III SOLAR POWER SYSTEM DESIGN 09

Solar Power System Components and Materials - - Storage Battery Technologies - Solar Power System Wiring - Considerations for - Lightning Protection - Central Monitoring and Logging System Requirements - Ground-Mount and Roof-Mount Photovoltaic Module Installations - Shading Analysis and Solar Energy Performance Multiplier - Site Evaluation - Solar Power Design.

MODULE IV SOLAR POWER GENERATION PROJECT IMPLEMENTATION 07

Designing a Typical Residential Solar Power System - Example of Typical Solar Power System Design and Installation Plans for a Single Residential Unit - Commercial Applications -Small-Scale Solar Power Pumping Systems -Large-Capacity Solar Power Pumping Systems - Pump Operation Characteristics - Semitropic Open Field Single-Axis Tracking System PV Array

MODULE V ECONOMICS OF SOLAR POWER SYSTEMS 06

Current Preliminary Engineering Design - Meteorological Data - Energy Cost Factor - Project Cost Analysis - Feasibility Study Report.

MODULE VI PASSIVE SOLAR HEATING TECHNOLOGIES 08

Passive Solar Water Heating - Pool Heating - Concentrator Solar Technologies - Solar Cooling and Air Conditioning - Direct Solar Power Generation - Innovations in Passive Solar Power Technology.

Total Hours: 45

REFERENCES:

1. Mukund R. Patel, "Wind and Solar Power Systems Design, Analysis, and Operation", Published in 2006 by CRC Press, Taylor & Francis Group
2. Ned Mohan, Tore M. Undeland. "Power Electronics- Converters, Applications and Design", John Wiley & Sons (Asia) Private Ltd., 2003.
3. M.D.Singh , " Power Electronics"Tata McGraw-Hill Education, 07-Jul-2008
4. R W Erickson and D Makgimovic,"Fundamental of Power Electronics" Springer, 2001 2nd Edition.
5. Vedam Subrahmanyam, "Power Electronics", New Age International (P) Limited, New Delhi, 1997.
6. D.M.Mitchell, DC-DC Switching Regulator Analysis McGraw-Hill Ryerson, Limited, 1988

OUTCOMES:

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

- Understand the characteristics of solar cell.
- Understand the constructional details of solar panel.
- Know about the monitoring and commissioning of solar panel
- Know about the solar pumping and mechanical tracking of solar power generation system.
- Cost analysis of solar power generation system.

EEC 6125	**MODELING AND ANALYSIS OF ELECTRIC MACHINES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To give an in-depth input on generalized theory of electric machines.
- To impart knowledge on the Modeling aspects of reference frame theory and transformational variables of electrical machines using reference frame theory.
- To impart knowledge on Analysis of electric machines using the reference frame theory model.
- Prediction of torque and other related variables for static and dynamic analysis of electric machines.

MODULE I PRICIPLE OF ELECTOMAGNETIC ENERGY CONVERSION 07

Stored magnetic energy – Co-energy – flux-linkage vs current curves – Singly excited and Doubly excited systems – Force and Torque predictions.

MODULE II BASIC CONCEPTS OF ELECTRIC MACHINES 07

Generalized theory of electric machines – Concept of d-q model – Kron’s Primitive Model – Airgap MMF, Per phase machine inductance, Voltage and Torque equations for DC machine and AC machines.

MODULE III MODELING AND ANALYSIS OF DC MACHINES 09

Static and Rotating reference frames and Transformation Relationships – R, L, M, V, I and T equations using direct and quadrature axes in: Modeling of separately excited DC machines – Modeling of DC series machines – Influence of brush shift.

MODULE IV REFERENCE FRAME THEORY FOR 3-PHASE INDUCTION MACHINES 09

Modeling of 3-phase symmetrical induction machines – V, I, L and T equations in actual variables and hypothetical variables – Rotor transformation – V, I, L and T equations in transformed machine.

MODULE V REFERENCE FRAME THEORY FOR 3-PHASE SYNCHRONOUS MACHINES 08

Modeling of Synchronous Machines – Determination of self inductances and mutual inductances – Transformation of self inductances and mutual inductances – Dynamic Modeling of AC machines.

MODULE VI MODELING OF SPECIAL ELECTRIC MACHINES 05

Modeling aspects of Magnetic Systems – Modeling Switched Reluctance Machines – Case Study (Modeling of DC and AC machines.)

Total Hours: 45

REFERENCES:

1. C.V. Jones, 'The Unified Theory of Electric Machines', Butterworth, London, 1967
2. R. Krishnan, 'Switched Reluctance Motor Drives', CRC Press.
3. MAGNET software rule book for Case study purpose.

OUTCOMES:

- Ability to understand the rudiments of electric machines for modeling and analysis.
- Ability to apply generalized machine theory for DC and AC machine modeling.
- Ability to apply Reference Frame theory for DC and AC machine modeling and analysis.
- Ability to model and analyze any new electric machine.
- Ability to use modeling software tools for machine modeling and analysis.

EEC 6126 ADVANCED POWER SEMICONDUCTOR DEVICES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the basics of devices selection.
- To understand the static and dynamic characteristics of power semiconductor devices
- To enable the students for the selection of devices for different power electronics applications
- To get the knowledge about the datasheet of power semiconductor Devices.
- To understand the control and firing circuit for different devices.
- Study about the thermal protection of the Devices

MODULE I INTRODUCTION 06

Power switching devices overview; Attributes of an ideal switch, application requirements, and circuit symbols. Power handling capability, Device selection strategy – On-state and switching losses -Power diodes - Types, forward and reverse characteristics, switching characteristics – rating.

MODULE II SILICON POWER ELECTRONIC SEMICONDUCTORS DEVICES and DRIVER CIRCUITS 10

Construction, static characteristics, switching characteristics and Gate characteristics of Thyristor – GTO – MOSFET- IGBTs – SIC – GAN – FCT – RCT. Converter grade and inverter grade SCR. High Speed Opto-Couplers – Zero Crossing Detectors - Optically Isolated High Voltage and High Current sensing circuits, Driver ICs**:** MOC series SCR , IR2XXX Series Full Bridge and Half Bridge MOSFET / IGBT Driver ICs.

,

MODULE III DATASHEET RATINGS FOR SEMICONDUCTOR DEVICES 09

Standards, Symbols and terms-Maximum ratings – Thermal Impedance and resistance-Component (type) designation system - Mechanical data –Safe Operating Area during switching and short circuit.

MODULE IV PROTECTION AND NOISE 07

Over voltage, Over current and gate protections and Design of snubber circuits - Noise generated due to switching-Common noise sources in SMPS-Noises Due to High frequency transformer-Measurement of Noise.

MODULE V THERMAL PROTECTION 07

Heat transfer – conduction, convection and radiation, Cooling – liquid cooling, vapour – phase cooling, Guidance for heat sink selection- heat sink types and design-Electrical analogy of thermal components– Mounting types.

MODULE VI CASE STUDY 06

Switching characteristics and VI characteristics of Thyristor – GTO – MOSFET-IGBTs – SIC – GAN. Design of drivers and Snubber Circuit.

Total Hours: 45

REFERENCES:

1. Rashid M.H., “Power Electronics circuits, Devices and Applications”, Prentice Hall India, Third Edition, New Delhi, 2008.
2. M.D. Singh and K.B.Khanchandani, “Power Electronics”, Tata McGraw Hill, 2006.
3. Vedam Subramanian, "Power Electronics", New Age International (P) Limited, New Delhi, 1997.
4. Ned Mohan, Undcland and Robins, “Power Electronics – Concepts, applications and Design, John Wiley and Sons, Singapore, 2000.
5. B.W. Williams, “Power Electronics – Devices, Drivers, Applications and Passive Components”, Macmillan, 1992.
6. Dr.-Ing. Arendt Wintrich,Dr.-Ing. Ulrich Nicolai,Dr. techn. Werner Tursky,Univ.-Prof. Dr.-Ing. Tobias Reimann,Application Manual Power Semiconductors ,published by SEMIKRON International GmbH

OUTCOMES:

At the end of the course, the student will

- Understand the operation and characteristics of the semiconductor devices
- Understand the gate drive circuits and its necessity.
- Select suitable component for the particular application with the help of data sheet.
- Design protection circuit for the semiconductor devices.
- Design heat sinks for semiconductor devices

EEC6127	ANALYSIS OF POWER CONVERTERS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge, analyze and to design the power Electronic converters.
- To discuss in depth the main families of PWM strategies.
- To enable the students to design Power Factor Correction(PFC) controller.

MODULE I AC – DC CONVERTER 08

Circuits and operating principles: Analysis of Single phase and three phase controlled rectifiers with RLE loads - Input line current harmonics and power factor – Fourier Analysis of controlled rectifiers - Dual converters.

MODULE II PERFORMANCE CHARACTERISTICS OF PHASE CONTROLLED CONVERTERS 08

Performance parameters: Dc voltage ratio – input displacement angle – displacement factor - power factor – current distortion factor- Harmonic content of DC terminal voltage and input current - THD of Two quadrant converters and one quadrant converters - reduction of reactive loading of the supply by the Two quadrant converter by means of consecutive firing angle control.

MODULE III PHASE CONTROLLED CYCLOCONVERTER 08

Symmetrical - open delta - Ring connected cycloconverter circuits - Harmonic distortion in the output voltage – General Expression for Three pulse waveform for an arbitrary firing angle control method - Harmonic series of three and six pulse cycloconverters – cosine wave control method – Firing pulse generation: Functional schemes – End stop control : reverence voltage - clamp method – pulse isolating output stage.

MODULE IV AC – AC 08

Analysis of Single-phase and Three phase AC Voltage Controllers- Matrix converter - Bi-directional switch topologies, Modulation techniques for matrix converters, Concept of Direct AC-AC frequency Converter.

MODULE V ACTIVE FRONT END RECTIFIERS 08

Overview of Power Factor Correction Approaches - Unity power factor rectifiers - Resistor emulation principle –mathematical modeling – control schemes- Design of feedback compensators -front end rectifiers with real and reactive power control

– Phase shifter.

MODULE VI DUAL ACTIVE BRIDGE CONVERTER 07

Dual active bridge converter – circuit configuration – steady state analysis – steady state model of DC-DC DAB Converters - Steady-State Model for AC-AC DAB Converters - soft switching analysis – DAB for Solid state transformer.

REFERENCES:

1. M. H. Rashid, "Power Electronics - Circuits, Devices and Applications", Pearson Education India, 2003
2. Ned Mohan, Tore M. Undeland. "Power Electronics- Converters, Applications and Design", John Wiley & Sons (Asia) Private Ltd., 2003.
3. M.D.Singh, " Power Electronics"Tata McGraw-Hill Education, 07-Jul-2008.
4. Eric Monmasson, Power Electronic Converters PWM Strategies and Current Control Techniques, John Wiley & Sons, Inc, © ISTE Ltd 2011.
5. ON Semiconductor "Power Factor Correction (PFC) Handbook", HBD853/D Rev. 5, Apr−2014.
6. D.M.Mitchell, DC-DC Switching Regulator Analysis McGraw-Hill Ryerson, Limited, 1988.

OUTCOMES:

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

- Understand the concept of Converters, choppers, and AC voltage controllers.
- Select the suitable devices for the required applications in power Electronic controller for rectification, inversion, frequency conversion.
- Use these devices to Design controllers for the AC and DC drive systems.
- Provides a comprehensive overview of PFC circuits and details of operation and design considerations for commonly used PFC circuits.
- Able to learn more about advanced power electronics converters.

EEC 6235 SOLID STATE AC & DC DRIVES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the stable steady-state operation and transient dynamics of a motor-load system.
- To study and analyze the operation of the converter / chopper fed dc drive and to solve simple Problems.
- To study and understand the operation of both classical and modern induction motor drives.
- To understand the differences between synchronous motor drive and induction motor drive and to learn the basics of permanent magnet synchronous motor drives with converter.
- To analyze and design the current and speed controllers for a closed loop solid-state DC and AC motor drive and simulation using a software package

MODULE I FUNDAMENTAL OF DC AND AC MOTOR 06

Components of electrical Drives-electric machines, power converter, controllers-dynamics of electric drive - torque equation - equivalent values of drive parameters - components of load torques types of load - four quadrant operation of a motor– steady state stability– load equalization – classes of motor duty - determination of motor rating

MODULE II SENSORS FOR DRIVES 06

Hall Effect Sensors – Mechanical Sensors for speed and angular positions – Absolute Encoders – Incremental Encoders – Resolvers –

MODULE III CLOSED LOOP CONTROL OF DC AND AC DRIVES 09

Transient analysis of separately excited motor – converter control of dc motors – analysis of separately excited & series motor with 1 - phase and 3 - phase converters – dual converter – analysis of chopper controlled dc drives – converter ratings and closed loop control – transfer function of self, separately excited DC motors – linear transfer function model of power converters – sensing and feeds back elements – current and speed loops, P, PI and PID controllers – response comparison – simulation of converter and chopper fed DC drive.

MODULE IV SCALAR METHODS FOR IM DRIVES FROM STATOR SIDE 09

Stator voltage control of induction motor–torque-slip characteristics-operation with different types of loads – operation with unbalanced source voltages and single phasing – analysis of induction motor fed from non - sinusoidal voltage supply – stator frequency control - variable frequency operation – V/F control, controlled current and controlled slip operation – effect of harmonics and control of harmonics

MODULE V SCALAR METHODS FOR IM DRIVES FROM ROTOR SIDE 08

PWM inverter drives – multiquadrant drives – rotor resistance control – slip torque characteristic – torque equations, constant torque operation – slip power recovery scheme – torque equation – torque slip characteristics – power factor – methods of improving power factor – limited sub synchronous speed operation – super synchronous speed operation

MODULE VI SYNCHRONOUS MOTOR DRIVES 07

Principle of synchronous motor control – Introduction to CSI Single phase and three phase CSI – CSI fed synchronous machines – adjustable frequency operation of synchronous motors –voltage source inverter drive with open loop control – self controlled synchronous motor with electronic commutation – self controlled synchronous motor drive using load commutated thyristor inverter.

Total Hours: 45

REFERENCES:

1. R. Krishnan, Electrical Motor Drives, PHI 2003.
2. G.K.Dubey, Powersemiconductor controlled drives, Prentice Hall- 2000.
3. G.K.Dubey, Fundamentals of Electrical Drives, Narosa-1999.
4. A. Nasar, Boldea , Electrical Drives, Second Edition, CRCPress-2006.
5. M. A. ElSharkawi , Fundamentals of Electrical Drives , Thomson Learning - 2000. 49
6. W. Leohnard, Control of Electric Drives,-Springer-2001.
7. Murphy and Turnbull, Power Electronic Control of AC motors, Pergamon Press, 1973.
8. Vedam Subrahmaniam, Electric Drives, TMH-2000.

OUTCOMES:

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

- Analyze the system considering the steady state and dynamic characteristics.
- Ability to design a closed loop control of AC and DC drives.
- Talent in selection of motor for various applications.
- Software knowledge in Matlab for drive application.
- Modeling AC,DC machines with appropriate loads
- Design a system with suitable parameters to control a drive system.

		L	T	P	C
EECY023	**ELECTRICAL INSULATION IN POWER APPARATUS AND SYSTEMS**	**2**	**0**	**0**	**2**

OBJECTIVES

- To expose the students to different insulating materials that could be used in high voltage technologies.
- To understand the breakdown mechanisms in various types of insulating materials.
- To understand the high voltage testing procedure for insulators.

MODULE I INSULATING MATERIALS IN HIGH VOLTAGE TECHNOLOGY 07

Requirement for insulating material - Properties and testing of insulating materials: Electrical properties, Thermal properties, Chemical Properties - Natural inorganic insulation materials, Synthetic inorganic insulation materials, Natural inorganic insulation materials, Synthetic organic insulating materials

MODULE II ELECTRIC FIELD AND BREAKDOWN VOLTAGE 06

Determination of electric fields, Maximum field strengths in geometrically similar configurations, Formulation for the calculation of the breakdown voltage, Fields in multi-dielectric, isotropic materials.

MODULE III BREAKDOWN MECHANISM IN GASES, SOLIDS AND LIQUIDS 09

Breakdown theory of gases: Charge carriers in gases, Classical gas laws, self sustaining discharges, Breakdown mechanism in strong inhomogeneous fields, Breakdown characteristics under transient voltages - Breakdown theory in solid insulating materials: Charge carriers at low field strengths, Intrinsic breakdown, Thermal breakdown, Partial discharge breakdown, Mechanism of failure in nanocomposite materials - Breakdown theory in Liquid insulation: Electric strength of technical configurations with insulating liquids, Theory of breakdown in liquid insulation

MODULE IV TESTING OF INSULATORS 08

High voltage testing procedures - statistical treatment of results - dynamic properties of dielectrics - Dielectric loss and capacitance measurements - Partial discharge measurements.

Total Hours: 30

REFERENCES

1. N.H. Malik, A.A. Al-Arainy, M.I. Qureshi, Electrical insulation in power system, Marcell&Dekker Inc, 1998.
2. Paul Gill, Electrical power equipment maintenance and testing, Second Edition, CRC Press, 2008.
3. A. Bradwell (ed.), Electrical insulation, Peter Peregrinus Ltd., London, England, 1983.
4. E. Kuffel, W.S. Zaengl, J. Kuffel, High voltage Engineering fundamentals, Newnes (an imprint of Elsevier),2005.
5. Dieter Kind, Hermann Karner, High voltage insulation technology, Translated from the German by Y. Narayana Rao, Friedr. Vieweg&Sohn, Braunschweig, 1985.

OUTCOMES

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

- Choose appropriate insulating material depending upon the application.
- Determine the electric fields and breakdown voltages in electric insulators.
- Explain the breakdown phenomena in gaseous, solid and liquid insulating materials.
- Use appropriate testing procedure to test the high voltage insulators.

EECY024 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.

MOUDULE I GENERAL ASPECTS, METHODOLOGY AND APPROACH 09

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 08

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 07

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 06

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

1. 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, A Wiley Interscience Publication
7. L.C. Witte, P.S. Schmidt, D.R. Brown ‘Industrial Energy Management and Utilization’, 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.

EECY025 WIDE AREA MEASUREMENT SYSTEMS

L	T	P	C
2	0	0	2

OBJECTIVE:

- To understand the operating principle of wide area measurement systems and performance of phasor measurement units.

MODULE I MATHEMATICAL BACKGROUND 08

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 PAHSOR 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 06

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 06

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.

EECY026	POWER SYSTEM SIMULATION SOFTWARE	L	T	P	C
		0	0	2	1

OBJECTIVE:

- 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.

EECY027	**SIMULATION OF POWER ELECTRONIC CIRCUITS**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

OBJECTIVE:

- To expose the students to various proprietary and open source software for simulation of power electronic circuits.

COURSE DESCRIPTION:

Study of both proprietary and open source software for simulation of power electronic circuits:

PROPRIETARY SOFTWARE

- PSIM
- PSPICE
- FEADMOS
- VISSIM

OPEN SOURCE SOFTWARE

- PYTHON POWER ELECTRONICS
- ZenitPCB
- NgSpice
- LTSpice

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 electronic circuit using any one of the software.

EECY028 ELECTRIC VEHICLES

L	T	P	C
1	0	0	1

History and development of on-road Electric Vehicles (EV). Different configurations of hybrid EVs with block diagram representation, merits & demerits of different configurations in view of vehicle efficiency and energy storage system. - Energy storage systems – Basics of EV batteries, specifications, power density, Energy density, Charging & Discharging cycle and recommended methodologies for charging. Recommended drives for EV and converter topology used in EVs.

Total Hours: 15

REFERENCES

1. Ron Hodkinson & John Fenton, Light Weight Electric/ Hybrid Vehicle design, Butterworth Publications, Heinemann
2. H. A. Kiehne, Battery Technology Handbook, MARCEDLE KKEIRN,C
3. Sandeep Dhameja , Electric vehicle battery systems , Butterworth–Heinemann

References:

- A.G. Phadke, J.S. Thorp, ‘Computer Relaying for Power Systems’, John Wiley and Sons Ltd., Research Studies Press Limited, 2 nd Edition, 2009
- A.G. Phadke, J.S. Thorp, ‘Synchronized Phasor Measurements and Their Applications’, Springer Publications, 2008

GENERAL ELECTIVES

GECY101 PROJECT MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

The objectives of the course would be to make the students

- Learn to e valuate and choose an optimal project and build a project profile.
- Attain knowledge on risk identification and risk analysis
- Gain insight into a project plan and components
- Familiar with various gamut of technical analysis for effective project implementation
- Learn to apply project management techniques to manage resources.

MODULE I INTRODUCTION & PROJECT INITIATION 09

Introduction to project and project management - projects in contemporary organization – The project life cycle - project initiation - project evaluation methods & techniques - project selection criteria - project profile.

MODULE II RISK ANALYSIS 09

Sources of risk: project specific - competitive - industry specific - market and international risk – perspectives of risk – risk analysis: sensitivity analysis - scenario analysis - breakeven analysis - simulation analysis - decision tree analysis – managing/mitigating risk – project selection under risk.

MODULE III PROJECT PLANNING & IMPLEMENTATION 09

Project planning – importance – functions - areas of planning - project objectives and policies - steps in planning process - WBS – capital requirements - budgeting and cost estimation - feasibility analysis - creation of project plan – project implementation: pre-requisites - forms of project organization

MODULE IV TECHNICAL ANALYSIS 09

Technical analysis for manufacturing/construction/infrastructure projects – process/technology - materials and inputs - product mix - plant capacity – plant location and site selection – plant layout - machinery and equipment – structures and civil works – schedule of project implementation – technical analysis for software projects.

MODULE V PROJECT MANAGEMENT TECHNIQUES 09

Project scheduling - network construction – estimation of project completion time – identification of critical path - PERT & CPM – crashing of project network - complexity of project scheduling with limited resources - resource allocation - resource leveling – resource smoothing – overview of project management software.

Total Hours: 45

REFERENCES:

1. Projects: Planning, Analysis, Financing, Implementation and Review, Prasanna Chandra, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
2. Project Management and Control, Narendra Singh, Himalaya Publishing, New Delhi, 2015.
3. A Management Guide to PERT/CPM, Jerome, D. Weist and Ferdinand K. Levy, Prentice Hall of India, New Delhi, 1994.

OUTCOMES:

On successfully completing this course, the student will be able to:

- Evaluate & select a project as well as develop a project profile.
- Identify various risks associated with the project and manage it effectively.
- Prepare a detailed project plan addressing its components.
- Perform technical analysis for effective project implementation
- Apply project management techniques for maximizing resource utilization.

GECY102	SOCIETY, TECHNOLOGY & SUSTAINABILITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To aware of new technologies through advances in Science and Engineering.
- To make them realise the profound impact on society.
- To understand the ethical issues raised by technological changes and its effect on society.
- To introduce students a broad range of perspectives on the adoption and use of technologies.
- To make them realize the need of sustainability in the context of emerging technologies.

MODULE I TECHNOLOGY AND ITS IMPACTS 09

Origin and evolution of technologies – Nature of technology- Innovation – Historical Perspective of technology – Sources of technological change - Co-evolution of technology and economy – Scientific knowledge and technological advance – Science and Engineering aspects of Technology – Impact on the Society – Social and Ethical Issues associated with technological change – Social and environmental consequences - Impact of technological change on human life – Technology and responsibility – Technology and social justice.

MODULE II TECHNOLOGY AND ITS ADVANCEMENT 09

Sociological aspects of technology – Ethics and technology – Technology and responsibility – International Economics, Globalisation and Human Rights – Sustainability and Technology – Population and environment - Technology, Energy and Environment – Organisations and technological change.

MODULE III SOCIETY AND TECHNOLOGY 09

Impact of technologies on contemporary society – Role of society in fostering the development of technology – Response to the adaption and use of technology – Impact of technology on developer and consumers – Technological change and globalisation.

MODULE IV IMPACT OF A SPECIFIC TECHNOLOGY ON HUMAN WELFARE 09

Impact of the following technologies on Human life – Medical and Biomedical – Genetics Technology – Electronics and Communications – Electronic media

Technology – Information Systems Technology – Nanotechnology – Space Technology and Energy Technology.

MODULE V THE IMPORTANCE OF SUSTAINABILITY 09

Sustainability – A brief history – Concepts and contexts for sustainability – Ecological imbalance and biodiversity loss – Climate change – Population explosion. Industrial ecology – systems approach to sustainability – Green engineering and technology- sustainable design- sustainable manufacturing- Green consumer movements – Environmental ethics – Sustainability of the planet Earth – Future planning for sustainability.

Total Hours: 45

REFERENCES:

1. Volti Rudi, "Society and Technology Change", 6th Edition, Worth publishers Inc, USA, 2009.
2. Arthur W.A, "The nature of Technology: What it is and how it evolves", Free Press, NY, USA, 2009.
3. Winston M and Edelbach R, "Society, Ethics and Technology", 3rd Edition, San Francisco, USA, 2005.
4. Martin A.A Abraham, "Sustainability Science and Engineering: Defining Principles", Elsevier Inc, USA, 2006.
5. R.V.G.Menon, "Technology and Society", Pearson Education, India, 2011.

OUTCOMES:

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

- Understand the benefits of modern technology for the well-being of human life.
- Connect sustainability concepts and technology to the real world challenges.
- Find pathway for sustainable society.

GECY103 ARTIFICIAL INTELLIGENCE

L	T	P	C
3	0	0	3

OBJECTIVES:

- Expose the history and foundations of artificial intelligence.
- Showcase the complexity of working on real time problems underlying the need for intelligent approaches.
- Illustrate how heuristic approaches provide a good solution mechanism.
- Provide the mechanisms for simple knowledge representation and reasoning.
- Highlight the complexity in working with uncertain knowledge.
- Discuss the current and future applications of artificial intelligence.

MODULE I HISTORY AND FOUNDATIONS 08

History – Scope – Influence from life – Impact of computing domains - Agents in environments - Knowledge representation – Dimensions of Complexity – Sample application domains – Agent structure.

MODULE II SEARCH 10

Problem solving as search – State spaces – Uninformed Search – Heuristic search – Advanced search – Constraint satisfaction - Applications.

MODULE III KNOWLEDGE REPRESENTATION AND REASONING 10

Foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications.

MODULE IV REPRESENTING AND REASONING WITH UNCERTAIN KNOWLEDGE 08

Probability, connection to logic, independence, Bayes rule, Bayesian networks, probabilistic inference, sample applications.

MODULE V CASE STUDY AND FUTURE APPLICATIONS 09

Design of a game / Solution for problem in student’s domain. Natural Language processing, Robotics, Vehicular automation – Scale, Complexity, Behaviour – Controversies.

Total Hours: 45

TEXT BOOK:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, Third Edition, 2010.
2. David Poole, Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010.
3. Nils J. Nilsson, The Quest for Artificial Intelligence, Cambridge University Press, Online edition, 2013.
4. Keith Frankish, William M. Ramsey (eds) The Cambridge Handbook of Artificial Intelligence, Cambridge University Press, 2014.

OUTCOMES:

Students who complete this course will be able to

- Discuss the history, current applications, future challenges and the controversies in artificial intelligence.
- Apply principle of AI in the design of an agent and model its actions.
- Design a heuristic algorithm for search problems.
- Analyze and represent the fact using logic for a given scenario
- Represent uncertainty using probabilistic models
- Develop a simple game or solution using artificial intelligence techniques.

GECY104 GREEN COMPUTING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To focus on the necessity of green computing technology.
- To expose to various issues with information technology and sustainability.
- To attain knowledge on the technologies for enabling green cloud computing.
- To elaborate on the energy consumption issues
- To illustrate a Green and Virtual Data Center
- To develop into a Green IT Technologist.

MODULE I INTRODUCTION 08

Trends and Reasons to Go Green - IT Data Center Economic and Ecological Sustainment - The Growing Green Gap: Misdirected Messaging, Opportunities for Action - IT Data Center “Green” Myths and Realities - PCFE Trends, Issues, Drivers, and Related Factors - Green Computing and Your Reputation- Green Computing and Saving Money- Green Computing and the Environment

MODULE II CONSUMPTION ISSUES 10

Minimizing power usage – Cooling - Electric Power and Cooling Challenges - Electrical – Power -Supply and Demand Distribution - Determining Energy Usage - From Energy Avoidance to Efficiency - Energy Efficiency Incentives, Rebates, and Alternative Energy Sources - PCFE and Environmental Health and Safety Standards- Energy-exposed instruction sets- Power management in power-aware real-time systems.

MODULE III NEXT-GENERATION VIRTUAL DATA CENTERS 09

Data Center Virtualization - Virtualization beyond Consolidation - Enabling Transparency - Components of a Virtual Data Center - Datacenter Design and Redesign - Greening the Information Systems - Staying Green- Building a Green Device Portfolio- Green Servers and Data Centers- Saving Energy

MODULE IV TECHNOLOGIES FOR ENABLING GREEN AND VIRTUAL DATA CENTERS 08

Highly Effective Data Center Facilities and Habitats for Technology - Data Center Electrical Power and Energy Management - HVAC, Smoke and Fire Suppression

- Data Center Location - Virtual Data Centers Today and Tomorrow - Cloud Computing, Out-Sourced, and Managed Services.

MODULE V SERVERS AND FUTURE TRENDS OF GREEN COMPUTING 10

Server Issues and Challenges - Fundamentals of Physical Servers - Types, Categories, and Tiers of Servers - Clusters and Grids - Implementing a Green and Virtual Data Center - PCFE and Green Areas of Opportunity- 12 Green Computer Companies- What's in Green computer science-Green off the Grid aimed for data center energy evolution-Green Grid Consortium- Green Applications- Green Computing Making Great Impact On Research

Total Hours: 45

REFERENCES:

1. Bud E. Smith,"Green Computing Tools and Techniques for Saving Energy, Money, and Resources", Taylor & Francis Group, CRC Press, ISBN-13: 978-1-4665-0340-3, 2014.
2. Jason Harris, "Green Computing and Green IT Best Practices, On Regulations and Industry Initiatives, Virtualization and power management, materials recycling and Tele commuting, Emereo Publishing .ISBN-13: 978-1-9215-2344-1,2014.
3. Ishfaq Ahmed & Sanjay Ranka, "Handbook of Energy Aware and Green Computing", CRC Press, ISBN: 978-1-4665-0116-4, 2013.
4. Kawahara, Takayuki, Mizuno, "Green Computing with Emerging Memory", Springer Publications, ISBN:978-1-4614-0811-6, 2012
5. Greg Schulz, "The Green and Virtual Data Center", CRC Press, ISBN-13:978-1-4200-8666-9, 2009.
6. Marty Poniatowski, "Foundation of Green IT: Consolidation, Virtualization, Efficiency, and ROI in the Data Center", Printice Hall, ISBN: 9780-1-3704-375-0, 2009.

OUTCOMES:

Students who complete this course will be able to

- Demonstrate issues relating to a range of available technologies, systems and practices to support green computing.
- Select appropriate technologies that are aimed to reduce energy consumption.
- Address design issues needed to achieve an organizations' green

computing objectives.

- Analyze the functionality of Data Centers.
- Critically evaluate technologies and the environmental impact of computing resources for a given scenario.
- Compare the impact of Green Computing with other computing techniques.

GECY105 GAMING DESIGN

L	T	P	C
3	0	0	3

OBJECTIVES:

- To master event-based programming
- To learn resource management as it relates to rendering time, including level-of-detail and culling.
- To become familiar with the various components in a game or game engine.
- To explore leading open source game engine components.
- To become familiar of game physics.
- To be compatible with game animation.

MODULE I INTRODUCTION 09

Magic Words – What Skills Does a Game Designer Need? – The Most Important Skill -The Five Kinds of Listening-The Secret of the Gifted.

MODULE II THE DESIGNER CREATES AN EXPERIENCE 09

The Game Is Not the Experience -Is This Unique to Games? -Three Practical Approaches to Chasing Rainbows -Introspection: Powers, Perils, and Practice -Dissect Your Feelings -Defeating Heisenberg -Essential Experience.

MODULE III THE EXPERIENCE IN THE PLAYER MIND AND GAME MECHANICS 08

Modeling – Focus -Empathy – Imagination – Motivation – Space – Objects, Attributes, and States – Actions – Rules.

MODULE IV GAMES THROUGH AN INTERFACE 09

Breaking it Down – The Loop of Interaction – Channels of Information – Other Interface.

MODULE V BALANCED GAME MECHANICS 10

Balance – The Twelve Most Common Types of Game Balance – Game Balancing Methodologies - Balancing Game Economies.

Total Hours: 45

REFERENCES:

1. Jesse Schell, "The Art of Game Design: A Book of Lenses", 2nd Edition ISBN-10: 1466598646, 2014.
2. Ashok Kumar, Jim Etheredge, Aaron Boudreaux, “Algorithmic and Architectural Gaming Design: Implementation and Development", 1st edition, Idea Group, U.S ISBN-10: 1466616342, 2012.
3. Katie Salen Tekinba, Melissa Gresalfi, Kylie Peppler, Rafi Santo, "Gaming the System - Designing with Gamestar Mechanic" MIT Press , ISBN-10: 026202781X, 2014.
4. James M. Van Verth, Lars M. Bishop "Essential Mathematics for Games and Interactive Applications", Third Edition, A K Peters / CRC Press, ISBN-10: 1482250926, 2015.

OUTCOMES:

Students who complete this course will be able to

- Realize the basic history and genres of games
- Demonstrate an understanding of the overall game design process
- Explain the design tradeoffs inherent in game design
- Design and implement basic levels, models, and scripts for games
- Describe the mathematics and algorithms needed for game programming
- Design and implement a complete three-dimensional video game

GECY106 SOCIAL COMPUTING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To create original social applications, critically applying appropriate theories and effective practices in a reflective and creative manner.
- To critically analyze social software in terms of its technical, social, legal, ethical, and functional features or affordances.
- To encourage the development of effective communities through the design, use, and management of social software.
- To give students with a base of knowledge and advances for them to critically examine existing social computing services.
- To plan and execute a small-scale research project in social computing in a systematic fashion.
- To become familiar with the concept of computational thinking.

MODULE I BASIC CONCEPTS 09

Networks and Relations: Relations and Attributes, Analysis of Network Data, Interpretation of network data -New Social Learning – Four Changes that Shift Work - Development of Social Network Analysis: Sociometric analysis and graph theory, Interpersonal Configurations and Cliques – Analysing Relational Data.

MODULE II SOCIAL LINK 09

Individual Actors, Social Exchange Theory, Social Forces, Graph Structure, Agent Optimization Strategies in Networks – Hierarchy of Social Link Motivation- Social Context.

MODULE III SOCIAL MEDIA 08

Trends in Computing – Motivations for Social Computing – Social Media: Social relationships, Mobility and Social context – Human Computation – Computational Models- Business use of social Media.

MODULE IV SOCIAL INFORMATION FILTERING 09

Mobile Location Sharing – Location based social media analysis – Social Sharing and Social Filtering – Automated recommender Systems – Traditional and Social Recommender Systems.

MODULE V SOCIAL NETWORK STRATEGY 10

Application of Topic Models – Opinions and Sentiments – Recommendation Systems – Language Dynamics and influence in online communities – Psychometric analysis – Case Study: Social Network Strategies for surviving the zombie apocalypse.

Total Hours: 45

REFERENCES:

1. Tony Bingham, Marcia Conner, "The New Social Learning, Connect. Collaborate. Work", 2nd Edition, ATD Press, ISBN-10:1-56286-996-5, 2015.
2. Nick Crossley, Elisa Bellotti, Gemma Edwards, Martin G Everett, Johan Koskinen, Mark Tranmer, "Social Network Analysis for Ego-Nets", SAGE Publication, 2015.
3. Zafarani, Abbasi and Liu, Social Media Mining: An Introduction, Cambridge University Press, 2014.
4. Christina Prell, "Social Network Analysis: History, Theory and Methodology", 1st Edition, SAGE Publications Ltd, 2012.
5. John Scott, "Social Network Analysis", Third Edition, SAGE Publication, 2013.
6. Jennifer Golbeck, "Analyzing the Social Web", Elsevier Publication, 2013.
7. Huan Liu, John Salerno, Michael J. Young, "Social computing and Behavioral Modeling", Springer Publication, 2009.

OUTCOMES:

Students who complete this course will be able to

- Realize the range of social computing applications and concepts.
- Analyze data left after in social media.
- Recognize and apply the concepts of computational models underlying social computing.
- Take out simple forms of social diagnostics, involving network and language models, applying existing analytic tools on social information.
- Evaluate emerging social computing applications, concepts, and techniques in terms of key principles.
- Design and prototype new social computing systems.

GECY107 SOFT COMPUTING

L	T	P	C
3	0	0	3

OBJECTIVES:

The aim of the course is to

- Enumerate the strengths and weakness of soft computing
- Illustrate soft computing methods with other logic driven and statistical method driven approaches
- Focus on the basics of neural networks, fuzzy systems, and evolutionary computing
- Emphasize the role of euro-fuzzy and hybrid modeling methods
- Trace the basis and need for evolutionary computing and relate it with other soft computing approaches

MODULE I SOFT COMPUTING - BASICS 06

Soft computing – Hard Computing – Artificial Intelligence as the basis of soft computing – Relation with logic driven and statistical method driven approaches- Expert systems – Types of problems: Classification, Functional approximation, Optimizations – Modeling the problem – Machine Learning – Hazards of Soft Computing – Current and future areas of research

MODULE II ARTIFICIAL NEURAL NETWORK 12

Artificial Neuron – Multilayer perceptron – Supervised learning – Back propagation network –Types of Artificial Neural Network: Supervised Vs Un Supervised Network – Radial basis function Network – Self Organizing Maps – Recurrent Network – Hopfield Neural Network – Adaptive Resonance Theory – Issues in Artificial Neural Network – Applications

MODULE III FUZZY SYSTEMS 09

Fuzzy Logic – Membership functions – Operators – Fuzzy Inference systems – Other sets: Rough sets, Vague Sets – Fuzzy controllers - Applications

MODULE IV NEURO FUZZY SYSTEMS 09

Cooperative Neuro fuzzy systems – Neural network driven fuzzy reasoning – Hybrid Neuro fuzzy systems – Construction of Neuro Fuzzy systems: Structure Identification phase, Parameter learning phase – Applications

MODULE V EVOLUTIONARY COMPUTING 09

Overview of evolutionary computing – Genetic Algorithms and optimization – Genetic Algorithm operators – Genetic algorithms with Neural/Fuzzy systems – Variants of Genetic Algorithms– Population based incremental learning – Evolutionary strategies and applications

Total Hours: 45

TEXTBOOKS:

1. Samir Roy, "Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms", Pearson, 2013
2. Anupam Shukla, Ritu Tiwari and Rahul Kala, "Real life applications of Soft Computing", CRC press, 2010.
3. Fakhreddine O. Karray, "Soft Computing and Intelligent Systems Design: Theory, Tools and Applications", Pearson, 2009

OUTCOMES:

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

- Enumerate the theoretical basis of soft computing
- Explain the fuzzy set theory
- Discuss the neural networks and supervised and unsupervised learning networks
- Demonstrate some applications of computational intelligence
- Apply the most appropriate soft computing algorithm for a given situation

GECY108	EMBEDDED SYSTEM PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the design of embedded computing systems with its hardware and software architectures.
- To describe entire software development lifecycle and examine the various issues involved in developing software for embedded systems.
- To analyze the I/O programming and Embedded C coding techniques
- To equip students with the software development skills necessary for practitioners in the field of embedded systems.

MODULE I INTRODUCTION OF EMBEDDED SYSTEM 09

Embedded computing – characteristics and challenges – embedded system design process – Overview of Processors and hardware units in an embedded system – Compiling, Linking and locating – downloading and debugging – Emulators and simulators processor – External peripherals – Memory testing – Flash Memory.

MODULE II SOFTWARE TECHNOLOGY 09

Software Architectures, Software development Tools, Software Development Process Life Cycle and its Model, Software Analysis, Design and Maintenance.

MODULE III INPUT/OUTPUT PROGRAMMING 09

I/O Instructions, Synchronization, Transfer Rate & Latency, Polled Waiting Loops, Interrupt – Driven I/O, Writing ISR in Assembly and C, Non Maskable and Software Interrupts

MODULE IV DATA REPRESENTATION IN EMBEDDED SYSTEMS 09

Data representation, Twos complement, Fixed point and Floating Point Number Formats, Manipulating Bits in -Memory, I/O Ports, Low level programming in C, Primitive data types, Arrays, Functions, Recursive Functions, Pointers, Structures & Unions, Dynamic Memory Allocation, File handling, Linked lists, Queues, Stacks.

MODULE V EMBEDDED C 09

Embedded Systems programming in C – Binding & Running Embedded C program in Keil IDE – Dissecting the program - Building the hardware. Basic techniques for reading & writing from I/O port pins – switch bounce - LED Interfacing using Embedded C.

Total Hours: 45

REFERENCES:

1. Marilyn Wolf, "Computers as components ", Elsevier, 2012.
2. Qing Li and Carolyn Yao, "Real-Time Concepts for Embedded Systems", CMP Books, 2003.
3. Daniel W. Lewis, "Fundamentals of embedded software where C and assembly meet", Pearson Education
4. Michael Bass, "Programming Embedded Systems in C and C++", Oreilly, 2003.

OUTCOMES:

On completion of this course the student will be able to

- Design the software and hardware components in embedded system
- Describe the software technology
- Use interrupt in effective manner
- Use keil IDE for programming
- Program using embedded C for specific microcontroller
- Design the embedded projects

GECY109 PRINCIPLES OF SUSTAINABLE DEVELOPMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge in the concepts and dimensions of sustainable development.
- To gain knowledge on the framework for achieving sustainability.

MODULE I CONCEPT OF SUSTAINABLE DEVELOPMENT 09

Environment and Development - Population poverty and Pollution – Global and Local environmental issues – Resource Degradation- Greenhouse gases – Desertification-industrialization – Social insecurity, Globalization and environment. History and emergence of the concept of sustainable development-Objectives of Sustainable Development.

MODULE II COMPONENTS AND DIMENSIONS OF SUSTAINABLE DEVELOPMENT 0**9**

Components of Sustainability – Complexity of growth and equity – Social economic and environmental dimensions of sustainable development – Environment – Biodiversity – Natural – Resources – Ecosystem integrity – Clean air and water – Carrying capacity – Equity, Quality of Life, Prevention, Precaution – Preservation and Public Participation Structural and functional linking of developmental dimensions.

MODULE III FRAMEWORK FOR ACHIEVING SUSTAINABILITY 09

Operational guidelines – interconnected prerequisites for sustainable development Empowerment of Women, children, Youth, Indigenous People, Non-Governmental Organizations Local Authorities, Business and industry – Science and Technology for sustainable development – performance indicators of sustainability and assessment mechanism – Constraints and barriers for sustainable development.

MODULE IV SUSTAINABLE DEVELOPMENT OF SOCIO ECONOMIC SYSTEMS 09

Demographic dynamics of sustainability – Policies for socio-economic development – Strategies for implementing eco-development programmes Sustainable development through trade – Economic growth – Action plan for implementing sustainable development – Urbanization and sustainable Cities – Sustainable Energy and Agriculture – sustainable livelihoods.

MODULE V SUSTAINABLE DEVELOPMENT AND INTERNATIONAL RESPONSE 09

Role of developed countries in the development of developing countries – international summits – Stockholm to Johannesburg – Rio principles – Agenda- Conventions – Agreements – Tokyo Declaration – Doubling statement – Tran boundary issues integrated approach for resources protection and management

Total Hours: 45

REFERENCES:

1. Sayer J. and Campbell, B., The Science of Sustainable Development: Local Livelihoods and the Global environment - Biological conservation restoration & Sustainability, Cambridge university Press, London, 2003.
2. M.K. Ghosh Roy. and Timberlake, Sustainable Development, Ane Books Pvt. Ltd, 2011.
3. Mackenthun K.M., Concepts in Environmental Management, Lewis Publications London, 1999.
4. APJ Abdul Kalam and Srijan Pal Singh, Target 3 Billion: Innovative Solutions Towards Sustainable Development, Penguin India, 2011

OUTCOMES:

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

- Describe the concepts of sustainable development
- Define the components and dimensions of sustainable development
- Outline the Frame work for achieving sustainability.
- State the policies and strategies for implementing sustainable development for Socio economic programmes.
- Examine the role of developed countries in sustainable development.

GECY110 QUANTITATIVE TECHNIQUES IN MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVE:

To impart knowledge on

- Concepts of operations research
- Inventory control in production management
- Financial management of projects
- Decision theory and managerial economics

MODULE I OPERATIONS RESEARCH 09

Introduction to Operations research – Linear programming – Graphical and Simplex Methods, Duality and Post-Optimality Analysis – Transportation and Assignment Problems

MODULE II PRODUCTION MANAGEMENT 09

Inventory control, EOQ, Quantity Discounts, Safety Stock – Replacement Theory – PERT and CPM – Simulation Models – Quality Control.

MODULE III FINANCIAL MANAGEMENT 09

Working Capital Management – Compound Interest and Present Value methods – Discounted Cash Flow Techniques – Capital Budgeting.

MODULE IV DECISION THEORY 09

Decision Theory – Decision Rules – Decision making under conditions of certainty, risk and uncertainty – Decision trees – Utility Theory.

MODULE V MANAGERIAL ECONOMICS 09

Cost concepts – Break even Analysis – Pricing techniques – Game Theory applications.

Total Hours: 45

REFERENCES:

1. Vohra, N.D. , Quantitative Techniques in Management, Tata McGraw Hill Co., Ltd, New Delhi, 2009.
2. Seehroeder, R.G., Operations Management, McGraw Hill, USA, 2002.
3. Levin, R.I, Rubin, D.S., and Stinsonm J., Quantitative Approaches to Management, McGraw Hill Book Co., 2008.

4. Frank Harrison, E., The Managerial Decision Making Process, Houghton Miffin Co. Boston, 2005.
5. Hamdy A. Taha, Operations Research- An Introduction, Prentice Hall, 2002.

OUTCOME:

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

- Apply the concepts of operations research for various applications
- Create models for inventory control in production management
- Compute the cash flow for a project
- Choose a project using decision theory based on the risk criterion.
- Apply the concepts of managerial economics in construction management

GECY111 PROGRAMMING USING MATLAB & SIMULINK	**L**	**T**	**P**	**C**
	1	**0**	**2**	**2**

OBJECTIVES:

The aim of this course is to:

- Teach students how to mathematically model engineering systems
- Teach students how to use computer tools to solve the resulting mathematical models. The computer tool used is MATLAB and the focus will be on developing and solving models of problems encountered in engineering fields

MODULE I INTRODUCTION TO MATLAB AND DATA PRESENTATION 10

Introduction to MATLAB-Vectors, Matrices -Vector/Matrix Operations & Manipulation- Functions vs scripts- Making clear and compelling plots-Solving systems of linear equations numerically and symbolically.

Lab Experiments

1. Study of basic matrix operations and manipulations.
2. Numerical and symbolical solution of linear equations.

MODULE II ROOT FINDING AND MATLAB PLOT FUNCTION 10

Linearization and solving non-linear systems of equations- The Newton-Raphson method- Integers and rational numbers in different bases- Least squares regression -Curve fitting-Polynomial fitting and exponential fitting.

Lab Experiments

1. Solution of non linear equations using Newton-Raphson method.
2. Determination of polynomial fit and exponential fit for the given data.

MODULE III LINEAR AND NON-LINEAR DIFFERENTIAL EQUATIONS 13

Numerical integration and solving first order, ordinary differential equations (Euler's method and Runge-Kutta) - Use of ODE function in MATLAB- Converting second order and higher ODEs to systems of first order ODEs- Solving systems of higher order 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 - Plot Function –Saving & Painting Plots.

Lab Experiments

1. Solution of fourth order linear differential equations using
   a. Trapezoidal Rule

   b. Euler method
2. Solution of fourth order non-linear differential equations using
   a. Modified Euler method
   b. Runge – Kutta method

MODULE IV INTRODUCTION OF SIMULINK 12

Simulink & its relations to MATLAB – Modeling a Electrical Circuit- Modeling a fourth order differential equations- - Representing a model as a subsystem- Programme specific Simulink demos.

Lab Experiments

1. Solution of fourth order non-linear differential equations using simulink.
2. Programme specific experiment based on simulink.

Total Hours (Including Practicals): 45

REFERENCE:

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

GECY112 JAVA PROGRAMMING

L	T	P	C
1	0	2	2

OBJECTIVES:

- To learn the fundamentals of Java programming such as data types, variables and arrays.
- To study the syntax and necessity of decision making and iterative statements.
- To create a class and invoke the methods.
- To instigate programming in overloading of methods.
- To emphasize the concept of packages.
- To learn the exception handling routines.

MODULE I INTRODUCTION TO JAVA PROGRAMMING 08

History and Evolution of Java – Overview of Java – Data types, variables and arrays – Operators – Control statements.

MODULE II METHODS AND CLASSES 07

Class fundamentals – Declaring objects – Methods – Constructors – Garbage collection – Overloading methods – Constructor overloading – Access control – Inheritance – Packages - Exception handling.

L: 15, P: 30, Total Hours: 15

REFERENCES:

1. Herbert Schildt, “Java The Complete Reference”, 9th Edition, Oracle Press, 2014, ISBN: 978007180855-2.
2. Nicholas S. Williams, **“**Professional Java for Web Applications: Featuring WebSockets, Spring Framework, JPA Hibernate and Spring Security (WROX)”, John Wiley & Sons, 2014, ISBN: 978111865651-8.
3. E Balagurusamy, “Programming with Java”, 5th Edition, Tata Mcgraw Hill, 2014.
4. Yashavant Kanetka**, “**Let Us Java”, 2nd Edition, BPB Publications, 2012**.**

OUTCOMES:

Students who complete this course will be able to

- Implement basic Java programming.
- Create a class and invoke methods for real world problems.

- Construct simple overloading of methods programs.
- Implement various types of inheritance concepts.
- Describe the access control mechanism.
- Handle exception thrown while implementing programming.

GECY113 PYTHON PROGRAMMING

L	T	P	C
1	0	2	2

OBJECTIVES:

- To learn the list and records of python programming.
- To study the control statements and string functions of python.
- To instigate the fundamental python programming.
- To emphasize GUI in python.
- To integrate python with embedded systems.
- To implement programs in python.

MODULE I INTRODUCTION TO PYTHON PROGRAMMING 08

Installation and environment set up – syntax used in python – variable types – operators – Loops – decision making – string functions - formatted files - GUI basics.

MODULE II EMBEDDED PROGRAMMING USING PYTHON 07

Web interface – system tools – script execution context - Motion-triggered LEDs – Python - Arduino prototyping-storing and plotting Arduino data-Remote home monitoring system.

L: 15, P: 30, Total Hours: 15

REFERENCES:

1. Nick Goddard, “Python Programming”, 2nd edition, ISBN: 1533337772, 2016.
2. Pratik Desai, “Python Programming for Arduino”, 1st edition, Packt publishing, 2015, ISBN: 9781783285938.
3. Mark Lutz, Learning Python: Powerful Object-Oriented Programming, 5th Edition, O'Reilly Media, 2013.
4. Richard H. Barnett, Sarah Cox, Larry O'Cull, “Embedded C Programming and the Atmel AVR”, 2nd edition, 2006.
5. Michael Barr, Anthony Massa, “Programming Embedded Systems”, 2nd Edition, O'Reilly Media, 2006.

OUTCOMES:

Students who complete this course will be able to

- Implement date and time function programming using python.

- Write formatted file programming.
- Construct simple python programs.
- Create web interface using python programming
- Develop embedded system with python programming.
- Build Arduino prototype using python programming.

GECY114 INTELLECTUAL PROPERTY RIGHTS (IPR)

L	T	P	C
1	0	0	1

OBJECTIVES:

- To study about Intellectual property rights and its need
- To explore the patent procedure and related issues

MODULE I INTRODUCTION 07

Introduction and the need for intellectual property right (IPR) – IPR in India – Genesis and Development – IPR in abroad – Important examples of IPR – Copyrights, Trademarks, Patents, Designs, Utility Models, Trade Secrets and Geographical Indications – Industrial Designs

MODULE II PATENT 08

Concept of Patent – Product / Process Patents & Terminology – Duration of Patents – Law and Policy Consideration Elements of Patentability –- Patentable Subject Matter – Procedure for Filing of Patent Application and types of Applications – Procedure for Opposition – Revocation of Patents – Working of Patents- Patent Agent – Qualification and Registration Procedure – Patent databases and information system – Preparation of patent documents – Process for examination of patent application- Patent infringement – Recent developments in patent system

Total Hours: 15

REFERENCES

1. B.L.Wadehra; Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India 2000
2. Ajit Parulekar and Sarita D’ Souza, Indian Patents Law – Legal & Business Implications; Macmillan India ltd , 2006
3. P. Narayanan; Law of Copyright and Industrial Designs; Eastern law House, Delhi, 2010.
4. E. T. Lokganathan, Intellectual Property Rights (IPRs): TRIPS Agreement & Indian Laws Hardcover, 2012
5. Alka Chawla, P N Bhagwati , Law of Copyright Comparative Perspectives 1st Edition, LexisNexis, 2013
6. V. K. Ahuja, Law Relating to Intellectual Property Rights 2nd Edition, LexisNexis, 2nd Edition, 2013

7. Deborah E. Bouchoux, Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets, 2015
8. Jatindra Kumar Das, Law of Copyright, PHI Learning, 2015

COURSE OUTCOMES:

Students should be able to

- Identify the various types of intellectual property and their value
- Apply the procedure to file a patent and to deal the related issues
- Search and extract relevant information from various intellectual database