ACADEMIC REGULATIONS, COURSE STRUCTURE

AND DETAILED SYLLABUS
UNDER

CHOICE BASED CREDIT SYSTEM (CBCS)

Effective from the Academic Year 2015-16

M. Tech. Two Year Degree Course

(MR-15 Regulations)

in

ELECTRICAL POWER SYSTEMS (EPS)
Department of Electrical & Electronics Engineering

MALLA REDDY ENGINEERING COLLEGE (Autonomous)

(An Autonomous Institution approved by UGC and affiliated to JNTUH, Approved by AICTE & Accredited by NAAC with 'A' Grade and NBA & Recipient of World Bank Assistance under TEQIP Phase – II, S.C 1.1)

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MALLA REDDY ENGINEERING COLLEGE (AUTONOMOUS)

MR 15– ACADEMIC REGULATIONS (CBCS) FOR M. Tech. (REGULAR) DEGREE PROGRAMME

Applicable for the students of M. Tech. (Regular) programme from the Academic Year ***2015-16*** and onwards

The M. Tech. Degree of Jawaharlal Nehru Technological University Hyderabad shall be conferred on candidates who are admitted to the programme and who fulfill all the requirements for the award of the Degree.

INSTITUTION VISION

A Culture of excellence , the hallmark of MREC as world class education center to impart Technical Knowledge in an ambience of humanity, wisdom, intellect, creativity with ground breaking discovery, in order to nurture the students to become Globally competent committed professionals with high discipline, compassion and ethical values.

INSTITUTION MISSION

Commitment to progress in mining new knowledge by adopting cutting edge technology to promote academic growth by offering state of art Under graduate and Post graduate programmes based on well-versed perceptions of Global areas of specialization to serve the Nation with Advanced Technical knowledge.

DEPARTMENT VISION

To strive and develop a learning centre in the field of electrical engineering and prepare the students to become talented and committed professionals with discipline and sincerity in serving the society.

DEPARTMENT MISSION

To impart quality education with dedication to achieve academic excellence and offer state-of-the-art technology in the field of electrical engineering to enhance the knowledge and employability of the students.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 1. To train students in core engineering knowledge with software skills, multi disciplinary approach, and make them capable to understand, analyze, design and control electrical machines, power systems and electronic products with solutions for real life applications.

PEO 2. To provide students an impressive academic environment for a successful career in industry/Technical profession and post graduate programmes, research and lifelong learning.

PEO 3. To instill in students professional and ethical attitude, team work skills, leadership qualities and improve oral and written communication skills.

PROGRAMME OUTCOMES (POs)

a) An ability to apply knowledge of mathematics, science, and engineering,

b) An ability to design and conduct experiments, as well as to analyze and interpret data,

c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability,

d) An ability to function on multidisciplinary teams,

e) An ability to identify, formulate, and solve engineering problems,

f) An understanding of professional and ethical responsibility,

g) An ability to communicate effectively,

h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context,

i) A recognition of the need for, and an ability to engage in life-long learning,

j) A knowledge of contemporary issues, and

k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

1.0 ELIGIBILITY FOR ADMISSIONS :

Admission to the above programme shall be made subject to eligibility, qualification and specialization as prescribed by the University from time to time.
Admissions shall be made on the basis of merit/rank obtained by the candidates at the qualifying Entrance Test conducted by the Government of Telangana or on the basis of any other order of merit as approved by the University, subject to reservations as laid down by the Govt. from time to time.

2.0 AWARD OF M.Tech. DEGREE :

2.1 A student shall be declared eligible for the award of the M.Tech. Degree, if the student pursues a course of study in not less than two and not more than four academic years. However, the student is permitted to write the examinations for two more years after four academic years of course work, failing which the student shall forfeit the seat in M. Tech. programme.

2.2 The student shall register for all 88 credits and secure all the 88 credits.

2.3 The minimum instruction days in each semester are 90.

3.0 COURSES OF STUDY :

The following specializations are offered at present for the M. Tech. programme of study.

1. Computer Science and Engineering
2. Digital Systems and Computer Electronics
3. Electrical Power Systems
4. Embedded Systems
5. Geotechnical Engineering
6. Machine Design
7. Structural Engineering
8. Thermal Engineering
9. VLSI System Design

and any other programme as approved by the University from time to time.

3.1 Departments offering M. Tech. Programmes with specializations are noted below:

CE	GTE	Geo Technical Engineering
	SE	Structural Engineering
EEE	EPS	Electrical Power Systems
ME	MD	Machine Design
	TE	Thermal Engineering
ECE	DSCE	Digital Systems and Computer Electronics
	ES	Embedded Systems
	VLSI SD	VLSI System Design
CSE	CSE	Computer Science and Engineering

4 COURSE REGISTRATION :

4.1 A 'Faculty Advisor or Counselor' shall be assigned to each student, who will advise him on the Post Graduate Programme (PGP), its Course Structure and Curriculum, Choice/Option for Subjects/ Courses, based on his competence, progress, pre-requisites and interest.

4.2 Academic Section of the College invites 'Registration Forms' from students within 15 days from the commencement of class work for the first semester through 'ON-LINE SUBMISSIONS', ensuring 'DATE and TIME Stamping'. The ON-LINE Registration Requests for any 'SUBSEQUENT SEMESTER' shall be completed BEFORE the commencement of SEEs (Semester End Examinations) of the 'CURRENT SEMESTER'.

4.3 A Student can apply for ON-LINE Registration, ONLY AFTER obtaining the 'WRITTEN APPROVAL' from the Faculty Advisor, which should be submitted to the College Academic Section through the Head of Department (a copy of it being retained with Head of Department, Faculty Advisor and the Student).

4.4 If the Student submits ambiguous choices or multiple options or erroneous entries during ON-LINE Registration for the Subject(s) / Course(s) under a given/ specified Course Group/ Category as listed in the Course Structure, only the first mentioned Subject/ Course in that Category will be taken into consideration.

4.5 Subject/ Course Options exercised through ON-LINE Registration are final and CANNOT be changed, nor can they be inter-changed; further, alternate choices will also not be considered. However, if the Subject/ Course that has already been listed for Registration (by the Head of Department) in a Semester could not be offered due to any unforeseen or unexpected reasons, then the Student shall be allowed to have alternate choice - either for a new Subject (subject to offering of such a Subject), or for another existing Subject (subject to availability of seats), which may be considered. Such alternate arrangements will be made by the Head of Department, with due notification and time-framed schedule, within the FIRST WEEK from the commencement of Class-work for that Semester.

5 ATTENDANCE :

The programmes are offered on a unit basis with each subject/course being considered as a unit.

5.1 Attendance in all classes (Lectures/Laboratories etc.) is compulsory. The minimum required attendance in each theory / Laboratory etc. is 75% including the days of attendance in sports, games, NCC and NSS activities for appearing for the Semester End examination (SEE). A student shall not be permitted to appear for the Semester End Examinations (SEE) if his attendance is less than 75%.

5.2 Condonation of shortage of attendance in each subject up to 10% (65% and above and below 75%) in each semester shall be granted by the College Academic Committee (CAC).

5.3 Shortage of Attendance below 65% in each subject shall not be condoned.

5.4 Students whose shortage of attendance is not condoned in any subject are not eligible to write their end Semester End Examination of that subject and their registration shall stand cancelled.

5.5 A fee prescribed by the CAC, shall be payable towards Condonation of shortage of attendance.

5.6 A Candidate shall put in a minimum required attendance in atleast three (3) theory subjects in I semester for promoting to II Semester. In order to qualify for the award of the M.Tech. Degree, the candidate shall complete all the academic requirements of the subjects, as per the course structure.

5.7 A student shall not be promoted to the next semester unless the student satisfies the attendance requirement of the present Semester, as applicable. The student may seek readmission into that semester when offered next. If any candidate fulfills the attendance requirement in the present semester, the student shall not be eligible for readmission into the same class.

6 EVALUATION - DISTRIBUTION AND WEIGHTAGE OF MARKS: :

The performance of the candidate in each semester shall be evaluated subject-wise, with a maximum of 100 marks for theory and 100 marks for practicals, on the basis of Continuous Internal Evaluation and Semester End Examinations. For all Subjects/ Courses, the distribution shall be 40 marks for CIE, and 60 marks for the SEE

6.1 Theory Courses :

6.1.1 Continuous Internal Evaluation (CIE):

The CIE consists of two Assignments each of 05 marks and two mid-term examinations each of 35 marks. The CIE shall be finalized based on the 70% of the best performed and 30% of the other performance.The first mid-term examination shall be conducted for the first 50% of the syllabus, and the second mid-term examination shall be conducted for the remaining 50% of the syllabus.

First Assignment should be submitted before the conduct of the first mid-term examinations, and the Second Assignment should be submitted before the conduct of the second midterm examinations. The Assignments shall be as specified by the concerned subject teacher.. Each mid-term examination shall be conducted for a total duration of 120 minutes, for 35 marks.

The division of marks for CIE is as given below:

Mid – Term Examination				
Part	**Type of Questions**	**No. of questions**	**Marks per question**	**Total**
Part A	Multiple-choice questions	10	0.5	05
	Fill-in the blanks	10	0.5	05
	Sub-Total			10
Part B	Compulsory questions	5	2	10
Part C	Choice questions (3 out of 5)	3	5	15
			Mid-Term Exam Total	35
			Assignment	05
			Grand Total	40

6.1.2 Semester End Examination (SEE):

The division of marks for SEE is as given below:

Semester End Examination				
Part	**Type of Questions**	**No. of questions to be answered**	**Marks per question**	**Total**
Part A	Compulsory Questions (One from each module)	5	4	20
Part B	Choice Questions (5 out of 8) (Minimum one from each module)	5	8	40
			Grand Total	60

6.2 Practical Courses:

6.2.1 Continuous Internal Evaluation (CIE):

There will be CIE for 40 marks, shall be awarded with a distribution of 20 marks for day-to-day performance and timely submission of lab records, 5 marks for viva-voce, 15 marks for internal lab exam (best out of two exams).

6.2.2 Semester End Examination (SEE):

There will be SEE for 60 marks, shall be awarded with a distribution of 20 marks for write-up on the given experiment, 20 marks for proficiency in the exam, 10 marks for results and 10 marks for viva-voce. For conducting SEE, one internal examiner and one external examiner will be appointed by the Chief Controller of Examinations of the College. The external examiner should be selected from outside the College among the autonomous/reputed institutions, from a panel of three examiners submitted by the concerned Head of the Department.

6.3 Seminar:

There shall be two seminar presentations during I semester and II semester. For seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Departmental Academic Committee consisting of Head of the Department, Supervisor and two other senior faculty members of the department. For each Seminar there will be only internal evaluation of 100 marks with a distribution of 30 marks for the report, 50 marks for presentation and 20 marks for the queries. A candidate has to secure a minimum of 50% of marks to be declared successful. If the student fails to fulfill minimum marks, the student has to reappear during the supplementary examinations.

6.4 Comprehensive Viva-Voce:

There shall be a Comprehensive Viva-Voce in III Semester. The Comprehensive Viva-Voce is intended to assess the students' understanding of various subjects studied during the M. Tech. course of study. The Head of

the Department shall be associated with the conduct of the Comprehensive Viva-Voce through a Committee. The Committee consists of the Head of the Department, one senior faculty member and an external examiner. The external examiner shall be appointed by the Chief Controller of Examinations from a panel of three examiners submitted by the concerned Head of the Department. There are no internal marks for the Comprehensive Viva-Voce and evaluates for maximum of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful. If the student fails to fulfill minimum marks, the student has to reappear during the supplementary examinations.

6.5. **General:** A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the Semester End Examination and a minimum of 50% of the total marks in the Semester End Examination and Continuous Internal Evaluation taken together. In case the candidate does not secure the minimum academic requirement in any subject he has to reappear for the Semester End Examination in that subject. A candidate shall be given one chance to re-register for the subject if the internal marks secured by the candidate are less than 50% and failed in that subject. This is allowed for a maximum of three subjects and should register within two weeks of commencement of that semester class work. In such a case, the candidate must re-register for the subjects and secure the required minimum attendance. The candidate's attendance in the re-registered subject(s) shall be calculated separately to decide upon the eligibility for writing the Semester End Examination in those subjects. In the event of the student taking another chance, the student's Continuous Internal Evaluation (CIE) marks and Semester End Examination (SEE) marks obtained in the previous attempt stands cancelled.

7 EXAMINATIONS AND ASSESSMENT - THE GRADING SYSTEM :

7.1 Marks will be awarded to indicate the performance of each student in each Theory Subject, or Lab / Practicals, or Seminar, or Project, etc., based on the % marks obtained in CIE + SEE (Continuous Internal Evaluation + Semester End Examination, both taken together) as specified in Item 6 above, and a corresponding Letter Grade shall be given.

7.2 As a measure of the student's performance, a 10-point Absolute Grading System using the following Letter Grades (UGC Guidelines) and corresponding percentage of marks shall be followed:

% of Marks Secured (Class Intervals)	Grade Points	Letter Grade (UGC Guidelines)
≥ 80%	10	O (Outstanding)
≥ 70% to < 80%	9	A+ (Excellent)
≥ 60% to < 70%	8	A (Very Good)
≥ 55% to < 60%	7	B+ (Good)
≥ 50% to < 55%	6	B (Above Average)
< 50%	0	F (Fail)
Absent	Ab	Ab

7.3 A student obtaining F Grade in any Subject shall be considered 'failed' and is be required to reappear as 'Supplementary Candidate' in the Semester End Examination (SEE), as and when conducted. In such cases, his Internal Marks (CIE Marks) in those Subjects will remain the same as those he obtained earlier.

7.4 A student not appeared for examination then 'Ab' Grade will be allocated in any Subject shall be considered 'failed' and will be required to reappear as 'Supplementary Candidate' in the Semester End Examination (SEE), as and when conducted.

7.5 A Letter Grade does not imply any specific Marks percentage and it will be the range of marks percentage.

7.6 In general, a student shall not be permitted to repeat any Subject/ Course (s) only for the sake of 'Grade Improvement' or 'SGPA/ CGPA Improvement'.

7.7 A student earns Grade Point (GP) in each Subject/ Course, on the basis of the Letter Grade obtained by him in that Subject/ Course. The corresponding 'Credit Points' (CP) is computed by multiplying the Grade Point with Credits for that particular Subject/ Course.
Credit Points (CP) = Grade Point (GP) x Credits …. For a Course

7.8 The Student passes the Subject/ Course only when he gets GP ≥ 6(B Grade or above).

7.9 The Semester Grade Point Average (SGPA) is calculated by dividing the Sum of Credit Points (∑CP) secured from ALL Subjects/ Courses registered in a Semester, by the Total Number of Credits registered during that Semester. SGPA is rounded off to TWO Decimal Places. SGPA is thus computed as:

$$\text{SGPA} = \left\{\sum_{i=1}^{N} C_i G_i\right\} / \left\{\sum_{i=1}^{N} C_i\right\} \ldots \text{For each Semester}$$

where 'i' is the Subject indicator index (takes into account all Subjects in a Semester), 'N'is the no. of Subjects 'REGISTERED' for the Semester (as specifically required and listed under the Course Structure of the parent Department), C_i is the no. of Credits allotted to the i^{th} Subject, and G represents the Grade Points (GP) corresponding to the Letter Grade awarded for that i^{th} Subject.

7.10 The Cumulative Grade Point Average (CGPA) is a measure of the overall cumulative performance of a student over all Semesters considered for registration. The CGPA is the ratio of the Total Credit Points secured by a student in ALL registered Courses in ALL Semesters, and the Total Number of Credits registered in ALL the Semesters. CGPA is rounded off to TWO Decimal Places. CGPA is thus computed from the II Semester onwards, at the end of each Semester, as per the formula

$$\text{CGPA} = \left\{\sum_{j=1}^{M} C_j G_j\right\} / \left\{\sum_{j=1}^{M} C_j\right\} \ldots \text{for all S semesters registered}$$
(i.e., upto and inclusive of S semesters, S ≥ 2)

where 'M' is the TOTAL no. of Subjects (as specifically required and listed under the Course Structure of the parent Department) the Student has

'REGISTERED' from the 1st Semester onwards upto and inclusive of the Semester S (obviously M > N), 'j' is the Subject indicator index (takes into account all Subjects from 1 to S Semesters), C_j is the no. of Credits allotted to the j^{th} Subject, and G_j represents the Grade Points (GP)corresponding to the Letter Grade awarded for that j^{th} Subject. After registration and completion of I Semester however, the SGPA of that Semester itself may be taken as the CGPA, as there are no cumulative effects.

7.11 For Calculations listed in Item 7.6 – 7.10, performance in failed Subjects/ Courses (securing F Grade) will also be taken into account, and the Credits of such Subjects/Courses will also be included in the multiplications and summations.

8. EVALUATION OF PROJECT/DISSERTATION WORK :

Every candidate shall be required to submit a thesis or dissertation on a topic approved by the Project Review Committee.

8.1 A Project Review Committee (PRC) shall be constituted with Head of the Department as Chairperson, Project Supervisor and one senior faculty member of the Departments offering the M. Tech. programme.

8.2 Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the subjects, both theory and practical.

8.3 After satisfying 8.2, a candidate has to submit, in consultation with his Project Supervisor, the title, objective and plan of action of his project work to the PRC for approval. Only after obtaining the approval of the PRC the student can initiate the Project work.

8.4 If a candidate wishes to change his supervisor or topic of the project, he can do so with the approval of the PRC. However, the PRC shall examine whether or not the change of topic/supervisor leads to a major change of his initial plans of project proposal. If yes, his date of registration for the project work starts from the date of change of Supervisor or topic as the case may be.

8.5 A candidate shall submit his project status report in two stages at least with a gap of 3 months between them.

8.6 The work on the project shall be initiated at the beginning of the III Semester and the duration of the project is two semesters. A candidate is permitted to submit Project Thesis only after successful completion of all theory and practical courses with the approval of PRC not earlier than 40 weeks from the date of registration of the project work. For the approval of PRC the candidate shall submit the draft copy of thesis to the Head of the Department and make an oral presentation before the PRC.
Note: *The project supervisor/guide has to ensure that the student has to publish a minimum of one paper related to the thesis in a National/International Conference/Journal.*

8.7 For the final approval by the PRC, the soft copy of the thesis should be submitted for ANTI-PLAGIARISM for the quality check and the plagiarism

report should be included in the final thesis. If the copied information is less than 24%, then only thesis will be accepted for submission.

8.8 Three copies of the Project Thesis certified by the supervisor, HOD and Principal shall be submitted to the Chief Controller of Examinations for project evaluation (viva voce).

8.9 For Project work part-I in III Semester there is an internal marks of 50, the evaluation should be done by the PRC for 30 marks and Supervisor will evaluate for 20 marks. The Supervisor and PRC will examine the Problem Definition, Objectives, Scope of Work, Literature Survey in the same domain. A candidate has to secure a minimum of 50% of marks to be declared successful for Project work part-I. If the student fails to fulfill minimum marks, the student has to reappear during the supplementary examination.

8.10 For Project work part-II in IV Semester there is an internal marks of 50, the evaluation should be done by the PRC for 30 marks and Supervisor will evaluate for 20 marks. The PRC will examine the overall progress of the Project Work and decide the Project is eligible for final submission or not. A candidate has to secure a minimum of 50% of marks to be declared successful for Project work part-II. If the student fails to fulfill minimum marks, the student has to reappear during the supplementary examination.

8.11 For Project Evaluation (Viva Voce) in IV Semester there is an external marks of 150 and the same evaluated by the External examiner appointed by the Chief Controller of Examinations. For this, the Head of the Department shall submit a panel of 3 examiners, eminent in that field, with the help of the supervisor/guide concerned. The candidate has to secure minimum of 50% marks in Project Evaluation (Viva-Voce) examination.

8.12 If the student fails to fulfill as specified in 8.11, based the recommendation of the external examiner, the student will reappear for the Viva-Voce examination with the revised thesis only after three months. In the reappeared examination also, fails to fulfill, the student will not be eligible for the award of the degree.

8.13 The Head of the Department shall coordinate and make arrangements for the conduct of Project Viva-Voce examination.

9. AWARD OF DEGREE AND CLASS :

9.1 A Student who registers for all the specified Subjects/ Courses as listed in the Course Structure, satisfies all the Course Requirements, and passes the examinations prescribed in the entire PG Programme (PGP), and secures the required number of **88** Credits (with CGPA $\geq$ 6.0), shall be declared to have 'QUALIFIED' for the award of the M.Tech. Degree in the chosen Branch of Engineering and Technology with specialization as he admitted.

9.2 Award of Class

After a student has satisfied the requirements prescribed for the completion of the programme and is eligible for the award of M. Tech. Degree, he shall be placed in one of the following three classes based on the CGPA:

Class Awarded	CGPA
First Class with Distinction	≥ 7.75
First Class	≥ 6.75 and < 7.75
Second Class	≥ 6.00 and < 6.75

9.3 A student with final CGPA (at the end of the PGP) < 6.00 will not be eligible for the Award of Degree.

10. <u>WITHHOLDING OF RESULTS</u> :

If the student has not paid the dues, if any, to the University or if any case of indiscipline is pending against him, the result of the student will be withheld and he will not be allowed into the next semester. His degree will be withheld in such cases.

11. <u>TRANSITORY REGULATIONS</u> :

11.1 If any candidate is detained due to shortage of attendance in one or more subjects, they are eligible for re-registration to maximum of three earlier or equivalent subjects at a time as and when offered.

11.2 The candidate who fails in any subject will be given two chances to pass the same subject; otherwise, he has to identify an equivalent subject as per MR15 Academic Regulations.

12. <u>GENERAL</u> :

12.1 **Credit**: A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.

12.2 **Credit Point:** It is the product of grade point and number of credits for a course.

12.3 Wherever the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”.

12.4 The academic regulation should be read as a whole for the purpose of any interpretation.

12.5 In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the CAC is final.

MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/Improper conduct	**Punishment**
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the SEE)	Expulsion from the examination hall and cancellation of the performance in that course only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that course only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to that course of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the courses of that Semester. The Hall Ticket of the candidate shall be cancelled.
3	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate, who has been impersonated, shall be cancelled in all the courses of the examination (including practicals and project work) already appeared and shall not

		be allowed to appear for examinations of the remaining courses of that semester. The candidate is also debarred for two consecutive semesters from class work and all SEE. The continuation of the programme by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that course and all the other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester. The candidate is also debarred for two consecutive semesters from class work and all SEE. The continuation of the programme by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that course.
6	Refuses to obey the orders of the Chief Controller of Examinations (CCE) / Controller of Examinations (CE) / Assistant Controller of Examinations (ACE) / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that course and all other courses the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the courses of that semester. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a

	the officer in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination	police cases registered against them.
7	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that course and all the other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all SEE. The continuation of the programme by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester. The candidate is also debarred and forfeits the seat.
9	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester. The candidate is also

		debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester.
11	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that course and all other courses the candidate has appeared including practical examinations and project work of that SEE.
12	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the CCE for further action toward suitable punishment.	

Note: ***The student(s) found indulging in malpractices during the CIE also will be punished based on the recommendations of the College Academic Committee.***

MALLAREDDY ENGINEERING COLLEGE (Autonomous)

Academic Year 2015-16 (Choice Based Credit System)

COURSE STRUCTURE – M.TECH Electrical Power Systems (EPS)

(MR15 Regulations)

I SEMESTER

S. No.	Category	Course Code	Name of the course	Contact hours/ week			Credits	Scheme of Valuation		Total Marks
				L	T	P		Internal (CIE)	External (SEE)	
1	CC I	52101	Advanced Power System Analysis	4	--	--	4	40	60	100
2	CC II	52102	Advanced Power System Protection	4	--	--	4	40	60	100
3	CC III	52103	Modern Control Theory	4	--	--	4	40	60	100
4	PE I	52104 52105 54132	1. EHV AC Transmission 2. High Voltage Generation & Measurement 3. Advanced Digital Signal Processing	4	--	--	4	40	60	100
5	PE II	52106 54133 52107	1. Power Quality 2. Microcontrollers and applications 3. Distribution Automation	4	--	--	4	40	60	100
6	OE I	50B15 53108 54106	1. Optimization Techniques 2. Energy Management 3. Embedded System Design	4	--	--	4	40	60	100
7	Laboratory I	52108	Power System Simulation Lab	--	--	4	2	40	60	100
8	Seminar I	52109	Seminar-I	--	--	4	2	100	--	100
			Total	24	--	8	28	Contact Periods: 32		

II SEMESTER

S. No.	Category	Course Code	Name of the course	Contact hours/ week			Credits	Scheme of Valuation		Total Marks
				L	T	P		Internal (CIE)	External (SEE)	
1	CC IV	52110	Power System Dynamics	4	--	--	4	40	60	100
2	CC V	52111	Flexible AC Transmission Systems (FACTS)	4	--	--	4	40	60	100
3	CC VI	52112	Power System Operation and Deregulation	4	--	--	4	40	60	100
4	PE III	52113 52114 52115	1. Gas Insulated Systems(GIS) 2. Programmable Logic Controllers and their Applications 3. High frequency magnetic components	4	--	--	4	40	60	100
5	PE IV	52116 52117 52118	1. Reactive Power Compensation and Management 2. Power System Reliability 3. Voltage Stability	4	--	--	4	40	60	100
6	OE II	52119 52120 52121	1. Intelligent Control 2. Smart grid technologies 3. AI Techniques in Electrical Engineering	4	--	--	4	40	60	100
7	Laboratory II	52122	Power Systems Lab	--	--	4	2	40	60	100
8	Seminar II	52123	Seminar-II	--	--	4	2	100	--	100
			Total	24	--	8	28	Contact Periods: 32		

III Semester

S. No.	Category	Course Code	Name of the course	Contact hours/week			Credits	Scheme of Valuation		Total Marks
				L	T	P		Internal (CIE)	External (SEE)	
1	CV	52124	Comprehensive Viva-Voce	--	--	--	4	--	100	100
2	PR I	52125	Project work Part I	--	--	16	8	50	--	50
Total				--	--	16	12	Contact Periods: 16		

IV Semester

S. No.	Category	Course Code	Name of the course	Contact hours/week			Credits	Scheme of Valuation		Total Marks
				L	T	P		Internal (CIE)	External (SEE)	
1	PR II	52126	Project work Part II	--	--	16	8	50	--	50
2	PR III	52127	Project Viva-Voce	--	--	--	12	--	150	150
Total				--	--	16	20	Contact Periods: 16		

*** CC – Core Course, PE – Professional Elective, CV – Comprehensive Viva – Voce, PR – Project Work**

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Course Code:52101 **Credits: 4**

M.Tech (EPS) I – Semester

ADVANCED POWER SYSTEM ANALYSIS
(Core Course I)

Prerequisite: Computer Methods in Power Systems

Course Objectives:

- To analyze a Power System Network using graph theory.
- To interpret the formation of Network matrices.
- To construct the necessity of load flow studies and various methods of Analysis.
- To examine short circuit analysis using Z_{Bus}.

Module I: **[10 Periods]**

Admittance Model and Network Calculations, Branch and Node Admittances, Mutually Coupled Branches in Y_{BUS} , An Equivalent Admittance Network, Modification of Y_{BUS} , Network Incidence Matrix and Y_{BUS} , Method of Successive Elimination, Node Elimination, Triangular Factorization, Sparsity and Near Optimal Ordering.

Module II: **[9 Periods]**

Impedance Model and Network Calculations, the BUS Admittance and Impedance Matrices, Thevenin"s Theorem and Z_{BUS} ,Algorithms for building Z_{BUS} Modification of existing $Z_{BUS,}$ Calculation of Z_{BUS} elements from $Y_{BUS,}$ Power Invariant Transformations, Mutually Coupled Branches in $Z_{BUS.}$

Module III: **[8 Periods]**

Gauss Seidel method, N-R Method, Decoupled method, fast decoupled method, comparison between power flow solutions. DC load flow.

Module IV: **[9 Periods]**

Z_{BUS} Method in Contingency Analysis, Adding and Removing Multiple Lines, Piecewise Solution of Interconnected Systems, Analysis of Single Contingencies, Analysis of Multiple Contingencies, Contingency Analysis of DC Model, System Reduction for Contingency and Fault Studies.

Module V: **[8 Periods]**

Fault Analysis: Symmetrical faults-Fault calculations using Z_{BUS}- Fault calculations using Z_{BUS} equivalent circuits –Selection of circuit breakers- Unsymmetrical faults-Problems on various types of faults.

TEXT BOOKS:

1. John J.Grainger and W.D. Stevenson, "Power System Analysis"- T.M.H.Edition.
2. Modern Power System Analysis – by I.J.Nagrath & D.P.Kothari Tata M Graw – Hi Publishing Company Ltd, 2nd edition.

REFERENCES:

1. Power System Analysis and Design by J.Duncan Glover and M.S.Sarma., cengage 3rd Edition.
2. Olle. L.Elgard, "Electrical Energy Systems Theory"-T.M.H.Edition.
3. Power systems stability and control, Prabha Kundur, The Mc Graw – Hill companies**.**
4. Power System Operation and Control, Dr. K. Uma Rao, Wiley India Pvt. Ltd.
5. Operation and Control in Power Systems, PSR Murthy, Bs Publications.
6. Power System Operation, Robert H. Miller, Jamesh H. Malinowski, The Mc Graw – Hill companies**.**
7. Power Systems Analysis, operation and control by Abhijit Chakrabarti, SModuleha Halder, PHI 3/e , 2010

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Remember proper mathematical models for analysis.
- Conclude methodologies of load flow studies for the power network.
- Apply contingency Analysis.
- Analyze power system studies.

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Course Code:52102 **Credits: 4**

M.Tech (EPS) I – Semester

ADVANCED POWER SYSTEM PROTECTION
(Core Course II)

Prerequisite: Switch Gear and Protection

Course Objectives:

- To distinguish all kinds of circuit breakers and relays for protection of Generators, Transformers and feeder bus bars from Over voltages and other hazards.
- To generalize neutral grounding for overall protection.
- To illustrate the phenomenon of Over Voltages and its classification.

Module I: **[9 Periods]**

Static Relays: Advantages of static relays-Basic construction of static relays-Level detectors-Replica impedance –Mixing circuits-General equation for two input phase and amplitude comparators-Duality between amplitude and phase comparators.

Amplitude Comparators: Circulating current type and opposed voltage type- rectifier bridge comparators, Direct and Instantaneous comparators.

Module II: **[8 Periods]**

Phase Comparators: Coincidence circuit type- block spike phase comparator, techniques to measure the period of coincidence-Integrating type-Rectifier and Vector product type- Phase comparators.

Static over Current Relays: Instantaneous over-current relay-Time over-current relays-basic principles –definite time and Inverse definite time over-current relays.

Module III: **[8 Periods]**

Static Differential Relays: Analysis of Static Differential Relays –Static Relay schemes – Duo bias transformer differential protection –Harmonic restraint relay.

Static Distance Relays: Static impedance-reactance–MHO and angle impedance relay-sampling comparator –realization of reactance and MHO relay using sampling comparator.

Module IV: **[9 Periods]**

Multi-Input Comparators: Conic section characteristics-Three input amplitude comparator –Hybrid comparator-switched distance schemes –Poly phase distance schemes-phase fault scheme –three phase scheme – combined and ground fault scheme.

Power Swings: Effect of power swings on the performance of distance relays –Power swing analysis-Principle of out of step tripping and blocking relays-effect of line and length and source impedance on distance relays.

Module V: **[10 Periods]**

Microprocessor based Protective Relays: (Block diagram and flowchart approach only)-Over current relays–impedance relays-directional relay-reactance relay .Generalized mathematical expressions for distance relays-measurement of resistance and reactance – MHO and offset MHO relays-Realization of MHO characteristics- Realization of offset MHO characteristics -Basic principle of Digital computer relaying.

TEXT BOOKS:

1. Badri Ram and D.N.Vishwakarma, "Power system protection and Switch gear ", TMH publication New Delhi 1995.
2. T.S.Madhava Rao , "Static relays", TMH publication, second edition 1989.

REFERENCES:

1. Protection and Switchgear, Bhavesh Bhalja, R. P. Mahesheari, Nilesh G. Chothani, Oxford University Press.
2. Electrical Power System Protection, C. Christopoulos and A. Wright, Springer International.

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Understand the basic function of a circuit breaker, all kinds of circuit breakers and differentiate fuse and circuit breakers under fault condition.
- Describe the necessity for the protection of alternators, transformers and feeder bus bars from over voltages and other hazards
- Illustrate neutral grounding, and how over voltages can be generated and how system can be protected against lightning and switching transient over voltages with various protective means Identify operation and control of microprocessor based relays.

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Course Code:52103 **Credits: 4**

M.Tech (EPS) I – Semester

MODERN CONTROL THEORY
(Core Course III)

Prerequisite: Control Systems

Course Objectives

- To explain the concepts of basic and modern control system for the real time analysis and design of control systems.
- To Explain and apply concepts of state variables analysis.
- To study and analyze non linear systems.
- To analyze the concept of stability of nonlinear systems and categorization.
- To apply the comprehensive knowledge of optimal theory for Control Systems.

Module I: **[8 Periods]**

Mathematical Preliminaries: Fields, Vectors and Vector Spaces – Linear combinations and Bases – Linear Transformations and Matrices – Scalar Product and Norms – Eigen-values, Eigen Vectors and a Canonical form representation of Linear operators – The concept of state – State Equations for Dynamic systems – Time invariance and Linearity – Non-uniqueness of state model – State diagrams for Continuous-Time State models.

Module II: **[10 Periods]**

State Variable Analysis: Linear Continuous time models for Physical systems– Existence and Uniqueness of Solutions to Continuous-Time State Equations – Solutions of Linear Time Invariant Continuous-Time State Equations – State transition matrix and its properties. General concept of controllability – General concept of Observability – Controllability tests for Continuous-Time Invariant Systems – Observability tests for Continuous-Time Invariant Systems – Controllability and Observability of State Model in Jordan Canonical form – Controllability and Observability Canonical forms of State model.

Module III: **[9 Periods]**

Non Linear Systems: Introduction – Non Linear Systems - Types of Non-Linearities – Saturation – Dead-Zone - Backlash – Jump Phenomenon etc;– Singular Points – Introduction to Linearization of nonlinear systems, Properties of Non-Linear systems – Describing function–describing function analysis of nonlinear systems – Stability analysis of Non-Linear systems through describing functions. Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase-plane analysis of nonlinear control systems.

Module IV: **[8 Periods]**

Stability Analysis: Stability in the sense of Lyapunov, Lyapunov‟s stability and Lypanov‟s instability theorems - Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski‟s method. State feedback controller design through Pole Assignment – State observers: Full order and Reduced order.

Module V: **[8 Periods]**

Optimal Control: Introduction to optimal control - Formulation of optimal control problems – calculus of variations – fundamental concepts, functional, variation of functional – fundamental theorem of theorem of Calculus of variations – boundary conditions – constrained minimization – formulation using Hamiltonian method – Linear Quadratic regulator.

TEXT BOOKS:

1. Modern control system theory by m.gopal – new age international -1984
2. Control System Engineering, Nagrath and Gopal - New Age International – Fourth Edition

REFERENCES:

1. Optimal control by Kirck , Dover Publications
2. Advanced Control Theory A. Nagoor Kani, RBA Publications, 1999
3. Modern Control Engineering by Ogata.K – Prentice Hall - 1997

Course Outcomes

Upon completion of this course, students should be able to:

- Apply the knowledge of basic and modern control system for the real time analysis and design of control systems.
- Understand the concepts of state variables analysis.
- Analyze the concept of stability of nonlinear systems and optimal control.

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Course Code: 52104 **Credits: 4**

M.Tech (EPS) I – Semester

EHV AC TRANSMISSION

(Professional Elective - I)

Prerequisite: Power Systems -II

Course objectives:

- To identify the different aspects of Extra High Voltage A.C and D.C Transmission design and Analysis
- To understand the importance of modern developments of E.H.V and U.H.V transmission systems.
- To demonstrate EHV ac transmission system components, protection and insulation level for over voltages.

Module I: **[8 Periods]**

E.H.V.A.C. Transmission line trends and preliminary aspect standard transmission voltages – Estimation at line and ground parameters-Bundle conductor systems-Inductance and Capacitance of E.H.V. lines – positive, negative and zero sequence impedance – Line Parameters for Modes of Propagation.

Module II: **[9 Periods]**

Electrostatic field and voltage gradients – calculations of electrostatic field of AC lines – effect of high electrostatic field on biological organisms and human beings - surface voltage gradients and maximum gradients of actual transmission lines – voltage gradients on sub conductor.

Module III: **[10 Periods]**

Electrostatic induction in unenergized lines – measurement of field and voltage gradients for three phase single and double circuit lines – un energized lines. Power Frequency Voltage control and over-voltages in EHV lines: No load voltage – charging currents at power frequency-voltage control – shunt and series compensation – static VAR compensation.

Module IV: **[8 Periods]**

Corona in E.H.V. lines – Corona loss formulae- attention of traveling waves due to Corona – Audio noise due to Corona, its generation, characteristic and limits. Measurements of audio noise radio interference due to Corona - properties of radio noise – frequency spectrum of RI fields – Measurements of RI and RIV.

Module V: **[8 Periods]**

Design of EHV lines based on steady state and transient limits - EHV cables and their characteristics.

TEXT BOOKS:

1. R. D. Begamudre ,"EHVAC Transmission Engineering", New Age International (p) Ltd. 3rd Edition.
2. K.R. Padiyar, "HVDC Power Transmission Systems" New Age International (p) Ltd. 2nd revised Edition, 2012.

REFERENCES:

1. S. Rao "EHVAC and HVDC Transmission Engg. Practice" Khanna publishers.
2. Arrillaga.J " High Voltage Direct Current Transmission" 2nd Edition (London) peter Peregrines, IEE, 1998.
3. Padiyar.K.R, " FACTS Controllers in Power Transmission and Distribution" New Age Int. Publishers, 2007.
4. Hingorani H G and Gyugyi. L " Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems" New York, IEEE Press, 2000.

Course Outcomes:

Upon the completion of the subject, the student will be able to

- List the necessity of EHV AC transmission, choice of voltage for transmission, line losses and power handling capability.
- Estimate the Statistical procedures for line designs, scientific and engineering principles in power systems.

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Course Code: 52105 **Credits: 4**

M.Tech (EPS) I – Semester

HIGH VOLTAGE GENERATION AND MEASUREMENT
(Professional Elective - I)

Prerequisite: Power Systems and Electrical & Electronics Instrumentation
Course Objectives:

- To distinguish the Gaseous, liquid and solid dielectric behavior under High Voltage.
- To understand the generation methods of High A.C, DC & Impulse Voltages required for various application.
- To apply the measuring techniques of High A.C., D.C & Impulse voltages and currents. To identify the testing techniques for High Voltage Equipment.

Module I **[9 Periods]**

GENERATION OF DIRECT VOLTAGES

Generation and transmission of electric energy – voltage stress – testing voltages-AC to DC conversion – single phase rectifier circuits – cascaded circuits – voltage multiplier circuits – Cockroft-Walton circuits – voltage regulation – ripple factor – Design of HVDC generator – Vande-Graff generator.

Module II **[8 Periods]**

GENERATION OF ALTERNATING VOLTAGES

Testing transformer – single unit testing transformer, cascaded transformer – equivalent circuit of cascaded transformer – series resonance circuit – resonant transformer – voltage regulation.

Module III **[9 Periods]**

GENERATION OF IMPULSE VOLTAGES

Marx generator – Impulse voltage generator circuit – analysis of various impulse voltage generator circuits – multistage impulse generator circuits – Switching impulse generator circuits – impulse current generator circuits – generation of non-standard impulse voltages and nanosecond pulses.

Module IV **[8 Periods]**

MEASURMENT OF HIGH VOLTAGES

Peak voltage measurements by sphere gaps – Electrostatic voltmeter – generating voltmeters and field sensors – Chubb-Fortescue method – voltage dividers and impulse voltage measurements

Module V **[9 Periods]**

GENERATION AND MEASUREMENT OF IMPULSE CURRENTS

Generation of impulse currents, measurement of impulse currents – Resistive shunts , measurement using magnetic coupling - Fast digital transient recorders for impulse measurements.

REFERENCES

1. Kuffel, E., Zaengl, W.S. and Kuffel J., "High Voltage Engineering Fundamentals", Elsvier India Pvt. Ltd, 2005
2. Dieter Kind, Kurt Feser, "High Voltage Test Techniques", SBA Electrical Engineering Series, New Delhi, 1999.
3. Naidu M S and Kamaraju V, "High Voltage Engineering", Tata McGraw-hill Publishing Company Ltd., New Delhi, 2004.
4. Gallagher, T.J., and Permain, A., "High Voltage Measurement, Testing and Design", John Wiley Sons, New York, 1983.
5. R.Mazen Abdel-Salam, Hussein Anis, Ahdab El-Morshedy, Roshdy Radwan, "High Voltage Engineering Theory and Practice" Second Edition, Revised and Expanded, Marcel Dekker, Inc., New York, 2000.
6. N.H.Malik, A.A.Al_Arainy, M.I.Qureshi, " Electrical Insulation in Power Systems", marcel Dekker,Inc., New York 1988.
7. Adolf J. Schwab, "High Voltage Measurement Techniques", M.I.T Press, 1972

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Know conduction and breakdown will occur in gases, liquids and solids dielectrics and different applications of the insulating materials in electrical power apparatus.
- Explain the insulation testing of various components in power systems for different types of voltages, namely power frequency A.C, high frequency, switching or lightning impulses, for which generation of high voltages in laboratories is essential
- Interpret the necessity to measure the voltages and currents accurately, ensuring perfect safety to the personnel and equipment.
- Detect the necessary condition for all the electrical equipment which are capable of withstanding the over voltages which met in service like natural causes lightning or system originated ones switching or power frequency transient voltages.

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Course Code: 54132 **Credits: 4**

M.Tech (EPS) I – Semester

ADVANCED DIGITAL SIGNAL PROCESSING
(Professional Elective - I)

Prerequisite: Digital Signal Processing

Course Learning Objectives

- To Comprehend characteristics of discrete time signals and systems
- To analyze and process signals using various transform techniques
- To identify various factors involved in design of digital filters
- To illustrate the effects of finite word length implementation.

Module I: **[8 Periods]**

Digital Filter Structures: Block diagram representation – Equivalent Structures – FIR and IIR digital filter Structures AII pass Filters-tunable IIR Digital Sine-cosine generator-Computational complexity of digital filter structures.

Module II: **[10 Periods]**

Digital Filter Design:

Preliminary considerations- Bilinear transformation method of IIR filter design –design of Low pass high-pass – Band-pass, and Band stop- IIR digital filters – Spectral transformations of IIR filters – FIR filter design –based on Windowed Fourier series – design of FIR digital filters with least – mean square-error – constrained Least –square design of FIR digital filters.

Module III: **[8 Periods]**

DSP Algorithm Implementation: Computation of the discrete Fourier transform- Number representation – Arithmetic operations – handling of overflow – Tunable digital filters – function approximation.

Module IV: **[9 Periods]**

Analysis Of Finite Word Length Effects: The Quantization process and errors-Quantization of fixed–point and floating –point Numbers – Analysis of coefficient Quantization effects – Analysis of Arithmetic Round-off errors- Dynamic range scaling – signal –to- noise in Low – order IIR filters- Low – Sensitivity Digital filter – Reduction of Product round-off errors feedback – Limit cycles in IIR digital filter – Round – off errors in FFT Algorithms.

Module V: **[9 Periods]**

Power Spectrum Estimation : Estimation of spectra from Finite Duration Observations signals-Non-parametric methods for power spectrum Estimation- parametric method for power spectrum Estimation- Estimation of spectral form-Finite duration observation of signals- Non-parametric methods for power spectrum estimation – Walsh methods – Blackman and torchy method.

TEXT BOOKS:

1. Digital Signal Processing principles –algorithms and Applications- john G. Proakis – PHI – 3rd edition 2002.
2. Digital Time Signal Procesing: Alan V.Oppenheim,Ronald W ,Shafer – PHI 1996 1st Edition reprint
3. Advanced Digital Signal Processing – Theory and Applications – Glenn Zelniker, Fred J. Taiylor.

REFERENCE BOOKS:

1. Digital Signal Processing – S Salivahanan . A Vallavaraj C. Gnanapriya –TMH – 2nd reprint 2001.
2. Digital Signal Processing – sanjit K.Mitra – TMH second edition.
3. Theory and Applications of Digital Signal Processing – Lourens R RebinarandBernold
4. Digital Filter Analysis and Design Auntoniam – TMH
5. Digital Signal Processing – J.S.Chitode – First Edition, 2008, Technical Publications

Course Outcomes

- Analyze and process signals in the discrete domain
- Design filters to suit specific requirements for specific applications Perform statistical analysis and inferences on various types of signals Design multi rate signal processing of signals through systems.
- Analyze binary fixed point and floating-point representation of numbers and arithmetic operations

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Course Code: 52106 **Credits: 4**

M.Tech (EPS) I – Semester

POWER QUALITY
(Professional Elective - II)

Prerequisite: Power Systems and Power Electronics

Course Objectives

- To know different terms of power quality.
- To Illustrate of voltage power quality issue - short and long interruption
- To construct study of characterization of voltage sag magnitude and three phase unbalanced voltage sag.
- To know the behavior of power electronics loads; induction motors, synchronous motor etc by the power quality issues
- To prepare mitigation of power quality issues by the VSI converters.

Module I: **[8 Periods]**

Introduction : Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring.

Module II: **[10 Periods]**

Long & Short Interruptions: Interruptions – Definition – Difference between failures, outage, Interruptions – causes of Long Interruptions – Origin of Interruptions – Limits for the Interruption frequency – Limits for the interruption duration – costs of Interruption – Overview of Reliability evaluation to power quality, comparison of observations and reliability evaluation.

Short interruptions: definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions.

Module III: **[8 Periods]**

1 & 3-Phase Voltage SAG Characterization: Voltage sag – definition, causes of voltage sag, voltage sag magnitude, and monitoring, theoretical calculation of voltage sag magnitude, voltage sag calculation in non-radial systems, meshed systems, and voltage sag duration.

Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags.

Module IV: **[8 Periods]**

Power Quality Considerations in Industrial Power Systems: Voltage sag – equipment behavior of Power electronic loads, induction motors, synchronous motors, computers, consumer electronics, adjustable speed AC drives and its operation. Mitigation of AC Drives, adjustable speed DC drives and its operation, mitigation methods of DC drives.

Module V: **[9 Periods]**

Mitigation of Interruptions & Voltage Sags: Overview of mitigation methods – from fault to trip, reducing the number of faults, reducing the fault clearing time changing the power system, installing mitigation equipment, improving equipment immModuley, different events and mitigation methods. System equipment interface – voltage source converter, series voltage controller, shunt controller, combined shunt and series controller.

Power Quality and EMC Standards: Introduction to standardization, IEC Electromagnetic compatibility standards, European voltage characteristics standards, PQ surveys.

TEXTBOOKS:

1. Math H J Bollen "Understanding Power Quality Problems", IEEE Press.
2. R.C. Dugan, M.F. McGranaghan and H.W. Beaty, "Electric Power Systems Quality." New York: McGraw-Hill.1996

REFERENCES:

1. G.T. Heydt, Electric Power Quality", 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 1994).
2. Power Quality VAR Compensation in Power Systems, R. SastryVedamMulukutla S. Sarma,CRC Press.
3. A Ghosh, G. Ledwich, Power Quality Enhancement Using Custom Power Devices. Kluwer Academic, 2002.

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Know the severity of power quality problems in distribution system;
- Understand the concept of voltage sag transformation from up-stream (higher voltages) to down-stream (lower voltage)
- compute the concept of improving the power quality to sensitive load by various mitigating custom power devices

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Course Code: 54133 **Credits: 4**

M.Tech (EPS) I – Semester

MICROCONTROLLERS AND APPLICATIONS
(Professional Elective - II)

Prerequisite: Microprocessors and Interfacing Devices

Course Objectives:

- To relate the basic architecture and addressing modes of a microcontroller.
- To summarize the principles of top down design to microcontroller software development
- To demonstrate assembly language programs for the advanced Microcontroller , assembly language code for high-level language structures such as IF-THEN-ELSE and DO-WHILE
- To analyze a typical I/O interface and to discuss timing issues
- To identify different types of memory used in microcontroller systems

Module I: **[8 Periods]**

Overview of Architecture & Microcontroller Resources: Architecture of a microcontroller – Microcontroller resources – Resources in advanced and next generation microcontrollers – 8051 microcontroller – Internal and External memories – Counters and Timers – Synchronous serial-cum asynchronous serial communication - Interrupts.

Module II: **[8 Periods]**

8051- Microcontrollers Instruction Set : Basic assembly language programming – Data transfer instructions – Data and Bit-manipulation instructions – Arithmetic instructions – Instructions for Logical operations on the test among the Registers, Internal RAM, and SFRs – Program flow control instructions – Interrupt control flow.

Module III: **[9 Periods]**

Real Time Control: Interrupts: Interrupt handling structure of an MCU – Interrupt Latency and Interrupt deadline – Multiple sources of the interrupts – Non-maskable interrupt sources – Enabling or disabling of the sources – Polling to determine the interrupt source and assignment of the priorities among them – Interrupt structure in Intel 8051.

Timers: Programmable Timers in the MCU‟s – Free running counter and real time control – Interrupt interval and density constraints.

Module IV: **[10 Periods]**

Systems Design: Digital and Analog Interfacing Methods: Switch, Keypad and Keyboard interfacings – LED and Array of LEDs – Keyboard-cum-Display controller (8279) – Alphanumeric Devices – Display Systems and its interfaces – Printer interfaces – Programmable instruments interface using IEEE 488 Bus – Interfacing with the Flash Memory – Interfaces – Interfacing to High Power Devices – Analog input interfacing – Analog output interfacing – Optical motor shaft encoders

– Industrial control – Industrial process control system – Prototype MCU based Measuring instruments – Robotics and Embedded control – Digital Signal Processing and digital filters.

Module V: **[9 Periods]**

Real Time Operating System for Microcontrollers: Real Time operating system – RTOS of Keil (RTX51) – Use of RTOS in Design – Software development tools for Microcontrollers.

16-Bit Microcontrollers: Hardware – Memory map in Intel 80196 family MCU system – IO ports – Programmable Timers and High-speed outputs and input captures – Interrupts – instructions. ARM 32 Bit MCUs: Introduction to 16/32 Bit processors – ARM architecture and organization – ARM / Thumb programming model – ARM / Thumb instruction set – Development tools.

TEXT BOOKS:

1. Raj Kamal," Microcontrollers Architecture, Programming, Interfacing and System Design"– Pearson Education, 2005.
2. Mazidi and Mazidi, "The 8051 Microcontroller and Embedded Systems" – PHI, 2000.

REFERENCES:

1. A.V. Deshmuk, "Microcontrollers (Theory & Applications)" – WTMH, 2005.
2. John B. Peatman, "Design with PIC Microcontrollers" – Pearson Education, 2005.
3. Microcontroller Programming, Julio Sanchez, Maria P. Canton, CRC Press.
4. The 8051 Microcontroller, Ayala, Cengage Learning.
5. Microprocessors and Microcontrollers, Architecture, Programming and System Design, Krishna Kant, PHI Learning PVT. Ltd.
6. Microprocessors, Nilesh B. Bahadure, PHI Learning PVT. Ltd.

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Distinguish Types of computers & microcontrollers,
- Generalize 8-Bit, 16- Bit & 32 Bit advanced Microcontrollers.
- Construct Real time Applications of Microcontrollers.
- Demonstrate RTOS for Microcontrollers.
- Translate Hardware applications using Microcontrollers.

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Course Code: 52107 **Credits: 4**

M.Tech (EPS) I – Semester

DISTRIBUTION AUTOMATION
(Professional Elective - II)

Prerequisite: Electrical Distribution Systems
Course objectives:

- To list the distribution systems for load modeling
- To understand the design & working of substations.
- To compute system protection
- To give a comprehensive idea on communication systems.

Module I: **[8 Periods]**

Distribution Automation and the Utility System: Introduction to Distribution Automation (DA), control system interfaces, control and data requirements, centralized (Vs) decentralized control, DA System (DAS), DA Hardware, DAS software.

Module II: **[8 Periods]**

Distribution Automation Functions: DA capabilities, Automation system computer facilities, management processes, Information management, system reliability management, system efficiency management, voltage management, Load management.

Module III: **[10 Periods]**

Communication Systems for DA: DA communication requirements, Communication reliability, Cost effectiveness, Data rate Requirements, Two way capability, Ability to communicate during outages and faults, Ease of operation and maintenance, Conforming to the architecture of data flow **Communication systems used in DA :**Distribution line carrier (Power line carrier), Ripple control, Zero crossing technique, telephone, cable TV, Radio, AM broadcast, FM SCA, VHF Radio, UHF Radio, Microwave satellite. Fiber optics, Hybrid Communication systems, Communication systems used in field tests.

Module IV: **[9 Periods]**

Technical Benefits: DA benefit categories, Capital deferred savings, Operation and Maintenance savings, Interruption related savings, Customer related savings, Operational savings, improved operation, Function benefits, Potential benefits for functions, and function shared benefits, Guidelines for formulation of estimating equations Parameters required, economic impact areas, Resources for determining benefits impact on distribution system, integration of benefits into economic evaluation.

Module V: **[9 Periods]**

Economic Evaluation Methods: Development and evaluation of alternate plans, Select study area, Select study period, Project load growth, Develop Alternatives, Calculate operating and maintenance costs, Evaluate alternatives. Economic comparison of alternate plans, Classification of expenses and capital expenditures, Comparison of revenue requirements of alternative plans, Book Life and Continuing plant analysis, Year by year revenue requirement analysis, short term analysis, end of study adjustment, Break even analysis, Sensitivity analysis computational aids.

TEXT BOOKS:

1. Control and Automation of Electrical Distribution Systems, James. Northcote – Green Robert Wilson, CRC Press.
2. Electric Power Distribution Automation, Dr. M. K. Khedkar, Dr. G.M.Dhole, University Science press.

REFERENCES:

1. IEEE Tutorial Course "Distribution Automation"
2. IEEE Working Group on "Distribution Automation"

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Find the transfer of electrical data in distribution system through Digital Communication. Predict load forecasting and reliability in economic point of view
- Apply Distribution Automation objectives and SCADA
- To have a knowledge on management of different electrical parameters.

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Course Code: 50B15 **Credits: 4**

M.Tech (EPS) I – Semester

OPTIMIZATION TECHNIQUES
(Open Elective I)

Course Objectives

- To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.
- To develop an interest in applying optimization techniques in problems of Engineering and Technology
- To apply the mathematical results and numerical techniques of optimization theory to concrete Engineering problems.

Module I **[10 Periods]**

Introduction and Classical Optimization Techniques: Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems.

Classical Optimization Techniques: Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints.

Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraints – Kuhn – Tucker conditions.

Module II **[8 Periods]**

Linear Programming: Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm.

Module III **[9 Periods]**

Transportation Problem: Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel‟s approximation method – testing for optimality of balanced transportation problems.

Unconstrained Nonlinear Programming: One – dimensional minimization methods: Classification, Fibonacci method and Quadratic interpolation method

Module IV **[9 Periods]**

Unconstrained Optimization Techniques: Univariate method, Powell's method and steepest descent method.

Constrained Nonlinear Programming: Characteristics of a constrained problem, Classification, Basic approach of Penalty Function method; Basic approach of Penalty Function method; Basic approaches of Interior and Exterior penalty function methods. Introduction to convex Programming Problem.

Module V **[8 Periods]**

Dynamic Programming: Dynamic programming multistage decision processes – types – concept of sub optimization and the principle of optimality – computational procedure in dynamic programming – examples illustrating the calculus method of solution - examples illustrating the tabular method of solution.

TEXT BOOKS:

1. "Engineering optimization: Theory and practice"-by S. S.Rao, New Age International (P) Limited, 3rd edition, 1998.
2. "Introductory Operations Research" by H.S. Kasene & K.D. Kumar, Springer (India), Pvt .LTd.

REFERENCE BOOKS:

1. "Optimization Methods in Operations Research and systems Analysis" – by K.V. Mital and C. Mohan, New Age International (P) Limited, Publishers, 3rd edition, 1996.
2. Operations Research – by Dr. S.D.Sharma.
3. "Operations Research : An Introduction" – by H.A. Taha, PHI Pvt. Ltd., 6th edition
4. Linear Programming – by G. Hadley

Course Outcomes

Upon the completion of the subject, the student will be able to

- Know basic theoretical principles in optimization
- formulation of optimization models
- solution methods in optimization
- methods of sensitivity analysis and post processing of results applications to a wide range of engineering problems

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Course Code: 53108

Credits: 4

M.Tech (EPS) I – Semester

ENERGY MANAGEMENT

(Open Elective-I)

OBJECTIVES :

To study the concepts behind economic analysis and Load management

To emphasize the energy management on various electrical equipments and metering.

To illustrate the concept of lighting systems and cogeneration

MODULE- I: Introduction: [9 periods]

Principles of Energy Management – Managerial Organization – Functional Areas for i. Manufacturing Industry ii. Process Industry iii. Commerce iv. Government. Role of Energy Manager in each of these organization. Initiating, Organising and Managing Energy Management Programs.

MODULE- II: Energy Audit: [10 periods]

Definition and Concepts, Types of Energy Audits – Basic Energy Concepts – Resources for Plant Energy Studies – Data Gathering – Analytical Techniques.

Energy Conservation: Technologies for Energy Conservation , Design for Conservation of Energy materials – energy flow networks – critical assessment of energy usage – formulation of objectives and constraints – synthesis of alternative options and technical analysis of options – process integration.

MODULE- III: Economic Analysis: [8 periods]

Scope, Characterization of an Investment Project – Types of Deprecication – Time Value of money – budget considerations, Risk Analysis.

MODULE- IV: Methods of Evaluation of Projects: [9 periods]

Payback – Annualised Costs – Investor's Rate of return – Present worth – Internal Rate of Return – Pros and Cons of the common methods of analysis – replacement analysis.

MODULE- V: Alternative Energy Sources: [8 periods]

Solar Energy – Types of devices for Solar Energy Collection – Thermal Storage System – Control Systems-Wind Energy – Availability – Wind Devices – Wind Characteristics – Performance of Turbines and systems.

TEXT BOOKS

1. W.C. Turner "Energy Management Hand book", 6th Edition,2006
2. H.Koontz and Cyrill O Donnell "Management", 3rd Edition,2008

REFERENCES BOOKS

1. S.C. Kuchhal **"Financial Management",8th** Edition,1982.
2. W.R.Murthy and G.Mc Kay **"Energy Management"**,
3. CB Smith **"Energy Management Principles"**, Edition,1981.

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Course Code: 54106 **Credits: 4**

M.Tech (EPS) I – Semester

EMBEDDED SYSTEMS DESIGN
(Open Elective I)

Prerequisite: Microprocessors and Interfacing Devices

Course Learning Objectives

- To Comprehend the general embedded system concepts , design of embedded hardware and software development tools
- To explain the basics of real time operating and embedded systems
- To describe key issues such as CPU scheduling, memory management, task synchronization, and file system in the context of real-time embedded systems.

Module I: **[8 Periods]**
Overview of Embedded System: Embedded System, types of Embedded System, Requirements of Embedded System, and Issues in Embedded software development, Applications.

Module II: **[8 Periods]**
Processor & Memory Organization: Structural Modules in a processor, Processor selection, Memory devices, Memory selection, Memory Allocation & Map, Interfacing.

Module III: **[10 Periods]**
Devices, Device Drivers & Buses for Device Networks: I/O devices, Timer & Counter devices, Serial Communication, Communication between devices using different buses. Device drives, Parallel and serial port device drives in a system, Interrupt servicing mechanism, context and periods for context switching, Deadline and Interrupt Latency.

Module IV: **[9 Periods]**
Programming & Modeling Concepts : Program elements, Modeling Processes for Software Analysis, Programming Models, Modeling of Multiprocessor Systems, Software algorithm Concepts, design, implementation, testing, validating, debugging, Management and maintenance, Necessicity of RTOS.

Module V: **[8 Periods]**
Hardware and Software Co-Design: Embedded system design and co design issues in software development, design cycle in development phase for Embedded System, Use of ICE & Software tools for development of ES, Issues in embedded system design.

TEXTBOOKS:

1. Embedded systems: Architecture, programming and design by Rajkamal, TMH
2. Embedded system design by Arnold S Burger, CMP

REFERENCES:

1. An embedded software primer by David Simon, PEA
2. Embedded systems design:Real world design be Steve Heath; Butterworth Heinenann, Newton mass USA 2002
3. Data communication by Hayt.

Course Outcomes:

- To analyze and design embedded systems and real-time systems
- Define the unique design problems and challenges of real-time systems
- Identify the unique characteristics of real-time operating systems and evaluate the need for real-time operating system
- Explain the general structure of a real-time system and Understand and use RTOS to build an embedded real-time system
- Gain knowledge and skills necessary to design and develop embedded applications based on real-time operating systems.

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Course Code: 52108 **Credits: 2**

M.Tech (EPS) I – Semester

POWER SYSTEM SIMULATION LAB

1. Develop MATLAB program for Y_{BUS} formation.
2. Load Flow Analysis for given Power system network using G-S method with MATLAB.
3. Load Flow Analysis for given Power system network using N-R method with MATLAB.
4. Develop MATLAB program for FDLF Load Flow Analysis.
5. Develop MATLAB program for Short Circuit Analysis for Single Line to Ground fault (L-G).
6. Develop MATLAB program for Short Circuit Analysis for Line to Line fault (L-L).
7. Develop MATLAB program for Short Circuit Analysis for Double Line to Ground fault (L-L-G).
8. Transient Stability Analysis for Single Machine connected to Infinite Bus by Point by Point Method.
9. Develop PSPICE Program for Generation System Reliability Analysis.
10. Develop PSPICE Program for Distribution System Reliability Analysis.

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Course Code: 52110 **Credits: 4**

M.Tech (EPS) II – Semester

POWER SYSTEM DYNAMICS
(Core Course IV)

Course Objectives:

- The basics of dynamic characteristics of power system equipment.
- Dynamic performance of power systems.
- System stability and controls.

Module I **[9 Periods]**

BASIC CONCEPTS

Power system stability, states of operation and system security - system dynamics – problems, system model analysis of steady state stability and transient stability - simplified representation of Excitation control.

Module II **[8 Periods]**

MODELING OF SYNCHRONOUS MACHINE

Synchronous machine - park's Transformation-analysis of steady state performance, per unit quantities-Equivalent circuits of synchronous machine-determination of parameters of equivalent circuits.

Module III **[10 Periods]**

EXCITATION SYSTEM

Excitation system modeling-excitation systems block Diagram - system representation by state equations- Dynamics of a synchronous generator connected to infinite bus - system model Synchronous machine model-stator equations.

Rotor equations - Synchronous machine model with field circuit - one equivalent damper winding on q axis (model 1.1) - calculation of Initial conditions.

Module IV **[8 Periods]**

ANALYSIS OF SINGLE MACHINE SYSTEM

Small signal analysis with block diagram - Representation Characteristic equation and application of Routh- Hurwitz criterion- synchronizing and damping torque analysis-small signal model - State equations.

Module V **[8 Periods]**

APPLICATION OF POWER SYSTEM STABILIZERS

Basic concepts in applying PSS - Control signals - Structure and tuning of PSS - Washout circuit - Dynamic compensator analysis of single machine infinite bus system with and without PSS.

TEXT BOOK:

1. Power system dynamics by K.R. Padiyar, B.S. Publications.

REFERENCE BOOKS:

1. Power system control and stability by P.M. Anderson and A.A. Fouad, IEEE Press.
2. Power Systems Dynamics by R. Ramanujam, PHI Publications.

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Understand Fundamental dynamic behavior and controls of power systems to perform basic stability analysis.
- Comprehend concepts in modeling and simulating the dynamic phenomena of power systems.
- Interpret results of system stability studies.
- Demonstrate theory and practice of modeling main power system components, such as synchronous machines, excitation systems and governor.

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Course Code: 52111 **Credits: 4**

M.Tech (EPS) II – Semester

FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS)
(Core Course V)

Course Objectives:

- Students should understand the fundamentals of FACTS Controllers, Importance of controllable parameters and types of FACTS controllers & their benefits .
- Objectives of Shunt and Series compensation.
- Control of STATCOM and SVC and their comparison And the regulation of STATCOM.
- Functioning and control of GCSC, TSSC and TCSC.

Module I **[8 Periods]**

FACTS CONCEPTS

Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, benefits from FACTS controllers.

Module II **[9 Periods]**

VOLTAGE SOURCE CONVERTERS

Single phase, three phase full wave bridge converters, transformer connections for 12 pulse, 24 and 48 pulse operation. Three level voltage source converter, pulse width modulation converter, basic concept of current source Converters, and comparison of current source converters with voltage source converters.

Module III **[8 Periods]**

STATIC SHUNT COMPENSATION

Objectives of shunt compensation, mid-point voltage regulation voltage instability prevention, improvement of transient stability, Power oscillation damping, Methods of controllable VAR generation, variable impedance type static VAR generators, switching converter type VAR generators, hybrid VAR generators.

Module IV **[8 Periods]**

SVC AND STATCOM

The regulation and slope transfer function and dynamic performance, transient stability enhancement and power oscillation, damping operating point control and summary of compensator control.

Module V **[10 Periods]**

STATIC SERIES COMPENSATORS

Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, and functional requirements of GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC), Control schemes for GSC, TSSC and TCSC.

TEXT BOOKS:

1. Understanding FACTS Devices by N.G. Hingorani and L. Guygi, IEEE Press Publications 2000.
2. Padiyar.K.R, " FACTS Controllers in Power Transmission and Distribution" New Age Int. Publishers, 2007.

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Choose proper controller for the specific application based on system requirements.
- Understand various systems thoroughly and their requirements.
- Understand the control circuits of Shunt Controllers SVC & STATCOM for various functions viz. Transient stability Enhancement, voltage instability prevention and power oscillation damping.
- Understand the Power and control circuits of Series Controllers GCSC, TSSC and TCSC.

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Course Code: 52112 **Credits: 4**

M.Tech (EPS) II – Semester

POWER SYSTEM OPERATION AND DEREGULATION
(Core Course VI)

Course Objectives:

- To get the knowledge on OPF with security constraints.
- To describe modeling of load frequency control of a power system.
- To get awareness on reactive power control of a power system.
- To get the concept of deregulation and ATC.

Module I OPTIMAL POWER FLOW [8 Periods]

Introduction- Solution to the optimal power flow-gradient method-Newton's method-Linear sensitivity analysis- Linear programming methods- Security constrained OPF-Interior point algorithm- Bus incremental costs

Module II POWER SYSTEM SECURITY [8 Periods]

Introduction –Factors affecting power system security-Contingency analysis-Detection of network problems-Linear sensitivity analysis-AC power flow methods-contingency selection-concentric relaxation-Bounding area method

Module III STATE ESTIMATION IN POWER SYSTEMS [10 Periods]

Introduction- Power system state estimation- Maximum likelihood Weighted Least squares estimation-Matrix formulation- State estimation of AC network- State estimation by orthogonal decomposition.

Detection and identification of Bad measurements- Estimation of quantities not being measured- Network Observability and pseudo measurements

Module IV POWER SYSTEM DEREGULATION [8 Periods]

Introduction- motivation for restructuring of power systems- Electricity market entities model-benefits of deregulation-terminology-deregulation in Indian power sector-Operations in power markets-power pools-transmission networks and electricity markets.

Module V AVAILABLE TRANSFER CAPABILITY [9 Periods]

Introduction methods: of determination of ATC - ATC calculation considering the effect of contingency analysis-Transmission open access and pricing-cost components of transmission system- transmission pricing methods-Incremental cost based transmission pricing.

TEXT BOOKS:

1. Power Generation Operation and Control by A.J.Wood & B.F.Woollenberg, John Wiley.
2. Electrical power systems: Analysis, security, Deregulation by P.Venkatesh. B.V.Manikandan, S.Charles Raja-A.Srinivasan, PHI.

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Analyze the optimal scheduling of power plants .
- Model Turbine and Generator.
- Analyze the steady state behavior of the power system for voltage and frequency fluctuations.
- Calculate ATC and the cost of transmission.

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Course Code: 52113 **Credits: 4**

M.Tech (EPS) II – Semester

GAS INSULATED SYSTEMS (GIS)
(Professional Elective - III)

Course objectives:

- To understand the GIS concepts and principles
- To understand the comparison between Air Insulated Substation and GIS.
- To understand the design and constructional aspects of GIS.
- To understand transient phenomenon, problems and diagnostic methods in GIS.

Module I INTRODUCTION TO GIS AND PROPERTIES OF SF_6 [9 Periods]

Characteristics of GIS- Introduction to SF_6 - Physical properties-Chemical properties - Electrical properties-Specification of SF_6 gas for GIS application - Handling of SF_6 gas before use - Safe handling of Sf_6 gas in electrical equipment - Equipment for handling the SF_6 Gas - SF_6 and environment.

Module II LAYOUT OF GIS STATIONS [8 Periods]

Advancement of GIS station - Comparison with Air Insulated Substation - Economics of GIS - User Requirements for GIS - Main Features for GIS - Planning and Installation components of a GIS station.

Module III DESIGN AND CONSTRUCTION OF GIS STATION [10 Periods]

Introduction - Rating of GIS components - Design Features - Estimation of different types of Electrical Stresses -Design Aspects of GIS components - Insulation Design for Components - Insulation Design for GIS - Thermal Considerations in the Design of GIS - Effect of very Fast Transient Over-voltages (VFTO) on the GIS design - Insulation Coordination systems - Gas handling and Monitoring System Design.

Module IV FAST TRANSIENT PHENOMENA IN GIS [8 Periods]

Introduction- Disconnect or Switching in Relation to Very fast Transients-Origin of VFTO-Propagation and Mechanism of VFTO-VFTO Characteristics- Effects of VFTO-Testing of GIS for VFTO.

Module V SPECIAL PROBLEMS IN GIS AND GIS DIAGNOSTICS [8 Periods]

Introduction - particles their effects and their control- Insulating Spacers and their Reliability - SF_6 Gas Decomposition - Characteristics of imperfections in insulation - Insulation Diagnostic methods - PD Measurement and UHF Method.

TEXT BOOK:

1. Gas Insulated Substations by M. S. Naidu, IK International Publishing House.

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Understand the advantages of GIS systems over air insulated systems.
- Understand constructional design features of GIS design.
- Distinguished the Problems and design diagnostic methods of GIS.

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Course Code: 52114 **Credits: 4**

M.Tech (EPS) II – Semester

PROGRAMMABLE LOGIC CONTROLLERS AND THEIR APPLICATIONS
(Professional Elective - III)

Course Objective:

- To impart knowledge on Mode of operation and programming of a Programmable Logic Controller (PLC),
- To impart knowledge on Characteristics of a PLC (synchronous, asynchronous)
- Analysis of the process schematic, analog PLC and PID controllers.

Module I BASICS **[8 Periods]**

PLC Basics PLC system, I/O modules and interfacing CPU processor programming equipment programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

Module II PROGRAMMING WITH EXAMPLES **[10 Periods]**

PLC programming input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation. Digital logical gates programming in the Boolean algebra SYSTEM, CONVERSION EXAMPLES-Ladder diagrams for process control – Ladder diagrams for sequence listings – ladder diagram construction and flow chart for spray process system.

Module III REGISTERS AND COUNTERS **[8 Periods]**

PLC Registers: Characteristics of registers – module addressing – holding registers – output registers – PLC functions – Timer functions and industrial application counters – counter function industrial application – Architecture functions – number function comparison functions.- number conversion functions.

Module IV **[9 Periods]**

DATA HANDLING FUCNTIONS AND SEQUENCE FUCNTIONS

Data handling functions: SKIP, Master control relay – Jump Move FIFO, FAL, ONS, CLR and sweep functions and their applications.

Bit pattern and changing a bit shift register, sequence functions and applications – controlling of two axes and three axis Robots with PLC, Matrix functions.

Module V ANALOG PLC **[9 Periods]**

Analog PLC operation: Analog modules and systems – Analog signal processing, multi-bit data processing, analog output application examples, PID principles, position indicator with PID control, PID modules, PID tuning, PID functions.

TEXT BOOKS:

1. Programmable Logic Controllers, W. Bolton, Elsevier, 5th edition, 2009.
2. Programmable Logic Controllers – Programming methods and Applications by J R Hackworth and F D Hackworth Jr - Pearson Publications, 5th edition, 2004.

REFERENCE BOOK:

1. Programmable Logic Controllers – Principles and Applications by John W Webb and Ronald A Reiss – Fifth edition – PHI, 1998.

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Characteristics of a PLC (synchronous, asynchronous)
- Analysis of the process schematic
- Statement of the interlocking functions and the safety requirements
- Creating of a control system function chart in conformity with DIN 40719.
- Selection of the necessary hardware units.

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Course Code: 52115 **Credits: 4**

M.Tech (EPS) II – Semester

HIGH-FREQUENCY MAGNETIC COMPONENTS
(Professional Elective - III)

Course Objectives:

- To study Fundamentals of Magnetic Devices.
- To study Fundamentals of, Skin effect and Proximity effect,
- To study the Design of Transformers, Analysis of Integrated inductors and self capacitance.

Module I FUNDAMENTALS OF MAGNETIC DEVICES [10 Periods]

Introduction, Magnetic Relationships, Magnetic Circuits, Magnetic Laws, Eddy Currents, Core Saturation, Volt-Second Balance, Inductance, Inductance Factor, Magnetic Energy, Self-Resonant Frequency, Classification of Power Losses in Magnetic Components, Non-inductive Coils.

Magnetic Cores: Introduction, Properties of Core Materials, Magnetic Dipoles, Magnetic Domains, Curie Temperature, Magnetization, Magnetic Materials, Hysteresis, Core Permeability, Core Geometries, Iron Alloy Cores, Amorphous Alloy Cores, Nickel–Iron and Cobalt–Iron Cores, Ferrite Cores, Powder Cores, Nano-crystalline Cores, Superconductors, Hysteresis Core Loss, Eddy-Current Core Loss, Total Core Loss, Complex Permeability.

Module II SKIN EFFECT & PROXIMITY EFFECT [10 Periods]

Introduction, Magnet Wire, Wire Insulation, Skin Depth, Ratio of AC-to-DC Winding Resistance, Skin Effect in Long Single Round Conductor, Current Density in Single Round Conductor, Impedance of Round Conductor, Magnetic Field Intensity for Round Wire, Other Methods of Determining the Round Wire Inductance, Power Density in Round Conductor, Skin Effect on Single Rectangular Plate. Proximity and Skin Effects in Two Parallel Plates, Anti-proximity and Skin Effects in Two Parallel Plates, Proximity Effect in Multiple-Layer Inductor, Appendix: Derivation of Proximity Power Loss.

Winding Resistance at High Frequencies: Introduction, Winding Resistance, Square and Round Conductors, Winding Resistance of Rectangular Conductor, Winding Resistance of Square Wire, Winding Resistance of Round Wire, Leakage Inductance, Solution for Round Conductor Winding in Cylindrical Coordinates, Litz Wire, Winding Power Loss for Inductor Current with Harmonics, Effective Winding Resistance for Non-sinusoidal Inductor Current, Thermal Model of Inductors.

Module III TRANSFORMERS [9 Periods]

Introduction, Neumann's Formula for Mutual Inductance, Mutual Inductance, Energy Stored in Coupled Inductors, Magnetizing Inductance, Leakage Inductance, Measurement of Transformer Inductances, Stray Capacitance, High-Frequency Transformer Model, Non interleaved Windings, Interleaved Windings, AC Current Transformers, Winding Power Losses with Harmonics, Thermal Model of Transformers.

Design of Transformers: Introduction, Area Product Method, Optimum Flux Density,

Transformer Design for Fly-back Converter in CCM, Transformer Design for Fly-back Converter in DCM, Transformer Design for Fly-back Converter in CCM, Transformer Design for Fly-back Converter in DCM.

Module IV INTEGRATED INDUCTORS [10 Periods]

Introduction, Resistance of Rectangular Trace, Inductance of Straight Rectangular Trace, Construction of Integrated Inductors, Meander Inductors, Inductance of Straight Round Conductor, Inductance of Circular Round Wire Loop, Inductance of Two-Parallel Wire Loop, Inductance of Rectangle of Round Wire, Inductance of Polygon Round Wire Loop, Bond-wire Inductors, Single-Turn Planar Inductor, Inductance of Planar Square Loop, Planar Spiral Inductors, Multi-metal Spiral Inductors, Planar Transformers, MEMS Inductors, Inductance of Coaxial Cable, Inductance of Two-Wire Transmission Line, Eddy Currents in Integrated Inductors, Model of RF Integrated Inductors, PCB Inductors.

Design of Inductors: Introduction, Restrictions on Inductors, Window Utilization Factor, Temperature Rise of Inductors, Mean Turn Length of Inductors, Area Product Method, AC Inductor Design, Inductor Design for Buck Converter in CCM, Inductor Design for Buck Converter in DCM method.

Module V SELF-CAPACITANCE [9 Periods]

Introduction, High-Frequency Inductor Model, Self-Capacitance Components, Capacitance of Parallel-Plate Capacitor, Self-Capacitance of Foil Winding Inductors, Capacitance of Two Parallel Round Conductors, Capacitance of Round Conductor and Conducting Plane, Self-Capacitance of Single-Layer Inductors, Self-Capacitance of Multi-layer Inductors, Capacitance of Coaxial Cable.

TEXT BOOKS:

1. Design of Magnetic Components for Switched Mode Power Converters, Umanand L., Bhat,S.R., ISBN:978-81-224-0339-8, Wiley Eastern Publication, 1992.

REFERENCES:

1. High-Frequency Magnetic Components, Marian K. Kazimierczuk, ISBN: 978-0-470-71453-9 John Wiley & Sons, Inc.
2. G.C. Chryssis, High frequency switching power supplies, McGraw Hill, 1989 (2nd Edn.)
3. Eric Lowdon, Practical Transformer Design Handbook, Howard W. Sams & Co., Inc., 1980
4. "Thompson --- Electrodynamic Magnetic Suspension.pdf"
5. Witulski --- "Introduction to modeling of transformers and coupled inductors" Beattie --- "Inductance 101.pdf

Course Outcomes:

Upon the completion of the subject, the student will be able to know

- Fundamentals of Magnetic Devices.
- Fundamentals of, Skin effect and Proximity effect.
- Study of the Design of Transformers, Analysis of Integrated inductors and self capacitance.

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Course Code: 52116 **Credits: 4**

M.Tech (EPS) II – Semester

REACTIVE POWER COMPENSATION AND MANAGEMENT
(Professional Elective - IV)

Course Objectives:

- To understand the necessity of reactive power compensation.
- To design load compensation.
- To analyze various types of reactive power compensation in transmission systems .
- To model reactive power coordination system.
- To get exposed to distribution side and utility side reactive power management.

Module I LOAD COMPENSATION [8 Periods]

Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.

Module II STEADY – STATE REACTIVE POWER COMPENSATION IN TRANSMISSION SYSTEM [9 Periods]

Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation –examples.

Transient state reactive power compensation in transmission systems:

Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation – compensation using synchronous condensers – examples.

Module III REACTIVE POWER COORDINATION [8 Periods]

Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations.

Effects of under voltages – frequency –Harmonics, radio frequency and electromagnetic interferences.

Module IV DEMAND SIDE MANAGEMENT [9 Periods]

Load patterns – basic methods load shaping – power tariffs- KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels.

Distribution side Reactive power Management:

System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks.

Module V USER SIDE REACTIVE POWER MANAGEMENT [10 Periods]

KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations.

Reactive power management in electric traction systems and are furnaces:
Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace.

REFERENCE BOOKS:

1. Reactive Power Control in Electric Power Systems by T.J.E.Miller, John Wiley and sons, 1982 (All Units)
2. Reactive Power Management by D.M.Tagare,Tata McGraw Hill,2004. (All Units)

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Understand the importance of load compensation in symmetrical as well as un symmetrical loads.
- Analysis various compensation methods in transmission lines .
- Model for reactive power coordination .
- Understand demand side reactive power management & user side reactive power management.

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Course Code: 52117 **Credits: 4**

M.Tech (EPS) II – Semester

POWER SYSTEM RELIABILITY
(Professional Elective-IV)

. **Course Objectives:**

To develop the generation system model and recursive relation for capacitive model Building.

- To evaluate the equivalent transitional rates, cumulative probability and cumulative Frequency.
- To evaluate the risk, system and load point reliability indices.
- To evaluate the basic reliability indices.

Module I: GENERATING SYSTEM RELIABILITY ANALYSIS–I [8 Periods]
Generation system model – capacity outage probability tables – Recursive relation for capacitive model building – sequential addition method – unit removal – Evaluation of loss of load and energy indices – Examples.

Module II: GENERATING SYSTEM RELIABILITY ANALYSIS–II [9 Periods]
Frequency and Duration methods – Evaluation of equivalent transitional rates of identical and non-identical units – Evaluation of cumulative probability and cumulative frequency of non-identical generating units – 2- level daily load representation - merging generation and load models – Examples.

Module III: OPERATING RESERVE EVALUATION [10 Periods]
Basic concepts - risk indices – PJM methods – security function approach – rapid start and hot reserve units – Modeling using STPM approach.
Bulk Power System Reliability Evaluation: Basic configuration – conditional probability approach – system and load point reliability indices – weather effects on transmission lines – Weighted average rate and Markov model – Common mode failures.

Module IV: INTER CONNECTED SYSTEM RELIABILITY ANALYSIS [9 Periods]
Probability array method – Two inter connected systems with independent loads – effects of limited and unlimited tie capacity - imperfect tie – Two connected Systems with correlated loads – Expression for cumulative probability and cumulative frequency.
Distribution System Reliability Analysis – I (Radial configuration): Basic Techniques – Radial networks –Evaluation of Basic reliability indices, performance indices– load point and system reliability indices – customer oriented, loss and energy oriented indices – Examples.

Module V: DISTRIBUTION SYSTEM RELIABILITY ANALYSIS - II (PARALLEL CONFIGURATION) [9 Periods]

Basic techniques – inclusion of bus bar failures, scheduled maintenance – temporary and transient failures – weather effects – common mode failures –Evaluation of various indices – Examples.

Substations and Switching Stations: Effects of short-circuits - breaker operation – Open and Short-circuit failures – Active and Passive failures – switching after faults – circuit breaker model – preventive maintenance – exponential maintenance times.

Text Books:

1. Roy Billinton and Ronald N. Allan, **"Reliability Evaluation of Power Systems"**, Plenum press, New York and London (Second Edition), 1996.
2. J. Endrenyi, **"Reliability Modeling in Electric Power Systems"**, John Wiley and Sons, 1978. (First Edition)

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Evaluate loss of load and energy indices for generation systems model
- Merge generation and load models.
- Evaluate various indices for distribution systems.

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Course Code: 52118 **Credits: 4**

M.Tech (EPS) II – Semester

VOLTAGE STABILITY
(Professional Elective - IV)

Course Objectives:

- SEC Planning and Operational Standards of Security.
- Reactive Power Control in Generation/Transmission Interconnected Networks.
- Stability/Instability in Generation/Transmission Interconnected Networks.
- Design and Operational Solutions.
- Voltage Control in Distribution Networks.

Module I INTRODUCTION TO VOLTAGE STABILITY [8 Periods]

Definitions: Voltage Stability, Voltage Collapse, Voltage Security; Physical relation indicating dependency of voltage on reactive power flow; Factors affecting Voltage collapse and instability; Previous cases of voltage collapse incidences.

Module II GRAPHICAL ANALYSIS OF VOLTAGE STABILITY [9 Periods]

Comparison of Voltage and angular stability of the system; Graphical Methods describing voltage collapse phenomenon: P-V and Q-V curves; detailed description of voltage collapse phenomenon with the help of Q-V curves.

Module III ANALYSIS OF VOLTAGE STABILITY [8 Periods]

Analysis of voltage stability on SMLB system: Analytical treatment and analysis.

Voltage Stability Indices: Voltage collapse proximity indicator; Determinant of Jacobin as proximity indicators; Voltage stability margin.

Module IV POWER SYSTEM LOADS [10 Periods]

Loads that influences voltage stability: Discharge lights, Induction Motor, Air-conditioning, heat pumps, electronic power supplies, OH lines and cables.

Reactive Power Compensation: Generation and Absorption of reactive power; Series and Shunt compensation; Synchronous condensers, SVC s; OLTCs; Booster Transformers.

Module V VOLTAGE STABILITY MARGIN [8 Periods]

Stability Margin: Compensated and un-compensated systems.Voltage Security Definition; Voltage security; Methods to improve voltage stability and its practical aspects.

TEXT BOOKS:

1. Performance, Operation and Control of EHV Power Transmission System"- A.Chakrabarthy, D.P.Kotari and A.K.Mukopadyay, A.H. Wheeler Publishing, I Edition, 1995.
2. Power System Dynamics: Stability and Control" – K.R.Padiyar, II Edition, B.S.Publications.

REFERENCE BOOK:

1. Power System Voltage Stability by C.W.Taylor, Mc Graw Hill, 1994.

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Develop the understanding of issues related to power system stability and control.
- Describe various load models in voltage stability analysis.
- Describe reactive power compensation techniques & their practical importance.

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Course Code: 52119 **Credits: 4**

M.Tech (EPS) II – Semester

INTELLIGENT CONTROL
(Open Elective II)

PRE-REQUISITES: Artificial neural networks, fuzzy logic controller, genetic algorithms, wavelet transforms.

Course Objectives:

1. To develop artificial neural network models
2. To know the concept of genetic algorithms in MATLAB
3. To study the operation and reasoning of fuzzy logic system
4. To develop neural network, fuzzy logic controller based power system solutions.

Module – I INTRODUCTION [8 Periods]

Approaches to intelligent control – architecture for intelligent control – symbolic reasoning system – rule based systems – AI approach –knowledge representation – expert systems.

Module – II ARTIFICIAL NEURAL NETWORKS [9 Periods]

Concepts of artificial neural networks and its basic mathematical model – Mculloch pitts neuron model – simple perceptron – adaline and madaline – feed-forward multilayer perceptron – learning and training the neural network – principle – component analysis and wavelet transforms – design of logic using all algorithms – neural network based control with any application.

Module – III GENETIC ALGORITHM [9 Periods]

Concept of genetic algorithm and detail algorithmic steps – genetic operators – solution of typical control problems using genetic algorithm, - concept on other searching techniques like tabu search, ant-colony search techniques for solving the optimization problems –case studies- speed control of Inductor motor using MATLAB – Neural network toolbox – Simple feed forward network programs

Module-4 FUZZY LOGIC SYSTEMS [10 Periods]

Introduction to crisp sets and fuzzy sets – basic fuzzy set operation and approximate reasoning – introduction to fuzzy logic modeling and control –fuzzication –Interfacing the defuizzifciation – fuzzy knowledge and rule bases – fuzzy modeling and control –schemes for non-linear systems – self organizing fuzzy logic control – implementation of fuzzy logic controller using MATLAB – fuzzy logic toolbox- stability analysis of fuzzy control systems.

Module-5 APPLICATION OF AI IN POWER SYSTEMS [8 Periods]

Power flow analysis using fuzzy logic – load forecasting using neural networks – economic dispatch using genetic algorithm

TEXT BOOKS:

1. S.N.Sivanandam , S.Sumati and S.N.Deepa **" Introduction to neural networks using MATLAB 6.0"** Mc Grawhill publishing companies limited, 3rd Edition , 2008.

2. Yong –uasong, allen johns and raj agarwal**"Computational intelligence applications to power systems "**science press klewer academic publishers, 2nd Edition, 2006.
3. Lio LEI Lai**," Intelligence system applications in Power Engineering,** Wiley, July, 1st edition, 1998.

REFERENCES:

1. Simopn S.Haykin "**Neural networks A comprehensive foundation**", Macmillian, 1st edition, 1994.
2. S.Rajashekaran , G.A.Vijaya lakshmi pai, "**Neural networks, Fuzzy logic and Genetic algorithms synthesis and applications** ", PHI, 3rd edition, 2007.
3. K.Warwick, Arthur Ekwue, Raj Agarwal, Institute of Electrical Engineers" **Artificial Intelligence techniques in Power Systems**" 2nd edition, 2007.

Course Outcomes:

After completion of the course, the student will be able to:

1. Apply the concept of about ANN models
2. Design the genetic algorithms using MATLAB
3. Emphasize the fuzzy logic controller using MATLAB
4. Analyze the application of artificial neural network and fuzzy logic controller in power systems.

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Course Code: 52120 **Credits: 4**

M.Tech (EPS) II – Semester

SMART GRID TECHNOLOGIES
(Open Elective II)

OBJECTIVES

To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.

To familiarize the power quality management issues in Smart Grid.

To familiarize the high performance computing for Smart Grid applications

Module I Introduction to Smart Grid [8 Periods]
Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self-Healing Grid, Present development & International policies in Smart Grid. Case study of Smart Grid . CDM opportunities in Smart Grid .

Module II Smart Grid Technologies: Part 1: [8 Periods]
Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

Module III Smart Grid Technologies: Part 2: [9 Periods]
Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

Module IV Micro grids and Distributed Energy Resources: [10 Periods]
Concept of micro grid, need & applications of micro grid, formation of micro grid, Issues of interconnection, protection & control of micro grid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel cells, micro turbines, Captive power plants, Integration of renewable energy sources.

Module V Power Quality Management in Smart Grid: [8 Periods]
Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Au

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",CRC Press
3. JanakaEkanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama," Smart Grid: Technology and Applications", Wiley
4. Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell
5. Tony Flick and Justin Morehouse, "Securing the Smart Grid", Elsevier Inc. (ISBN: 978-1-59749-570-7)
6. Peter S. Fox-Penner, "Smart Power: Climate Change, the Smart Grid, and the Future of Electric

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Course Code: 52121 **Credits: 4**

M.Tech (EPS) II – Semester

AI TECHNIQUES IN ELECTRICAL POWER SYSTEMS
(Open Elective II)

Course Objectives:

- To cater the knowledge of soft commanding methodologies, such as artificial neural networks, Fuzzy logic and genetic Algorithms.
- To expose the students to the concepts of feed forward neural networks and about feedback neural networks.
- To teach about the concept of fuzziness involved in various systems and comprehensive knowledge of fuzzy logic control and to design the fuzzy control.
- To understand about genetic algorithm, genetic operations and genetic mutations.

Module I: ARTIFICIAL NEURAL NETWORKS [9 Periods]

Introduction-Models of Neural Network - Architectures – Knowledge representation – Artificial Intelligence and Neural networks–Learning process – Error correction learning – Hebbian learning –Competitive learning –Boltzmann learning – Supervised learning – Unsupervised learning– Reinforcement learning- learning tasks.

Module II: ANN PARADIGMS [8 Periods]

Multi – layer perceptron using Back propagation Algorithm-Self – organizing Map – Radial Basis Function Network – Functional link, network – Hopfield Network.

Module III: FUZZY LOGIC [8 Periods]

Introduction – Fuzzy versus crisp – Fuzzy sets - Membership function – Basic Fuzzy set operations – Properties of Fuzzy sets – Fuzzy Cartesian Product –Operations on Fuzzy relations. Fuzzy logic – Fuzzy Quantifiers-Fuzzy Inference-Fuzzy Rule based system-Defuzzification methods.

Module IV: GENETIC ALGORITHMS [10 Periods]

Introduction-Encoding –Fitness Function-Reproduction operators-Genetic Modeling – Genetic operators-Crossover-Single – site crossover-Two point crossover –Multi point crossover-Uniform crossover – Matrix crossover-Crossover Rate-Inversion & Deletion – Mutation operator –Mutation –Mutation Rate-Bit-wise operators-Generational cycle-convergence of Genetic Algorithm.

Module V: APPLICATIONS OF AI TECHNIQUES [8 Periods]

Load forecasting – Load flow studies – Economic load dispatch – Load frequency control – Single area system and two area system – Small Signal Stability (Dynamic stability), Reactive power control – speed control of DC and AC Motors.

Text Book:

1. S.Rajasekaran and G.A.V.Pai, **"Neural Networks, Fuzzy Logic & Genetic Algorithms"**, PHI, New Delhi, 2003.

References:

1. P.D.Wasserman, Van Nostrand Reinhold, **"Neural Computing Theory & Practice"**, New York, 1989.
2. Bart Kosko, **"Neural Network & Fuzzy System"**, Prentice Hall, 1992.
3. G.J.Klir and T.A.Folger, **"Fuzzy Sets,Uncertainty and Information",** PHI, Pvt.Ltd,1994.
4. D.E.Goldberg, Addison Wesley, **"Genetic Algorithms"**, 1999.

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Describe feed forward neural networks and learning and understanding of feedback neural networks.
- Understand fuzziness involved in various systems and fuzzy set theory.
- Explain fuzzy logic control and design.

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Course Code: 52122 **Credits: 2**

M.Tech (EPS) II – Semester

POWER SYSTEMS LAB

1. Determination of Equivalent circuit of a 3-Winding Transformer.
2. Determination of Sequence Impedances of a Cylindrical Rotor Synchronous Machine.
3. Determination of Sequence Impedances of Three Phase Transformer
4. Characteristics of Over Current Relays
    a. IDMT Electromagnetic Relay (7051 A).
    b. Microprocessor based Relay (7051 B)
5. Characteristics of Percentage biased Differential Relay.
    a. Electromagnetic Relay (7054 A).
    b. Static Relay (7054 B).
6. Characteristics of Microprocessor based Over Voltage Relay (7053 B).
7. Characteristics of Under Voltage (UV) Microprocessor based Relay(7052 B).
8. Characteristics of Static Negative sequence Relays (7055B).
9. Performance and Testing of Transformer Protection System.
10. Performance and Testing of Transmission Line Model.

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Course Code: 52123 **Credits: 2**

M.Tech (EPS) II – Semester

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Course Code: 52124 **Credits: 4**

M.Tech (EPS) III – Semester

Comprehensive Viva - voce

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Course Code: 52125 **Credits: 8**

M.Tech (EPS) III – Semester

Project Work Part I

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Course Code: 52126 **Credits: 8**

M.Tech (EPS) IV – Semester

Project Work Part II

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Course Code: 52127 **Credits: 12**

M.Tech (EPS) IV – Semester

Project Viva – Voce