UNIVERSITY VISION AND MISSION

VISION

B.S. Abdur Rahman Institute of Science & 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
M.Tech (Power Systems Engineering)

PROGRAMME EDUCATIONAL OBJECTIVES

- To develop competent and skilled power system engineers to meet the needs of society globally
- To equip the students to tackle the problems and challenges faced by the power sector
- To train the students in appropriate software tools to model, analyze and solve power system problems
- To meet the needs of clean and renewable energy sector and to address the environmental and social issues
- To train the students in simulated realistic industrial environment and modern engineering practices

PROGRAMME OUTCOMES :

On completion of Program, the graduates will

- have ability to provide solutions for power system problems to meet global requirements
- have skills to apply various industrial power system software packages in the areas of planning and operation
- posses knowledge in emerging areas such as deregulation of power system, smart grid and clean energy
- be able to work in multi functional teams and deliver results

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)
Seethakathi Estate, G.S.T. Road, Vandalur, Chennai - 600 048.

REGULATIONS 2013
FOR
M.TECH. DEGREE PROGRAMMES
(WITH AMENDMENTS INCORPORATED TILL JUNE 2015)

B.S. ABDUR RAHMAN UNIVERSITY, CHENNAI 48.

REGULATIONS -2013 FOR M.TECH / MCA / M.Sc. DEGREE PROGRAMMES

(With amendments incorporated till June 2015)

1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires

i) **"Programme"** means 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 of this University.

vi) **"Dean (Academic Affairs)"** means Dean (Academic Affairs) of B.S.Abdur Rahman University.

vii) **"Dean (Student Affairs)"** means Dean(Student Affairs) of B.S.Abdur Rahman University.

viii) **"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.	Full Time
M.Tech.	Part Time – Day / Evening
M.C.A.	Full Time
M. Sc.	Full Time
M. Sc.	Full Time

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 Projectwork in part-time mode for valid reasons, shall apply to the Dean (Academic Affairs) through the Head of the Department, if the student satisfies the clause 2.3.4 of this Regulation. 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 - Day time

In this mode of study, the students are required to attend classes for the courses registered along with full time students.

2.2.4 Part time - Evening

In this mode of study, the students are required to attend normally classes in the evening and on Saturdays, if necessary.

2.2.5 A part time student is not permitted to convert to full time mode of study.

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 A student eligible for admission to M.Tech. Part Time / Day Time programme shall have his/her permanent place of work within a distance of 65km from the campus of this Institution.

2.3.5 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. (Full Time) – (Lateral Entry)	4	8
M.Sc. (Full Time)	4	8

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

i. Core courses

ii. Elective courses

iii. Project work / thesis / dissertation

iv. Laboratory Courses

v. Case studies

vi. Seminars

vii. 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. degree Mech./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)	
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. in ECE / Electronics / EIE / ICE / EEE
		M.Tech.(Signal Processing)	
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)
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 and Predictive Analytics)	
		M.Tech. (Computer Science and Engineering with specialization in Big Data Analytics)	
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)	

ELIGIBLE ENTRY QUALIFICATIONS FOR ADMISSION TO P.G. PROGRAMMES

Sl. No.	Name of the Department	P.G. Programmes offered	Qualifications for admission
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. (Full Time) – (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)	
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)	
13	Chemistry	M.Sc.(Chemistry)	B.Sc (Chemistry) of B.Sc. (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 credit range
M.Tech.	75 to 85
M.C.A.	120 to 130
M.Sc.	75 to 85

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
* 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.

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	**Non-project Semester**	**Project semester**
M.Tech. (Full Time)	15 to 29	12 to 20
M.Tech. (Part Time)	6 to 18	12 to 16
M.C.A. (Full Time)	15 to 29	12 to 20
M.Sc. (Full Time)	15 to 25	12 to 20

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

3.10 A student may be permitted by the Head of the Department to choose electives offered from other PG programmes either within the Department or from other Departments up to a maximum of three courses during the period of his/her study, provided the Heads of the Departments offering such courses also agree.

3.11 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.

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

3.13 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.

3.14 PROJECT WORK/THESIS/DISSERTATION

3.14.1 Project work / Thesis / Dissertation shall be carried out under the supervision of a qualified teacher in the concerned Department.

3.14.2 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.

3.14.3 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.

3.14.4 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.

3.14.5 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.

3.14.6 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.

3.14.7 A student who has acquired the minimum number of total credits prescribed in the Curriculum for the award of Masters Degree will not be permitted to enroll for more courses to improve his/her cumulative grade point average (CGPA).

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 and enroll for all the courses.

7.2 For the subsequent semesters registration for the courses will be done by the student during a specified week before the semester-end examination 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 Adviser for the choice of courses. The Registration form shall be filled in and signed by the student and the Faculty Adviser.

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 Adviser. 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 should have registered for all preceding semesters before registering for a particular semester.

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)	18 (III semester)
M.Tech. (Part time)	18 (V semester)
M.C.A. (Full time)	45 (V semester)
M.C.A. (Full time) – (Lateral Entry)	22 (V semester)
M.Sc.(Full time)	30 (IV semester) if project is in IV semester 18 (III semester) if project is in III semester

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.

10.3 Every student should have been certified by the HOD that his / her conduct and discipline have been satisfactory.

11.0 ATTENDANCE

11.1 Attendance rules for all Full Time Programme and Part time - day 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 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.

13.0 ASSESSMENTS AND EXAMINATIONS

13.1 The following rule shall apply to the full-time and part-time 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, in each lecture based course.

13.3 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.

13.4 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

$$GPA = \frac{\sum_{i=1}^{n} (C_i)(GPi)}{\sum_{i=1}^{n} C_i} \qquad Where\ n = number\ of\ courses$$

where Ci 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:

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.

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 (FOUR SEMESTERS / FULL TIME)

CURRICULUM

SEMESTER I

Sl. No	Course Code	Course Title	L	T	P	C
1	MAB6185	Applied Mathematics for Electrical Engineers	3	1	0	4
2	EEB6101	Research Methodology	3	0	0	3
3	EEB6102	Power System Analysis	3	1	0	4
4	EEB6103	Power System Protection	3	0	0	3
5	EEB6104	Systems Theory	3	0	0	3
6		Elective I	3	0	0	3
7	EEB6105	Advanced Power System Simulation Lab - I	0	0	3	1
8	EEB6106	Seminar in Power System Engineering	0	1	0	1
						22

SEMESTER II

Sl. No	Course Code	Course Title	L	T	P	C
1	EEB6211	Power system Operation and Control	3	0	0	3
2	EEB6212	Power System Dynamics	3	0	0	3
3	EEB6213	Flexible AC Transmission systems	3	0	0	3
4	EEB6214	Restructured Power Systems	3	0	0	3
5		Elective II	3	0	0	3
6		Elective III	3	0	0	3
7	EEB6215	Advanced Power System Simulation Laboratory II	0	0	3	1
8	EEB6216	Design / Simulation Project	0	0	2	1
						20

SEMESTER III

Sl. No	Course Code	Course Title	L	T	P	C
1.		Elective - IV	3	0	0	3
2.		Elective - V	3	0	0	3
3.		Elective - VI	3	0	0	3
4.	EEB7101	Project Management	3	0	0	3
5.	EEB7102	Project Work Phase - I	0	0	12	6#
						12

SEMESTER IV

Sl. No	Course Code	Course Title	L	T	P	C
1	EEB7102	Project work - Phase II	0	0	36	18*
						18 + 6 = 24

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

TOTAL CREDITS : 78

LIST OF ELECTIVES

Sl. No	Course Code	Course
1.	EEBY01	Electro Magnetic Field Computation and Modeling
2.	EEBY02	Analysis of Electrical Machines
3.	EEBY03	EHV Power Transmission
4.	EEBY04	Special Electrical Machines and Controllers
5.	EEBY05	Power Quality
6.	EEBY06	Power system Planning and Reliability
7.	EEBY07	Advanced Digital Signal Processing
8.	EEBY08	Control System Design
9.	EEBY09	High Voltage Switch Gear
10.	EEBY10	Optimal Control and Filtering
11.	EEBY11	Advanced Power System Dynamics
12.	EEBY12	System Identification and Adaptive Control
13.	EEBY13	Industrial Power System Analysis and Design
14.	EEBY14	High Voltage Direct Current Transmission
15.	EEBY15	Wind energy Conversion Systems
16.	EEBY16	Application of MEMS Technology
17.	EEBY17	Outdoor Insulators
18.	EEBY18	Power Distribution Systems
19.	EEBY19	Electrical Transients in Power Systems
20.	EEBY20	High voltage Pulse Generation, Measurement and Testing for Life Sciences
21.	EEBY21	Smart Power Grid
22.	EEBY22	Automotive Infotainment Systems
23.	EEBY23	Soft Computing Techniques
24.	EEBY34	Power Electronics in Wind and Solar Power Conversion
25.	SSBY01	Society, Technology and Sustainability

SEMESTER I

MAB6185	**APPLIED MATHEMATICS FOR ELECTRICAL ENGINEERS**	**L T P C**
		3 1 0 4

OBJECTIVES:

The aim of this course is to

- familiarize students with of Advanced Matrix Theory.
- expose the students to Operations Research using concepts of linear programming and basic queuing models.
- enable the students to obtain numerical solutions of Ordinary and Partial differential equations.

MODULE I ADVANCED MATRIX THEORY 8

Matrix norms – Jordan canonical form – Generalized eigenvectors – Singular value decomposition – Pseudo inverse – Least square approximations – QR algorithm.

MODULE II LINEAR PROGRAMMING 8

Basic concepts – Graphical and Simplex methods –Transportation problem – Assignment problem.

MODULE III ONE DIMENSIONAL RANDOM VARIABLES 8

Random variables – Probability functions – Moments – Moment generating functions and their properties - Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions– Function of random variables.

MODULE IV QUEUING MODELS 8

Poisson Process – Markovian Queues – Single and Multi-server Models – Little’s formula – Machine Interference Model – Steady State analysis – Self Service Queue.

MODULE V INITIAL VALUE PROBLEM FOR ORDINARY DIFFERENTIAL EQUATIONS 5

Taylor’s series method – Euler’s and modified Euler’s methods – Fourth order Runge-Kutta method for first order equations

MODULE VI BOUNDARY VALUE PROBLEMS IN PARTIAL DIFFERENTIAL EQUATIONS 8

Numerical solution of PDE - Solution of Laplace's and Poisson equations - Liebmann's iteration process – Solution of heat conduction equation by Schmidt explicit formula and Crank Nicolson implicit scheme - Solution of wave equation.

Total Hours: 60

REFERENCES:

1. Lewis.D.W., “Matrix Theory”, Allied Publishers, Chennai 1995.
2. Elsgoltis, “Differential Equations and Calculus of Variations”, MIR Publishers, Moscow,1970.
3. Taha, H.A., “Operations research - An Introduction”, Mac Millan publishing Co., 1982.
4. Ochi, M.K., “Applied Probability and Stochastic Processes”, John Wiley & Sons, 1992.
5. Jain M.K., Iyengar S.R.K. and Jain R.K., “Numerical methods for Scientific and Engineering Computation”, New Age International (P) Ltd, Publishers, 2003.

OUTCOMES:

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

- solve algebraic eigenvalue problems from practical areas.
- solve problems of linear programming and basic queueing models.
- solve real life problems using standard distributions.
- solve initial and boundary value problems numerically.

EEB6101	RESEARCH METHODOLOGY	L T P C
		3 0 0 3

OBJECTIVES:

- The aim of the course is to introduce scholars to a number of perspectives on research and to broaden their conceptions of what research involves. This course covers research design, information retrieval, problem formulation, use of statistical techniques, evaluation and writing of research reports, papers and ethics in research.

MODULE I RESEARCH PROBLEM FORMULATION 7

Research - objectives - types, Research process, solving engineering problems Identification of research topic - formulation of research problem, literature survey and review.

MODULE II RESEARCH DESIGN 8

Research design - meaning and need - basic concepts - Different research designs, Experimental design - principle - important experimental designs, Design of experimental setup, Mathematical modeling - Simulation - validation and experimentation, Dimensional analysis - similitude.

MODULE III USE OF STATISTICAL TOOLS IN RESEARCH 8

Importance of statistics in research - concept of probability – popular distributions - sample design. Hypothesis testing, ANOVA, Design of experiments - factorial designs - orthogonal arrays, Multivariate analysis - correlation and regression, Curve fitting.

MODULE IV ANALYSIS AND INTERPRETATION OF DATA 7

Research Data analysis - interpretation of results- correlation with scientific facts - repeatability and reproducibility of results - accuracy and precision - limitations,Use of optimization techniques - Traditional methods – evolutionary optimization techniques.

MODULE V THE RESEARCH REPORT 7

Purpose of written report - audience - synopsis writing - preparing papers for International Journals, Thesis writing - organization of contents - style of writing - graphs and charts - referencing, Oral presentation and defence, Ethics in research, Patenting, IPR.

MODULE VI EVOLUTIONARY ALGORITHMS 8

Introduction to evolutionary algorithm – Genetic Algortithm, simulated annealing, neural networks, optimization of neural networks, Fuzzy systems.

Total Hours: 45

REFERENCES:

1. Kothari C.R., “Research, Methodology - Method and Techniques”, New Age International (P) Ltd., New Delhi, Reprint 2003.
2. R.Ganesan, “Research Methodology for Engineers”, MJP Publishers, 2011.
3. Doebelin, Ernest O., “Engineering Experimentation: planning, execution, reporting”, McGraw - Hill International edition, 1995.
4. George E. Dieter., “Engineering Design”, McGraw Hill - International edition, 2000.
5. Rao S.S.,“Engineering Optimization - theory and Practice”, New Age International (P) New Delhi, reprint, 2001.
6. Madhav S. Phadke, “Quality Engineering using Robust Design”, Prentice Hall, Eaglewood Cliffs, New Jersey, 1989.
7. Dan Jones, “Technical writing style”, Pearson Education Company, Massachusetts, 1998.
8. Abdul Rahim R., “Thesis writing: A Manual for Researchers”, New Age International (P) Ltd., 1996.
9. Timothy J.Ross, “Fuzzy Logic with Engg Applications”, Wiley Publications, 2nd Edition, 2004.
10. P.J. Van Laarhoven& E.H. Aarts,”Simulated Annealing: Theory and Applications (Mathematics and Its Applications”, Kulwar academic Publisher Group,1992
11. David E. Goldberg, “Genetic Algorithms in Search, Optimization, and Machine

Learning", Pearson Education Inc and Darling Kindersley Publishing Inc, 2009.

OUTCOMES:

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

- The research scholar is expected to have attained proficiency in formulating a research problem and use statistical tools in the analysis and interpretation of data pertaining to the research.
- The student is expected to follow ethics in his research and bring out a comprehensive research report.
- The student is also expected to present technical papers related to the area of research.

EEB6102 POWER SYSTEM ANALYSIS L T P C

3 1 0 4

OBJECTIVES:

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

MODULE I SOLUTION TECHNIQUE 8

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 8

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; Net Interchange power control in Multi-area power flow analysis: ATC, Assessment of Available Transfer Capability (ATC) using Repeated Power Flow method.

MODULE III OPTIMAL POWER FLOW 8

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.

MODULE IV SHORT CIRCUIT ANALYSIS 8

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 TRANSIENT STABILITY ANALYSIS 8

Introduction, Numerical Integration Methods: Euler and Fourth Order Runge-Kutta methods, Algorithm for simulation of SMIB and multi-machine system with classical synchronous machine model; Factors influencing transient stability, Numerical stability and implicit Integration methods.

MODULE VI DC POWERFLOW AND DC OPF 5

Electricity trading in Restructured Power system – DC Power flow model and solution; DC OPF method for Market Clearing in Electricity Primary Market; Shift Factor Matrix for incorporating Transmission line constraint; Numerical example and solution.

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.

OUTCOMES:

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

- Ability to perform load flow study and interpret the result effectively for tomorrow's operational problem.
- Ability to perform short circuit studies and interpret the result for designing the circuit breaker and protection system in long term planning problem.
- Ability to perform transient stability study and interpret the result effectively for long term planning problem.

EEB6103 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.

- To understand the Fault Characteristics of individual Power System elements
- Knowledgeable about the tripping characteristics of various protective relays and matching them
- The various schemes of protection employed in Generator and Transformer protection
- Significance of Over Current Protective Schemes
- The relays used for protection of Transmission lines, bus bars, etc. including Electro Mechanical and Numerical Relays

MODULE I EQUIPMENT PROTECTION 8

Transformer Protection: 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.

Generator Protection: Electrical circuit of the generator -Various faults and abnormal operating conditions - Rotor faults -Abnormal operating conditions; Numerical examples for typical transformer and generator protection schemes.

MODULE II OVER CURRENT PROTECTION 8

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 relay - Static over current relays; Numerical example for a radial feeder.

MODULE III DISTANCE PROTECTION OF TRANSMISSION LINES 8

Drawbacks of over Current protection – Introduction to distance Protection – Simple impedance relay – Reactance relay – Mho relay - comparison between distance relays – Distance protection of a three Phase line - Reasons for inaccuracy of distance relay reach.

MODULE IV CARRIER AIDED PROTECTION OF TRANSMISSION LINES 8

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 for acceleration of zone II – Phase comparison relaying.

MODULE V BUSBAR PROTECTION 5

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 busbar differential scheme.

MODULE VI NUMERICAL PROTECTION 8

Introduction – Block diagram of numerical relay - Sampling theorem - Correlation with a reference wave – Least Error Squared (LES) technique - Digital filtering - Numerical over Current protection – Numerical transformer differential protection. Numerical distance protection of transmission line.

Total Hours: 45

REFERENCES:

1. Y.G. Paithankar and S.R Bhide, “Fundamentals of Power System Protection”, Prentice-Hall of India, 2010.
2. P.Kundur, “Power System Stability and Control”, McGraw-Hill, 2008.
3. Badri Ram and D.N. Vishwakarma, “Power System Protection and Switchgear”, Tata McGraw- Hill Publishing Company, 2011.

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.
- Tripping characteristics of various protective relays and matching them.
- Various schemes employed in Generator and Transformer protection
- Significance of Over Current Protective Schemes
- Distance and Carrier Protection of Transmission lines.

EEB6104 SYSTEMS THEORY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce the concept of state variable representation of physical systems
- To introduce the concept of Controllability, Stabilisability ,Detectability and Observability .
- To evaluate Stability of Linear and Non Linear Systems.

MODULE I STATE VARIABLE REPRESENTATION 8

Introduction- Concept of state – State equation for dynamic systems –Time invariance and linearity - Non uniqueness of state model – State Diagrams.

MODULE II SOLUTION OF STATE EQUATION 8

Existence and uniqueness of solutions to continuous time state equations-Solution of nonlinear and linear time varying state equations – Evaluation of matrix exponential - System modes – Role of eigen values and eigen vectors.

MODULE III CONTROLLABILITY AND OBSERVABILITY 8

Controllability and Observability – Stabilizability and Detectability – Test for continuous time systems – Time varying and time invariant case – Output controllability.

MODULE IV STABILITY FOR LINEAR SYSTEMS 6

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.

MODULE V STABILITY FOR NON LINEAR SYSTEMS 7

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 MODAL CONTROL 8

Introduction – SISO and MIMO systems – the effect of state feedback on controllability and observability – pole placement by state feedback for SISO systems – Full Order and reduced order observers.

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 student is expected to possess knowledge and achieve skills on the following:

- Ability to design observer using pole placement techniques.
- Ability to analyze complex systems using mathematical models.
- Ability to analyze the stability of Linear and Non-Linear Systems.

EEB6105	**ADVANCED POWER SYSTEM SIMULATION LABORATORY- I**	**L T P C** **0 0 3 1**

OBJECTIVES:

- To study and develop programs for steady state analysis of Power systems using Newton-Raphson method Fast decoupled method.
- To study and develop programs for transient stability analysis of power systems.
- To study and analyse electromagnetic transients in power systems.

LIST OF EXPERIMENTS

1. Development of Load flow analysis program by Newton-Raphson method using MAT LAB
2. Development of Load flow analysis program by FDPF method using MATLAB.
3. Development of Transient stability program for single machine-infinite bus system using classical machine model using MATLAB.
4. Transient stability analysis of multi machine power system using EUROSTAG.
5. Contingency analysis: Calculation of Generator shift factors and line outage distribution factors using MATLAB.
6. Economic dispatch using lambda-iteration method using C language.
7. Economic Dispatch with line flow constraints using MATLAB.
8. Unit commitment: Priority-list schemes and dynamic programming using MATLAB.
9. Analysis of switching surge using EMTP: Energisation of a long distributed-parameter line.
10. Simulation of Transient over voltages using PSCAD

OUTCOMES:

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

- perform load flow studies using Gauss seidal, Newton Raphson and fast decoupled method.

- short circuit studies for singe phase to ground fault and three phase fault.
- Perform transient and small signal stability study
- Perform simulation of transient over voltages.
- Find optimal scheduling using economic dispatch programme.

EEB6106 SEMINAR IN POWER SYSTEM ENGINEERING

L	T	P	C
0	1	0	1

OBJECTIVES:

- To understand how research papers are written and how to read and review the papers critically and efficiently
- To enable the student to acquire knowledge in any of the current topics relevant to power system engineering or any other allied area in the absence of a text book
- To impart skills necessary for presenting and defending a research work.

COURSE DESCRIPTION

The student is expected to undertake a detailed study on a chosen topic relevant to power system engineering or any other allied area, under the supervision of a faculty member as well as to give presentations on the topic. The topic should be based on research papers published in refereed journals/ conferences or original research work conducted by the student.

Every student is expected to present a minimum of three seminars in a semester. Each seminar will be assessed by the course teacher. A final presentation also should be given at the end of the semester and it would be assessed by the department committee. Final grade will be awarded based on the performance in all the continuous assessments and the final assessment. 50% weightage should be given to continuous assessment and 50% weightage for the final assessment, while awarding the grades.

OUTCOMES:

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

- Do a self assessment on his/her presentation skills and improve upon the weaker areas.
- Listen to a scientific presentation and to ask pertinent questions regarding the material presented.
- Actively participate in a discussion of strengths and weaknesses of a research work presented by scholars.
- Critically evaluate the technical work presented in journals/conferences and present such materials in a seminar.
- Defend approaches and conclusions by providing appropriate answers to questions posed by the audience.

SEMESTER II

EEB6211 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.

MODULE I LOAD FORECASTING 8

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 7

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 8

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 8

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 7

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 7

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:

- Proper understanding of basics of power system operation and control
- Ability to do optimal generation scheduling with and without transmission loss
- Ability to carry out real time unit commitment problem.
- Better understanding of load forecasting, automatic generation control, Hydro thermal co-ordination, SCADA and state estimation.

EEB6212 POWER SYSTEM DYNAMICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To model and analyse the dynamics of power system with its synchronous machines, turbines and various controllers when subjected to small signal and large signal disturbances and to design the system with enhanced stability.

MODULE I INTRODUCTION TO POWER SYSTEM STABILITY 3

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 9

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 9

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 modelling: 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 9

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.

MODULE V SMALL-SIGNAL STABILITY ANALYSIS WITH CONTROLLERS 9

Effects of Excitation System: Equations with definitions of appropriate K-constants and simple thyristor excitation system and AVR, block diagram with the excitation system, analysis of effect of AVR on synchronizing and damping components using a numerical example, Power System Stabilizer: Block diagram with AVR and PSS, Illustration of principle of PSS application with numerical example, Block diagram of PSS with description, system state matrix including PSS, analysis of stability with numerical a example. Multi-Machine Configuration: Equations in a common reference frame, equations in individual machine rotor coordinates, illustration of formation of system state matrix for a two-machine system with classical models for synchronous machines, illustration of stability analysis using a numerical example. Principle behind small-signal stability improvement methods: delta-omega and delta P-omega stabilizers.

MODULE VI ENHANCEMENT OF SMALL SIGNAL STABILITY 6

Power System Stabilizer - Stabilizer based on shaft speed signal (delta omega) - Delta -P-Omega stabilizer-Frequency-based stabilizers - Digital Stabilizer - Excitation control design - Exciter gain - Phase lead compensation - Stabilizing signal washout stabilizer gain - Stabilizer limits.

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:

- Understanding of detailed model of the electrical and mechanical parts of a three phase synchronous machine.
- Acquire the knowledge about the models of basic controllers of the synchronous machine, excitation and turbine governing systems for dynamics studies.
- Understanding the analysis methodology for small-signal stability of power system.
- Acquire the knowledge about electromagnetic transients involving synchronous machines.

EEB6213 FLEXIBLE A.C. TRANSMISSION SYSTEMS **L T P C**

3 0 0 3

OBJECTIVES:

- To understand the working principles of different types of shunt and series FACTs Controllers.
- To understand and derive the steady state model of FACTS devices suitable for use in power system studies.
- To understand the dynamic models of FACTS devices suitable for use in transient stability programs.

MODULE I INTRODUCTION 8

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

MODULE II STATIC VAR COMPENSATOR (SVC) 8

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) 7

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 7

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 7

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 8

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:

- Describe how FACTS devices are designed
- Explain and analyze their functions
- Derive basic mathematical models for these components
- Analyze the impact of these components on power system stability
- Perform calculations on different control strategies for these devices
- Apply the controllers for various problems by simulation.

EEB6214 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 and to highlight electric energy trading in the electricity market.

MODULE I OVERVIEW OF KEY ISSUES IN ELECTRIC UTILITIES RESTRUCTURING 8

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 8

California Markets: ISO, Generation, Power Exchange, Scheduling Co-ordinator, 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 8

FERC order 889 - Structure of OASIS: Functionality and Architecture of OASIS - Implementation of OASIS Phases: Phase 1, Phase 1-A, Phase 2 - Posting of information: 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 8

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 8

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 SELF STUDY – RESTRUCTURED POWER SYSTEM IN INDIA 5

Power Exchanges in India – Indian Energy Exchange, Power Exchange India limited; Different types of Markets hosted by these exchanges; Central Electricity Regulatory Commission (CERC) – Different Regulations of CERC highlighting different aspects of energy trading and sharing transmission service.

Total Hours: 45

REFERENCES:

1. Mohammad Shahidehpour and Muwaffaq Almoush, “Restructured Electrical Power systems: Operation, Trading and Volatility”, Marcel Dekkar, Inc., 2001.

2 G.Zaccour, “Deregulation of Electric Utilities”, Kluwer Academic Publishers, 1998.

3 M.Ilic, F. Galiana and L.Fink, "Power Systems Restructuring : Engineering

and Economics", Kluwer Academic Publishers, 2000.

4 Editor: Loi Lei Lai, "Power System Restructuring and Deregulation: Trading, Performance and Information Technology", John Wiley and sons Ltd, 2001.

5 K.Bhattacharya, M.H.J.Bollen and J.E.Daader, "Operation of Restructured Power Systems", Kluwer Academic Publishers, 2001.

6 J.H.Chow,F.F.Wu and J.A.Momoh, "Applied Mathematics for restructured electric power systems: Optimization, Control and Computation Intelligence", Springer 2004.

7 F.C.Schweppe, M.C.Caramanis, R.D.Tabors and R.E.Bohn, "Spot Pricing of Electricity", Kluwer Academic Publishers, 2002.

OUTCOMES:

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

- Ability to perform the various steps of electricity trading operation such as market clearing and settlement for an exchange.
- Ability to perform the various steps of trading such as forecasting of energy requirement and billing of supply offers / demand bids for GENCOS / DISCOS
- Ability to understand and carry out the various transformation process required for converting our present Indian power system into a restructured power system with competitive energy trading.

EEB6215	ADVANCED POWER SYSTEM SIMULATION LABORATORY II	L	T	P	C
		0	0	3	1

OBJECTIVES:

- To analyse the small signal stability of power system with simple machine models.
- To study the effect of controllers like AVR, PSS, Governor in small signal stability of power systems.
- To develop models for FACTS devices for steady state and dynamic analysis.

LIST OF EXPERIMENTS

1. Development of small signal stability program for single machine infinite bus system using classical machine model using MATLAB.
2. Development of small signal stability program for multi machine power system using classical machine model using MATLAB.
3. Co-ordination of over-current and distance relays for radial line protection using ETAP.
4. Induction motor starting analysis using EUROSTAG.
5. Load flow analysis of two-bus system with STATCOM.
6. Transient analysis of single machine infinite bus system with STATCOM using MATLAB.
7. Available Transfer Capability calculation using repeated load flow and DCOPF method.
8. Small signal stability enhancement with TCSC in a SMIB system using MATLAB.
9. Transient stability analysis of power system with fixed speed induction generator using CYME.
10. Transient stability analysis of power system with doubly fed induction generator using CYME.
11. Computation of harmonic indices generated by a rectifier feeding an R-L load using PSPICE

Total Hours: 45

OUTCOMES:

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

- Able to develop programs for load flow studies, small signal stability and transient stability with FACTS devices such as TCSC and STATCOM
- Able to determine ATC using repeated load flow and DCOPF method.
- Ability to perform Induction motor starting analysis using EUROSTAG.
- Ability to perform Co-ordination of over-current and distance relays for radial line protection using ETAP.

EEB6216 DESIGN / SIMULATION PROJECT

L	T	P	C
0	0	2	1

OBJECTIVE:

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

COURSE DESCRIPTION:

Design and 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.

The design and 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) HV AC/DC and EHV transmission

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 and practically and to suggest a viable solution.
- Use appropriate software tools for simulation and analysis.

SEMESTER III

EEB7101	**PROJECT MANAGEMENT**	**L T P C**
		3 0 0 3

OBJECTIVES:

- To familiarize the students with all aspects of Project Management
- To use various tools like PERT / CPM for enhancing the project management skills
- To discuss various safety aspects and familiarize with Government Regulations on Export – Import, pollution control etc.

MODULE I **7**

Project definition, Project Profile and standards, Feed back information (MIS), Evaluation and Modification, Selection, Criteria.

MODULE II **8**

Planning the process, Strategic and Managerial Planning, Organising the process planning, cost and costing, Cost Control systems, Economic Balancing, Network Planning, Methods (PERT/CPM), Engineering Flow Diagrams, Cost requirements, Analysis and Estimation of Process Feasibilities (Technical/Economical) Analysis, Cost – Benefit Ratio Analysis, Project Budgeting, Capital Requirements, capital Market, Cash Flow Analysis, Break even strategies.

MODULE III **7**

Plant Engineering Management, Objectives, Programme, Control, Plant Location and Site Selection, Layout diagrams, Selection and procurement of equipment and machineries, Installation, Recommission, Commissioning and performance appraisal, Strategies choice and Influence, Product planning and development, Provision and maintenance of service facilities.

MODULE IV **7**

Process safety, Materials safety and Handling regulations, Safety in equipment and machinery operations, Design considerations of safety organization and control, Pollution, Pollution control and Abatement, Industrial Safety Standard Analysis.

MODULE V **7**

Government regulations on procurement of raw materials and its allocation. Export – Import regulations, Pricing policy, Industrial licensing procedure, Excise and other commercial taxes, Policies on depreciation and corporate tax, Labour laws, Social welfare legal measurements, Factory act, Regulations of Pollution Control Board.

MODULE VI **9**

Case Study in Computer aided project management.

Total Hours: 45

REFERENCES:

1 Cheremisinoff, N. P., “Practical Guide to Industrial Safety: Methods for Process Safety Professionals”, CRC Press, 2001.

2 Couper, J. R., “Process Engineering Economics”, CRC Press, 2003.

3 Perry, J. H., “Chemical Engineer’s Hand Book”, 8th Ed., McGraw Hill, New York, 2007.

4 Peters, M.S., Timmerhaus, C. D. and West, R. E., “Plant Design and Economics for Chemical Engineers”, 5th Edn., McGraw Hill, 2003.

5 Silla, H., “Chemical Process Engineering: Design and Economics”, CRC Press, 2003

6 Vinoski, W., “Plant Management Handbook”, Pearson Education Limited, 1998

7 Watermeyer, P., “Handbook for Process Plant Project Engineers”, John Wiley and Sons, 2002

OUTCOMES:

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

- The students is expected to become a professional in project management by acquiring the skills in a scientific manner

EEB7102	**PROJECT WORK**	**L**	**T**	**P**	**C**
	PHASE - I (SEMESTER III)	**0**	**0**	**12**	**6***
	PHASE - II (SEMESTER IV)	**L**	**T**	**P**	**C**
		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, modeling, 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.

ELECTIVES

EEBY01 ELECTROMAGNETIC FIELD COMPUTATION AND MODELING

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 6

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 9

Limitations of the conventional design procedure, need for the field analysis based design, problem definition, solution by analytical methods-direct integration method – variable separable method – method of images, solution by numerical methods- Finite Difference Method.

MODULE III SOLUTION OF FIELD EQUATIONS II 9

Finite element method (FEM) – Differential/ integral functions – Variational method – Energy minimization – Discretisation – Shape functions –Stiffness matrix –1D and 2D planar and axial symmetry problem.

MODULE IV FIELD COMPUTATION FOR BASIC CONFIGURATIONS 7

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

MODULE V BASIC EXERCISES IN FEA PACKAGES 6

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

MODULE VI DESIGN APPLICATIONS **8**

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 model and analyze electrical system through Finite Element techniques.

EEBY02 ANALYSIS OF ELECTRICAL MACHINES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge on Reference frame theory, Transformational variables and Analysis of conventional machines (DC machines, Induction machines and synchronous machines) using the Reference frame theory to predict torque, output and performance of the machine.

MODULE I PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION 8

General expression of stored magnetic energy, co-energy and force/ torque - example using single and doubly excited system - Calculation of air gap mmf and per phase machine inductance using physical machine data.

MODULE II REFERENCE FRAME THEORY 8

Static and rotating reference frames - transformation of variables - reference frames - transformation between reference frames - transformation of a balanced set -balanced steady state phasor and voltage equations - variables observed from several frames of reference.

MODULE III DC MACHINES 8

Voltage and toque equations - dynamic characteristics of permanent magnet and shunt DC motors - state equations - solution of dynamic characteristic by Laplace transformation.

MODULE IV INDUCTION MACHINES 8

Voltage and toque equations - transformation for rotor circuits - voltage and torque equations in reference frame variables - analysis of steady state operation - free acceleration characteristics - dynamic performance for load and torque variations - dynamic performance for three phase fault - computer simulation in arbitrary reference frame.

MODULE V SYNCHRONOUS MACHINES 5

Voltage and Torque Equation - voltage Equation in arbitrary reference frame and rotor reference frame - Park equations - rotor angle- steady state analysis

- dynamic performances for torque variations- dynamic performance for three phase fault - transient stability limit - critical clearing time - computer simulation.

MODULE VI CASE STUDY 8

Modeling of DC machines – Modeling of AC machines through Reference frame theory – Modeling of Synchronous Machines.

Total Hours: 45

REFERENCES:

1 Paul C.Krause, OlegWasyzczuk, Scott S, Sudhoff, “Analysis of Electric Machinery and Drive Systems”, IEEE Press, Second Edition, 1995.

2 R.Krishnan, “Electric Motor Drives, Modeling, Analysis and Control” , Prentice Hall of India, 2002.

3 Samuel Seely, “Electromechanical Energy Conversion”, Tata McGraw Hill Publishing Company, 2000.

4 A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, “Electric Machinery”, Tata McGraw Hill, 5^{th} Edition, 1992.

OUTCOMES:

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

- Ability to model DC and AC machines using reference frame theory.
- Ability to analyze special electrical machines.

EEBY03 EHV POWER TRANSMISSION

	L	T	P	C
EEBY03 EHV POWER TRANSMISSION	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 8

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 8

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 LOAD WIGS 8

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 6

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 8

Corona Power loss and its comparison with leakage loss and line I2R 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 7

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:

- Ability to choose between EHVAC and HVDC alternatives based on technical and economic factors.
- Ability to recognize the occurrence of Corona and regulate its effects in the form of audible and radio noises.
- Ability to design an EHVAC / HVDC line for transferring a specified amount power over a given distance.

EEBY04	**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 stepping motors.
- To understand the Construction, principle of operation and performance of switched reluctance motors.
- 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 8

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

MODULE II STEPPING MOTORS 8

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 8

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

MODULE IV PERMANENT MAGNET MOTORS 8

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 5

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 8

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
- Ability to model small power rating of motor for real time application
- Software knowledge in Magnet ,ANSYS for electrical application.

EEBY05	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 8

Introduction-Consequences of Poor Power Quality: Technical impacts - Financial impacts- Responsibility sharing among various parties - The Impact of Power Quality on the Economy of Electricity Markets: The quality market model outline- The consumers representation - The firm representation- Peculiarities of electricity markets - The Insertion of quality in the electricity Market Model.

MODULE II CHARACTERISATION OF ELECTRIC POWER QUALITY 8

Power Quality Standards and Guidelines- Unbalance- Harmonics - Transients- Sag, Swell, Interruption, Under voltage and Overvoltage - DC Offset, Electric Noise, Voltage Fluctuation, Flicker and Power Frequency Variation.

MODULE III POWER QUALITY ANALYSIS 8

Unbalance Assessment Using Sequence Components- Unbalance Assessment Using Feature Pattern Extraction Method (FPEM).- Harmonic Assessment using FPEM-Harmonic Assessment by Area Based Technique(ABT)- Assessment of Power Components by FPEM and ABT-. Transients Analysis: Model Based Approaches- ESPRIT Method.

MODULE IV MITIGATION METHODS 8

Active Power Filters (APF):Control methods and strategies-Grid Synchronization - Voltage controller- Current controller - Inductive filter design-

DC-link capacitor design- Power quality applications of predictive controlled converters: Multilevel converters- Unity power factor rectifier-Dynamic voltage restorer. Harmonics Effect in Industrial- Harmonic Distortion in Renewable Energy Systems.

MODULE V POWER QUALITY MONITORING 5

Power Quality indexes, levels and limits Monitoring in installations - Monitoring in grids- Normalizing and classifying Power Quality –data- Automation and control of distribution systems - SAF control - PAF control- Numerical Relays: Harmonic analyzers - Transient-disturbance analyzers- Data loggers and chart recorders.

MODULE VI POWER QUALITY IMPROVEMENT 8

Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, Unified Power Quality Conditioner Based on a Fuzzy Logic--UPQC -control strategies: P-Q theory, Synchronous detection method.

Total Hours: 45

REFERENCES:

1 Arindam Ghosh, “Power Quality Enhancement Using Custom Power Devices”, Kluwer Academic Publishers, 2002.

2 G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, (2nd edition) 1994.

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
- Identify the techniques to mitigate power quality disturbances.

EEBY06 POWER SYSTEM PLANNING AND RELIABILITY **L T P C**

3 0 0 3

OBJECTIVES:

- To familiarize with the different types of load forecasting techniques used in power systems.
- To study the different types of indices used in power system reliability studies.
- To understand the distribution system planning problem and capacitor placement problem.

MODULE I LOAD FORECASTING **8**

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 GENERATION SYSTEM RELIABILITY ANALYSIS **8**

Probabilistic generation and load models- Determination of LOLP and expected value of demand not served -Determination of reliability of iso and interconnected generation systems.

MODULE III TRANSMISSION SYSTEM RELIABILITY ANALYSIS **8**

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 IV EXPANSION PLANNING **8**

Basic concepts on expansion planning-procedure followed for integrate transmission system planning, current practice in India-Capacitor placer problem in transmission system and radial distributions system.

MODULE V DISTRIBUTION SYSTEM PLANNING OVERVIEW **5**

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

MODULE VI CASE STUDY **8**

System study required for designing Power Evacuation system for a Power Plant to be commissioned in the grid; Power flow study, short circuit study and Transient stability study of projected Grid with the new power plant.

Total Hours: 45

REFERENCES:

1 R.L .Sullivan, “Power System Planning”, Tata McGraw Hill Inc., 1997.

2 Roy Billington and Allan Ronald, “Reliability Evaluation of Power Systems”, Plenum Press, 1984.

3 Turan Gonen, “Electric power distribution system Engineering” ,Tata 'McGraw Hill, 1986.

4 Feasibility report of TNEB, “Study on Transmission System for Power Evacuation of ayamkondan Lignite Power Project (3x500MW)”, 1996.

OUTCOMES:

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

- Ability to use commercial software for load forecasting and system expansion planning for electric utilities
- Ability to develop new software that may be required to address new issues that may arise from time to time such as “Optimal planning of capacitor banks in transmission system and radial distribution system for minimizing loss and improving voltage profile”
- Ability to conduct feasibility study of transmission corridor for evacuating power from a proposed power plant

EEBY07 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 8

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 8

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 8

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 8

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 5

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 8

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:

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

- To analyze multirate DSP systems.
- Determine coefficients for perfect reproduction filter banks and wavelets.
- Choose parameters to take a wavelet transform, and interpret and process the result.
- To program with DSP processor

EEBY08 CONTROL SYSTEM DESIGN

L	T	P	C
3	0	0	3

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 with dynamic programming.
- To secure knowledge in State Estimation by filtering and observer techniques.
- To study the Non - linear control system design with emphasis to sliding mode control.

MODULE I INTRODUCTION TO CONTROL SYSTEMS 8

Concept of control - Control system terminology, classification of Control Systems. Mathematical Models of Systems - Differential equations of physical system, transfer function of linear systems, block diagram models, signal flow graph. D.C. & A.C Servomotors and Synchros.

MODULE II DESIGN OF FEEDBACK CONTROL SYSTEM 8

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 8

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 8

Controllability - Observability - Pole placement using state feedback - Ackerman’s formula, Limitations of state variable feedback - Introduction to PID and ON - OFF control actions - Dynamic Programing - Design Problems.

MODULE V STATE ESTIMATION 5

State estimation methods - State Estimation Problem - Luenberger's observer - Noise characteristics - Kalman - Bucy filter - Separation Theorem - Controller Design - Wiener filter - Design examples.

MODULE VI NON - LINEAR CONTROL SYSTEM DESIGN 8

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

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, Gianluca Zito," 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.

OUTCOMES:

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

- A detailed understanding of basic control system design approach is achieved.
- Design in Discrete Domain, State variable feedback with dynamic programming and State Estimation by filtering and observer techniques are made thorough.
- Non - linear control system design with emphasis to sliding mode control is studied in detail.

EEBY09 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.

By the end of the semester, each student will be able to do the following:

- Be able to understand the concept of insulation clearance in the medium like Air, Oil, SF6, vacuum etc.
- Be able to understand the various characteristics and phenomena of "Arc"
- Be able to assimilate a comprehensive knowledge on various types of Circuit Breakers and their applications
- The testing technique, short circuit calculation and rating of Circuit Breaker will be understood

MODULE I INSULATION OF SWITCHGEAR 8

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 8

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 8

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 8

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 5

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 8

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 Flursscheim, C.H. (Editor), “Power Circuit breaker – theory and design”, IEE Monograph series 17, Peter Peregrinus Ltd. Southgatge House, Stevenage, Herts, SC1 1HQ, Englsand, 1977.

4 Anathakrishnan S and Guruprasad K.P., “Transient Recovery Voltage and Circuit Breakers”, Tata McGraw Hill Publishing company ltd., New Delhi, 1999.

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 method
- Circuit breaks – their types, rating, testing and design features.

EEBY10 OPTIMAL CONTROL AND FILTERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To give students a background in the historical trends in dynamic optimization.
- 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 8

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

MODULE II PONTRYAGIN'S MINIMUM PRINCIPLE 8

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

MODULE III NUMERICAL TECHNIQUES FOR OPTIMAL CONTROL PROBLEMS 8

Linear optimal regulator problem - Matrix Riccatti equation and solution method - Choiceof weighting matrices - Steady state properties of optimal regulator - Solution of Ricattiequation 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 8

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

MODULE V FILTERING & ESTIMATION **5**

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 **8**

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, Draguna Vrabie, Vassilis L. Syrmos, “Optimal Control”, Wiley & Sons; Inc Hobkoken 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.

EEBY11 ADVANCED POWER SYSTEM DYNAMICS L T P C

3 0 0 3

OBJECTIVES:

- To Understand and familiarize with different type of numerical integration algorithms used for transient stability analysis of power systems.
- To understand the phenomena of sub-synchronous resonance and model power system components suitably to analyze sub-synchronous oscillations.
- To understand the phenomena of voltage instability in power systems and enhancements of transient and small signal stability.

MODULE I TRANSIENT STABILITY ANALYSIS 8

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 II SUBSYNCHRONOUS OSCILLATIONS 8

Introduction - Turbine Generator Torsional Characteristics: Shaft system model - Examples of torsional characteristics - Torsional Interaction with Power System Controls: Interaction with generator excitation controls - Interaction with speed governors - Interaction with nearby DC converters.

MODULE III SUBSYNCHRONOUS RESONANCE (SSR) 8

Sub synchronous Resonance (SSR): Characteristics of series compensated transmission systems - Self-excitation due to induction generator effect - Torsional interaction resulting in SSR - Analytical Methods - Numerical examples illustrating instability of sub synchronous oscillations - Impact of Network-Switching Disturbances: Steady-state switching - Successive network-Switching disturbances - Torsional Interaction Between Closely Coupled Units;

time-domain simulation of sub synchronous resonance - EMTP with detailed synchronous machine model.

MODULE IV TRANSMISSION, GENERATION AND LOAD ASPECTS OF VOLTAGE STABILITY ANALYSIS 8

Review of transmission aspects - Generation Aspects: Review of synchronous machine theory - 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 - Induction motors - Load tap changers - Thermostatic load recovery - General aggregate load models.

MODULE V ENHANCEMENT OF TRANSIENT STABILITY AND COUNTER MEASURES FOR SUB SYNCHRONOUS RESONANCE 5

Principle behind transient stability enhancement methods: high-speed fault clearing, reduction of transmission system reactance, regulated shunt compensation, dynamic braking, reactor switching, independent pole-operation of circuit-breakers, single-pole switching, fast-valving, high-speed excitation systems; NGH damper scheme.

MODULE VI ENHANCEMENT OF SMALL SIGNAL STABILITY AND ITS COUNTERMEASURES 8

Power system stabilizer-Supplementary control of synchronous Machine Excitation-supplementary control of Static Var Compensator- Supplementary Control of HVDC transmission links.

Total Hours: 45

REFERENCES:

1. P. Kundur, “Power System Stability and Control”, McGraw-Hill, 1993.
2. H.W. Dommel and N.Sato, "Fast Transient Stability Solutions", IEEE Trans., Vol. PAS-91, pp:1643-1650, July/August 1972.
3. AU Power Lab Laboratory Manuals, Anna University, pp : 7-1 to 7-12, May 2004.

4 H. W. Dommel, “EMTP THEORY BOOK”, Microtran Power System Analysis Corporation, Second Edition, 1996.

5 T.V. Cutsem and C.Vournas, "Voltage Stability of Electric Power Systems", Kluwer Publishers, 1998.

OUTCOMES:

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

- Understand and familiarize with different type of numerical integration algorithms used for transient stability analysis of power systems.
- Acquire the knowledge about the phenomena of sub-synchronous resonance for analyzing sub-synchronous oscillations.
- Understanding the enhancing methods of transient, small signal stability and its counter measures.

EEBY12 SYSTEM IDENTIFICATION AND ADAPTIVE CONROL

L	T	P	C
3	0	0	3

OBJECTIVES:

- To give students a background of system identification and adaptive control techniques.
- To study the models for identification of linear and non linear systems.
- To study the parametric and non parametric system identification methods.
- To have a basic understanding of adaptive control and adaptation technique.
- To impart knowledge in adaptive control methods through the case studies suggested.

MODULE I SYSTEM IDENTIFICATION MODEL 6

Models of LTI systems - Linear Models - State space Models - OE model - Model sets,Structures and Identifiability - Models for Time-varying and Non-linear systems - Modelswith Nonlinearities - Non-linear state-space models - Black box models - Fuzzy models.

MODULE II PRINCIPLES OF MODELLING AND TRANSFER FUNCTION IDENTIFICATION 9

System Identification and Stochastic Modeling - Structure and parameter estimation -properties of estimates - Validation of models - Impulse Response - Step Response - Frequency response- Transfer function from these.

MODULE III NON-PARAMETRIC AND PARAMETRIC IDENTIFICATON 9

Guiding principles behind parameter estimation methods - Minimizing prediction errors - Linear regression and least squares methods - Forgetting factor - Maximum likelihood estimation - Instrumental Variable methods.

MODULE IV NON-LINEAR IDENTIFICATION AND MODEL VALIDATION 9

Open and closed loop identification - Direct and indirect identification - Joint input-outputidentification - Non-linear system identification - Wiener models - Power series expansions- State estimation techniques - Non linear identification using Neural Network and Fuzzy Logic.

MODULE V ADAPTIVE CONTROL **9**

Adaptive Control – Effects of process variation - Adaptive schemes - Auto tuning - SelfTuning Regulators (STR) - Reference Adaptive Control (MRAC) - Types of STR andMRAC - Different approaches to self-tuning regulators – Gain Scheduling.

MODULE VI CASE STUDIES **6**

Inverted Pendulum - Robotic arm - Process control application - Heat exchanger -Distillation column - Application to power systems - Adaptive Power System Stabilizer.

Total Hours: 45

REFERENCES:

1 Karl Jhon Astrom & Bjom Wittenmark, “Adaptive Control”, Addison Wesley, 2003.

2 Astrom and Wittenmark, "Adaptive Control", Addison Wesley Publising Company,1995.

3 William S. Levine, "Control Hand Book",CRC Press inc, 2010.

4 Torsten Soderstrom, Petre Stoica, "System Identification", Prentice Hall International (UK) Ltd, 1989.

OUTCOMES:

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

- To have a detail understanding of system identification and adaptive control techniques.
- To understand the basic models for identification of linear and non linear systems.
- To understand the parametric and non parametric system identification methods.
- To have a basic understanding of adaptive control and adaptation technique.

EEBY13 INDUSTRIAL POWER SYSTEM ANALYSIS AND DESIGN

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the calculations used with induction motor starting studies.
- To understand and calculate harmonics indices in power quality studies.
- To study and calculate the rating of capacitors for power factor correction studies.
- To introduce computer analysis methods for ground grid calculations.

MODULE I MOTOR STARTING STUDIES 8

Introduction-Evaluation Criteria-Starting methods-System Data –Voltage Drop calculation-Calculation of Acceleration time-motor starting with limited –Capacity generators-Computer Aided Analysis –Conclusions.

MODULE II POWER FACTOR CORRECTION 8

System description and modeling-Acceptance Criteria-Frequency Scan analysis-Voltage Magnification-Sustained Overvoltage-Switching surge analysis-Back-to back switching.

MODULE III HARMONICS ANALYSIS 8

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

MODULE IV FLICKER ANALYSIS 8

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

MODULE V GROUND GRID ANALYSIS 5

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

MODULE VI INDUSTRIAL CABLE ANALYSIS 8

Cable shielding –Recommend practice for industrial cable system-Cable insulation characteristics- Cable Insulation level and its reliability-Application of Power cables to power electronics drives.

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.

OUTCOMES:

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

- Acquire the knowledge about the induction motor studies, harmonics indices in power quality study, designing the rating of capacitor in Power factor correction studies and cable insulation.
- Understand the computer analysis methods for ground grid calculations.

EEBY14	**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 7

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 8

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 8

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 7

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 8

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 **7**

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
- The operation and control of converter / inverter for power control
- Steady state performance simulation and analysis
- MTDC systems and its development

EEBY15 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, control systems.
- To simulate the wind turbine dynamic behavior when integrated to grid.

MODULE I INTRODUCTION 8

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 8

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 8

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

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

Modeling of Fixed speed Induction generator-axes transformation-flux linkage equations-voltage equations-state equations-modeling of variable speed DFIG for Wind Energy Conversion Systems-Converter Control System- transient stability simulation of fixed speed induction generator using EUROSTAG 4.3-Doubly Fed Induction Generator(DFIG) modeling - controller modelling -

modelling of DFIG in EUROSTAG - transient stability simulation of power systems with induction generators using EUROSTAG 4.3.

MODULE V POWER ELECTRONICS IN WIND ENERGY CONVERSION SYSTEM 8

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

MODULE VI GRID CONNECTED SYSTEMS 5

Stand alone and Grid Connected WECS system-Grid connection Issues- - Impacts of wind power on Power System Stability-wind plant reactive power capability and its requirements-voltage Control and active power control - Storage technologies.

Total Hours: 45

REFERENCES:

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

OUTCOMES:

- Understanding of fundamental of wind power detailed model of the Wind Energy components and its control systems.
- Acquire the knowledge about the modeling of various wind generators and its dynamic behavior when integrate with grid.

EEBY16 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 ELECTRO-MECHANICAL CONCEPTS 8

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 8

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

MODULE III THERMAL SENSING AND ACTUATION 7

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

MODULE IV PIEZOELECTRIC SENSING AND ACTUATION 7

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

MODULE V RF APPLICATIONS OF MEMS 9

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 6

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:

- 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.

EEBY17 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.

Upon completing the Course, the student will be able to do the following:

- Become familiar with different stresses encountered in the service of the insulator as well as the types and performance of Insulators.
- Able to connect the current area of Research in insulators including non-ceramic insulators
- Design and Manufacturing process of insulators can be understood
- The testing standards, selection and maintenance of insulators will also be made aware.

MODULE I INTRODUCTION 7

Overview – Important Definitions – Types of Outdoor Insulators – Uses of Outdoor Insulators – Stresses Encountered in Service – Electrical Performance – Mechanical Performance – Role of Insulators on Overall Power System Reliability – Shapes of Outdoor Insulators – Mechanical and Electrical Ratings of Insulators – Comparison of Porcelain, Glass and Composite Insulators – Life Expectancy.

MODULE II NONCERAMIC INSULATOR TECHNOLOGY 7

Introduction - Materials for Weathersheds / Housings – Shed Design – Insulator Core – Hardware – Establishing Equivalency to Porcelain/Glass – Manufacturing Changes and Quality Control (QC) – Un-standardization/ Propagation - Live-line Maintenance Handling, Cleaning and Packaging - Brittle Fracture – Water Drop Corona – Aging and Longevity – Grading Control Rings.

MODULE III DESIGN AND MANUFACTURE OF INSULATORS 8

Porcelain Insulators – Manufacture of Porcelain Insulators – The Porcelain Suspension Insulator – Porcelain Pin-type Insulators – Porcelain Multicone Insulators – Porcelain Long-rod and Post Insulators – Porcelain Insulators Glazes - Porcelain Insulator Hardware – Porcelain Insulator Cement – The

Porcelain Dielectric. 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 8

Need for Standards – Standards Producing Organizations – Insulator Standards – Classification of Porcelain / Glass Insulator Tests – Brief Description and Philosophy of Various Tests for Cap and Pin Porcelain/Glass Insulators – Summary of Standards for Porcelain/Glass Insulators – Standards of Nonceramic (Composite) Insulators – Classification of Tests, Philosophy and Brief Description – Standards for Nonceramic Insulators.

MODULE V DETECTING DEFECTIVE INSULATORS 7

Detecting defective porcelain insulators – principles involved – electrical methods – thermography.

Detecting defective non ceramic insulators – detection prior to installation – detecting degraded insulator during service.

MODULE VI SELECTION AND MAINTENANCE OF INSULATORS 8

Introduction – Cost and Weight – National Electricity Safety Code (NESC) – Basic Lightning Impulse Insulation Level (BIL) – Contamination Performance – Experience with Silicone Rubber Insulators in Salt Areas – Compaction – Grading Rings for Nonceramic Insulators.Maintenance of Insulators-Maintenance Inspection – Hotline washing – equivalent salt deposit

Total Hours: 45

REFERENCES:

1. Ravi S. Gorur, Edward A. Cherney and Jeffrey T. Burnham, “Outdoor Insulators”, Ravi S. Gorur. Inc., 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, 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 defensive insulators

EEBY18 POWER DISTRIBUTION SYSTEMS

	L	T	P	C
	3	0	0	3

OBJECTIVES:

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

MODULE I INTRODUCTION TO DISTRIBUTION SYSTEMS 8

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 8

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 8

Voltage drop and power loss calculations : Derivation for volt-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 8

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

MODULE V CAPACITIVE COMPENSATION FOR POWER FACTOR CONTROL 8

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 5

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.Graw-Hill Book Company, 1986.

2 A.S.Pabla, "Electric Power Distribution", Tata Mc Graw-Hill Publishing Company, 4^{th} 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 possess knowledge and achieve skills on the following:

- Distribution feeders and substations
- Voltage drop calculations
- distribution system planning
- reactive power compensation in distribution system.

EEBY19 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 **8**

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 **7**

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 **7**

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 **7**

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 **8**

Lightning and switching over voltages - their influence on line design - simulation of switching (opening and closing) by injected voltage and current at the switch - circuit breaker recovery voltage - current chopping - compound transients -switching surges in capacitive circuits - switching surges in distributed parameter systems.

MODULE VI PROTECTION AND INSULATOR CO-ORDINATION 8

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”, PHI Learning. 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 their control
- Apply to analyse the propagation characteristics of surges in multiconductor lines
- Design insulation co-ordination schemes for 220kV and 400kV systems.

EEBY20 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 8

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 8

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 8

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 7

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

MODULE V ELECTROPORATION 7

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 7

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. Uwe F.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 Electropres", IEEE Trans. Dielectrics and electrical insulation Vol. 16, No. 5; pp1251-1258., October 2009.

8. Raji Sundararajan, “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:

- High voltage generation and measurement
- Bio Electrics
- NDT technique
- Electroporation and Electroporator in Cancer Treatment

EEBY21 SMART POWER GRID

L	T	P	C
3	0	0	3

OBJECTIVES:

- Introduce the fundamentals of smart grid and associated Information Technology services.
- Introduce the modeling of devices associated with smart grid.
- Introduce about the concept of wide area measuring systems (WAMS) and Phasor Measurement units.

MODULE I RECENT TRENDS IN INFORMATION AND COMMUNICATION TECHNOLOGIES 9

Distributed services - Web services – Creation and deployment – Application development frameworks – XML – RPC-AXIS- SOAP - Communication models - Service oriented architecture fundamentals.

MODULE II SMART GRID FUNDAMENTALS 8

Smart grid structure – Interactive grid – Micro grid – Distributed resources modeling – communication Infrastructure – sensing and control devices – smart grid characteristics.

MODULE III COMPONENTS AND STANDARDS 8

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

MODULE IV AUTOMATION TECHNOLOGIES 8

Control centre systems – Data management principles – Smart grid implementation standards and procedure – Operational Issues – Modeling and control – Advanced metering infrastructure –Outage management – Distribution and substation automation –Customer interactions.

MODULE V CASE STUDY I 6

Smart meters – Smart grid experimentation plan for load forecasting – Optimal placement of Phasor Measurement Units (PMU)

MODULE VI CASE STUDY II **6**

Coordination between cloud computing and smart power grids-Development of power system models and control and communication Software.

Total Hours: 45

REFERENCES:

1. Tony Flick and Justin Morehouse, “Securing the Smart Grid – Next Generation Power Grid Security”, Elsevier Publications, 2011.
2. Ali Keyhani- “Design of Smart Power Grid Renewable Energy Systems “, First Edition, John Wiley Inc., 2011.

OUTCOMES:

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

- Ability to design and implement Smart Grid Power Systems independently.
- Ability to use Software for Load Forecasting with special reference to Smart Grids.
- Ability to coordinate cloud computing with smart grids.

EEBY22 AUTOMOTIVE INFOTAINMENT SYSTEMS

	L	T	P	C
	3	0	0	3

OBJECTIVES:

- This course provides an overview of automotive electrical and electronics systems, the types of ignition systems with the principle of operation, and the various power fluctuations that can affect the hardware and software performance of Automotive Infotainment systems in cars.
- An emphasis is placed on Infotainment systems with the use of Microprocessor Architecture & systems control.

MODULE I FUNDAMENTALS OF AUTOMOTIVE ELECTRICAL SYSTEMS 8

Batteries – Types, Use and Maintenance, Failures, Construction, Performance characteristics – battery rating capacity – Battery Testing –electric power steering.

MODULE II FUNDAMENTALS OF AUTOMOTIVE ELECTRONIC SYSTEMS 8

Automotive chassis system – automotive microprocessor uses – electronic dash board instruments – onboard diagnosis system –electronic control of braking and traction - automatic transmission, electronic clutch.

MODULE III IGNITION SYSTEMS 7

Types of solid state ignition systems and their principle of operation, advantages of electronic ignition systems, contactless electronic ignition system, distributor-less ignition, electronic sparks timing and control, spark arrester, throttle body injection and multi port or point fuel injection.

MODULE IV POWER FLUCTUATIONS IN CAR 7

Power drop-out, Crank drop-out, Slow recovery waveforms, Programmable Power Supply related crank generation, CI Test Jig, Ford EMC specifications, Fiat EMC Specifications.

MODULE V INFOTAINMENT SYSTEMS 8

Types of AI systems, Different OEMs, Features – Single / Dual Tuner, CD, CDDA, Aux, Traffic Announcements, News, Alarm, Parking Aid Control, Touch Screen displays, Diagnostics, Network Management.

MODULE VI MICROPROCESSOR APPLICATIONS IN AUTOMOTIVE SYSTEMS 7

Architecture: General 8 bit microprocessor and its architecture 8085, Z-80 and its pin functions-Architecture-Functions of different sections. Instruction Set: Instruction format-addressing modes-instruction set of 8085-Timing diagrams-Different machine cycles. Assembly Language Programming: Construct of the language programming- Code conversion using look up tables-stack and subroutines. Data Transfer Schemes: Interrupt structure-Programmed I/O, DMA-Serial I/O Interfacing Devices: Types of interfacing devices-Input/Output ports 8212. Octal latches, LED's ROM and RAM interfacing. Applications: Data acquisitions-Temperature control-Stepper motor control-Automotive applications engine control.

Total Hours: 45

REFERENCES:

1 Young, A.P. and Griffiths, L.," Automobile Electrical Equipment", English Languages Book Society and New Press, 1990.

2 Vinal, G. W., "Storage batteries", John Wiley and Sons Inc. New York, 1985

3 Crouse, W.H., "Automobile Electrical Equipment", McGraw Hill Book Co. Inc. New York, 1980.

4 Spread Bury, F.G., "Electrical Ignition Equipment", Constable and Co. Ltd., London, 1962.

5 Kholi, P. L., "Automotive Electrical Equipment", Tata McGraw-Hill Co Ltd, New Delhi, 1975.

6 Rizzo, "Advances in Automotive Control",(2-volume set), Elsevier Science, 2005.

7 Reimpell, "The Automotive Chassis: Engineering Principles Book", Second Edition, Butterworth Heinemann publisher, 2001.

8 Ribbens, “Automotive Engineering Book”, Elsevier Science, 2009.

9 Ramesh, Goankar.S., “Microprocessor Archietecture Programming and Applications”, Wiley Eastern Ltd., New Delhi,1986.

10 Aditya .P. Mathur, “Introduction to Microprocessors”, III Edition Tata McGraw Hill Publishuing Co Ltd New Delhi,1989.

11 Ahson. S. I., “Microprocessors with Applications in Process Control”,Tata McGraw Hill New Delhi,1986.

12 Jabez Dhinagfar .S., “Microprocessor Applications in Automobiles”,Tata McGraw-Hill, 2002.

13 Bianco and A. Labella., “Automotive Micro Electronics”, Elsevier science Publishers,1986.

OUTCOMES:

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

- Battery Management and analysis of failures / performance of batteries used in Cars
- On-board diagnosis and electronic control of braking and traction
- Ignition systems and Fuel injection
- Crank waveforms while Ignition is ON and EMC Specifications of OEMs
- Features of Infotainment systems and displays
- Microprocessor Architecture and applications

EEBY23 SOFT COMPUTING TECHNIQUES L T P C

3 0 0 3

OBJECTIVES:

- To expose the students to the concepts of feed forward neural networks.
- To provide adequate knowledge about feedback neural networks.
- To teach about the concept of fuzziness involved in various systems. To provide adequate knowledge about fuzzy set theory.
- To provide comprehensive knowledge of fuzzy logic control and adequate knowledge of application of fuzzy logic control to real time systems.
- To expose the ideas of GA and EP in optimization and control.

MODULE I INTRODUCTION 6

Approaches to intelligent control - Architecture for intelligent control- Symbolic reasoning system - rule-based systems - the AI approach - Knowledge representation- Expert systems – applications of expert systems.

MODULE II FUNDAMENTALS OF ARTIFICIAL NEURAL NETWORKS 9

Objectives - History- Biological Inspiration- Neuron Model- McCulloch-Pitts neuron model, Single- Input Neuron-Multi-Input Neuron- Network Architectures- A Layer of Neurons-Multiple Layers of Neurons. Perceptron. Architecture- Single-Neuron Perceptron- Multi-Neuron Perceptron- Perceptron- Learning Rules - Constructing Learning Rules- Training Multiple-Neuron Perceptrons.

MODULE III ASSOCIATIVE NETWORKS 8

Simple Associative Networks- Auto-associative and hetero-associative nets; Learning in neural nets: Supervised and unsupervised learning; Unsupervised Hebb Rule- Hebb Rule with Decay-Instar Rule-Outstar Rule- Kohonen Rule. Adaline Network- Madaline Network - Back Propagation Neural networks – Hopfield Networks-adaptive networks.

MODULE IV FUZZY SET THEORY & FUZZY SYSTEMS 8

Fuzzy versus crisp- crisp sets, fuzzy sets – operations and properties - Membership function – Crisp relations – Fuzzy relations .Crisp logic – fuzzy logic – Fuzzy rule based system- defuzzification methods – Applications.

MODULE V GENETIC ALGORITHMS 8

Genetic Algorithms-: History- Basic concepts –working principle- Encoding - Fitness Function – Reproduction .Genetic operators-Cross over- types – Mutation Operator - coding steps of GA - Convergence characteristics.

MODULE VI APPLICATIONS OF AI TECHNIQUES USING MATLAB 6

Matlab Neural Network toolbox – Matlab Fuzzy logic toolbox- Applications of AI techniques: Power Systems -Load forecasting - Load flow studies – Applications to Power electronics.

Total Hours: 45

REFERENCES:

1. Laurene Fausett, "Fundamentals of Neural Networks – Architectures, Algorithms and applications", Pearson Education, 2008.
2. Wassermann, P. D. "Neural Computing" Van Reinhold, 1988.
3. Zimmermann, H. J., "Fuzzy Set Theory and Its Applications", Kluwer Academic Publishers, 2nd Edition ,1996.
4. Martin T. Hogan, Howard B.Demuth. M, "Neural network design", Thomson Learning, New Delhi, 2003.
5. Zureda, J.M., "Introduction to Artificial Neural Systems", Jaico publishing house, Bombay, 1994.
6. Bose N.K, Liang P. "Neural Network Fundamentals with graphs, Algorithms and applications", TMH Pub. Co. Ltd, 2001.
7. S.Rajasekaran, G.A.Vijayalaksmi Pai,"Neural Networks, Fuzzy logic and Genetic algorithms Synthesis and Applications, PHI private learning Ltd, New Delhi, 2011.

OUTCOMES:

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

- understand the concepts, advantages and disadvantages of the techniques in evolutionary computation

- design suitable neural networks, fuzzy systems, genetic representations with appropriate fitness functions for simple problems,
- know the key issues in using these techniques in Matlab for search of difficult search-spaces
- be aware of the different approaches and different applications in the field.

EEBY34	**POWER ELECTRONICS IN WIND AND SOLAR POWER CONVERSION**	**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, control systems.
- To simulate the wind turbine dynamic behavior when integrated to grid.
- To study and understand about the solar power generation, Peak power tracking techniques and its control systems.

MODULE I INTRODUCTION 6

Historical Development and current status of Wind power-Generators and Power Electronics for wind turbines - Impact of wind power-Wind speed estimation-wind speed measurements-Rayleigh distribution-Maximum Power obtainable-Bertz limit-Power coefficient Tip speed ratio–aerodynamics of wind rotor-Blade element theory-aerodynamic efficiency-Wind energy Conversion System Components.

MODULE II WIND ENERGY SYSTEM 8

Basic principle of Wind Energy Conversion System(WECS)-Performance of Induction generator for WECS-Self excited Induction generator(SEIG) for isolated Power generators-capacitance requirements-power conditioning schemes.

MODULE III POWER ELECTRONICS IN WIND ENERGY CONVERSION SYSTEM 8

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

MODULE IV PHOTOVOLTAIC ENERGY CONVERSION 8

Introduction- Solar radiation and measurement - Solar cells and their characteristics - Influence of insulation and temperature - PV arrays - Electrical storage with batteries - Solar availability in India - Switching devices for solar energy conversion – PV cell technologies.

MODULE V POWER CONDITIONING SCHEMES 8

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

MODULE VI POWER ELECTRONICS IN PV SYSTEMS AND APPLICATIONS 7

Basic switching Devices - Line commutated inverters – Charge controllers – Water pumping – Audio visual equipments – Street lighting.

Total Hours: 45

REFERENCES:

1. S.N.Bhadra, D.Kasthra, S.Banerjee, “Wind Electrical Systems”, Oxford Higher Eduction, 2005.
2. Thomas Ackermann, “Wind Power in Power system,” Wiley 2012.
3. L.L.Freris "Wind Energy conversion Systems", Prentice Hall, 1990.
4. Jian Zhang, Adam Dysko, John O'Reilly, William E. Leithead," Modeling and performance of fixed-speed induction generators in power system oscillation stability studies", Electric Power System Research Vol. 78, pp:1416-1424, 2008.
5. Mukund R. Patel, “Wind and solar power systems”, CRC Press 2004.
6. Rai. G. D. “Non – conventional energy sources”, Khanna Publishers, 2002.

OUTCOMES:

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

- Understanding of fundamental of wind power, detailed model of the Wind Energy components and its control systems.
- Acquire the knowledge about the modeling of various wind generators and its dynamic behavior when integrate with grid.
- Understanding the basic characteristics, working and application of PV cells.
- Understanding of stand - alone systems and Grid connected systems.

SSBY01 SOCIETY, TECHNOLOGY AND SUSTAINABILITY L T P C

3 0 0 3

OBJECTIVES:

- Aware of new technologies through advances in Science and Engineering.
- To make them realise the profound impact on society.
- 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 9

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 9

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 9

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 9

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 9

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.