J.B. INSTITUTE OF ENGINEERING AND TECHNOLOGY

(UGC AUTONOMOUS)

Bhaskar Nagar, Moinabad Mandal, R.R. District, Hyderabad -500075

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE STRUCTURE FOR M. Tech - ELECTRICAL POWER SYSTEMS (EPS): R-20

M.TECH REGULAR TWO-YEAR DEGREE PROGRAMME

FOR THE BATCHES ADMITTED FROM THE ACADEMIC YEAR

2020 -2021

Vision And Mission of the Institution

VISION

To be a centre of excellence in engineering and management education, research and application of knowledge to benefit society with blend of ethical values and global perception.

MISSION

- To provide world class engineering education, encourage research and development.
- To evolve innovative applications of technology and develop entrepreneurship.
- To mould the students into socially responsible and capable leaders.

Vision And Mission of The Department

VISION

- To be a Centre for State-of-the-art learning and research in the area of Electrical and Electronics Engineering, where the stakeholders could explore, experiment and exhibit their expertise with an industrial outlook.

MISSION

- To EQUIP the student with advanced learning skills in the field of Electrical and Electronics Engineering as well as the professional skills necessary to face the challenges of the future.
- To ENGINEER the student to engage in research activities leading to innovative applications of technology for the benefit of society.
- To ENABLE the student with the qualities of leadership and social responsibility.

Program Educational Objectives (PEOs):

1. Graduates of electrical power systems, which are employable in public and private industries /institutes /organizations or pursue higher education.
2. Ability to identify and address current and future problems in the domain of power system.
3. Inculcate research attitude and lifelong learning among postgraduates.

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.

2. An ability to write and present a substantial technical report/document.

3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

4. An ability to design and analyze the various controllers for improvement of performance of Power System & Drives.

5. An ability to develop and apply artificial intelligence based techniques for the analysis of problems related to Power System.

6. Develop confidence for self-study and to engage in lifelong learning.

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(UGC AUTONOMOUS)

Bhaskar Nagar, Yenkapally (V), Moinabad (M), Hyderabad – 500075, Telangana, India

Academic Regulations– JBIET - R20

Applicable to

M.Tech Regular Two Year Degree Programme

(For the Batches admitted from the Academic Year 2020- 2021)

J. B. INSTITUTE OF ENGINEERING & TECHNOLOGY
UGC AUTONOMOUS

(Permanently Affiliated to JNTUH, Approved By AICTE, New Delhi and Accredited By NBA, NAAC)

Academic Regulations of M.Tech (Regular/Full Time) Programmes, 2020-21 (R20) (CBCS)

(Effective for the students admitted into I year from the Academic Year 2020-21 and onwards)

1.0 Post-Graduate Degree Programmes in Engineering & Technology (PGP in E & T)

J. B. Institute of Engineering and Technology (JNTUH) offers **Two** Years (**Four** Semesters) full-time Master of Technology (M. Tech.) Degree programmes, under Choice Based Credit System (CBCS) in the following branches of Engineering and Technology with different specializations as mentioned below:

Computer Science & Engineering	Computer Science & Engineering
Electronics & Communication Engineering	VLSI System Design
Electrical & Electronics Engineering	Electrical Power Systems
Mechanical Engineering	CAD / CAM
Civil Engineering	Structural Engineering

2.0 Eligibility for Admissions

2.1 Admission to the PGPs shall be made subject to eligibility, qualification and specializations prescribed by the University from time to time, for each specialization under each M.Tech programme.

2.2 Admission to the post graduate programme shall be made on the basis of either the merit rank or Percentile obtained by the qualified student in the relevant qualifying GATE Examination/ the merit rank obtained by the qualified student in an entrance test conducted by Telangana State Government (PGCET) for M.Tech. programmes.

2.3 The medium of instructions for all PG Programmes will be **ENGLISH** only.

3.0 M.Tech. Programme (PGP in E & T) Structure

3.1 The M.Tech Programmes in E & T of JBIET are of Semester pattern, with **Four** Semesters consisting of **Two** academic years, each academic year having **Two** Semesters (First/Odd and Second/Even Semesters). Each Semester shall be of 22 weeks duration (inclusive of Examinations), with a minimum of 90 instructional days per Semester.

3.3 **UGC/AICTE** specified definitions/descriptions are adopted appropriately for various terms and abbreviations used in these PG academic regulations, as listed below:

3.3.1 Semester Scheme

Each Semester shall have 'Continuous Internal Evaluation (CIE)' and 'Semester End Examination (SEE)'. Choice Based Credit System (CBCS) and Credit Based Semester System (CBSS) are taken as 'references' for the present set of Regulations. The terms 'SUBJECT' and 'COURSE' imply the same meaning here and refer to 'Theory Subject', or Lab Course', or 'Design/Drawing Subject', or 'Seminar', or 'Comprehensive Viva', or 'Project', or 'Technical Paper Writing' as the case may be.

3.3.2 Credit Courses

All subjects/courses are to be registered by the student in a semester to earn credits which shall be assigned to each subject/course in an L: T: P: C (Lecture Periods: Tutorial Periods: Practical Periods: Credits) structure based on the following general pattern:

- One credit for one hour/week/semester for theory/lecture (L) courses
- One credit for two hours/ week/semester for laboratory/ practical (P) courses or tutorials (T)
- Other student activities like study tour, guest lecture, conference/workshop participations, technical paper presentations, and identified mandatory courses, if any, will not carry credits.

3.3.3 Subject Course Classification

All subjects / courses offered for the Post-Graduate Programme in E & T (M.Tech Degree Programme) are broadly classified as follows. The institute has followed in general the guidelines issued by AICTE/UGC.

S.No.	Broad Course Classification	Course Group/ Category	Course Description
1	Core Courses (CoC)	PC- Professional Core	Includes subjects related to .the parent discipline/department/ branch of Engineering.
		Project Work	M.Tech Project or PG Project or Major Project
		Seminar, Technical Paper Writing	Seminar/Colloquium based on core contents related to parent discipline/department/branch of Engineering.
		Comprehensive Viva-Voce	Viva-voce covering all the PG subjects studied during the course work and related aspects
2	Elective Courses	PE - Program Electives	Includes elective subjects related to the parent discipline/department/branch of Engineering.

	(EIE)	OE - Open Electives	Elective subjects which include inter-disciplinary subjects or subjects in an area outside the parent discipline/department/ branch of Engineering.
Total number of Credits = 68			

4.0 Course Registration

4.1 A 'Faculty Advisor or Counselor' shall be assigned to each specialization, who will advise 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 The Department invites 'Registration Forms' from students. Registration requests for any 'CURRENT SEMESTER' shall be completed BEFORE the commencement of SEEs (Semester End Examinations) of the 'PRECEDING SEMESTER'.

4.3 A Student can apply for Registration, ONLY AFTER obtaining the 'WRITTEN APPROVAL' from his Faculty Advisor, which should be submitted to the Department

4.4 If the Student submits ambiguous choices or multiple options or erroneous entries during 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 Registration are final and CANNOT be changed, nor can they be inter-changed; further, alternate choices also will not be considered. However, if the Subject/ Course that has already been listed for Registration by the Department in a Semester could not be offered due to unforeseen or unexpected reasons, then the Student will be allowed to have alternate choice either for a new Subject, if it is offered, or for another existing Subject (subject to availability of seats). 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.

4.6 Open electives: The students have to choose one open elective (OE-I) from the list of open electives given in II year I semester.

4.7 Program electives: The students have to choose 5 Program electives (PE-I to V) from the list of program electives given. (2 PEs in I Semester, 2 PEs in II Semester and 1 in III Semester)

5.0 Attendance Requirements

The programmes are offered on the basis of a unit system with each subject being considered a unit.

5.1 A student is eligible to appear for the semester end examinations, if the student acquires a minimum of 75% of attendance in aggregate of all the subjects / courses (excluding attendance in mandatory courses) for that semester..

5.2 Shortage of attendance in aggregate up to 10% (65% and above, and below 75%) in each semester may be condoned on medical grounds.

5.3 Shortage of attendance below 65% in aggregate shall in no case be condoned.

5.4 Students whose shortage of attendance is not condoned in any semester are not eligible to take their end examinations of that semester.

5.5 A student fulfills the attendance requirement in the present semester, shall not be eligible for readmission into the same class.

5.6 A prescribed fee per subject shall be payable for condoning shortage of attendance.

6.0 Academic Requirements

The following academic requirements have to be satisfied, in addition to the attendance requirements mentioned in item no. 5. The performance of the candidate in each semester shall be evaluated subject-wise, with a maximum of 100 marks per subject / course (theory / practical), on the basis of Internal Evaluation and Semester End Examination.

6.1 A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/course, if he secures not less than 40% of marks (28 out of 70 marks) in the End Semester Examination, and a minimum of 50% of marks in the sum total of CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

6.2 A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to a subject/ course, if he secures not less than 50% of the total marks. The student is deemed to have failed, if he (i) does not attend the comprehensive viva-voce as per the schedule given, or (ii) does not present the seminar as required, or (iii) does not present the Technical Paper Writing as required. In such a case, he may reappear for comprehensive viva-voce in supplementary examinations and for seminar/ technical paper writing, in the subsequent semesters, as and when scheduled.

6.3 A student shall register for all subjects for total of 68 credits as specified and listed in the course structure for the chosen specialization, put in required the attendance and fulfill the academic requirements for securing 68 credits obtaining a minimum of 'B' Grade or above in each subject, and all 68 credits securing Semester Grade Point Average **(SGPA) 6.0** (in each semester) and final Cumulative Grade Point Average **(CGPA)** (i.e., CGPA at the end of PGP**) 6.0**, to complete the PGP successfully.

6.4 Marks and Letter Grades obtained in all those subjects covering the above specified 68 credits alone shall be considered for the calculation of final CGPA, which will be indicated in the Grade Card /Marks Memo of second year second semester.

6.5 If a student registers for extra subject(s) (in the parent department or other departments/ branches of Engineering) other than those listed subjects totalling to 68 credits as specified in the course structure, the performance in extra subject(s) (although evaluated and graded using the same procedure as that of the required 68 credits) will not be taken into account while calculating the SGPA and CGPA. For such extra subject(s) registered, a certificate will be issued with a letter grade indicated as a performance measure, subject to completion of the attendance and academic requirements as stated in items 5 and 6.1 - 6.3.

6.6 A student eligible to appear for the Semester End Examination in any subject, but absent from it or failed (failing to secure 'B' Grade or above), may reappear for that subject at the supplementary examination as and when conducted. In such cases, his Internal Marks assessed earlier for that subject will be carried over, and added to the marks secured in the supplementary examination, for the purpose of evaluating his performance in that subject.

6. 7 A Student who fails to earn 68 credits as per the specified course structure, and as indicated above, within **four** academic years from the date of commencement of his first year first semester, shall forfeit his seat in M.Tech. programme and his admission **shall stand cancelled.**

7.0 Evaluation - Distribution and Weightage of Marks

7.1 The performance of a student in every subject/course (including practicals) will be evaluated for 100 marks each, with 30 marks allotted for CIE (Continuous Internal Evaluation) and 70 marks for SEE (Semester End-Examination).

7.2 For theory courses, during the semester there are 2 mid-term examinations (internal exams of 25 marks each) and 2 assignments carrying 5 marks each.

7.3 Each mid-term examination will be of 1 hour 20 minutes consisting of Part-A (short answer questions) for 10 marks and Part-B (long answer) for 15 marks. Part-A consists of 5 two marks questions and Part- B consists of 4 questions carrying 5 marks each and student should answer 3 questions.

7.4 First mid-term examination is conducted for first 2 units of syllabus and second mid-term examination is conducted for remaining 3 units of syllabus.

7.5 The Continuous Internal Evaluation for theory course shall be made as average of marks obtained in CIE – I and CIE –II as detailed in the table below.

CIE – I	Marks	CIE - II	Marks
MID – I	25	MID - II	25
Assignment – I	5	Assignment - II	5
Total	30	Total	30

7.6 If a student is absent for any test/assignment, he is awarded zero marks for that test/assignment. However a candidate may be permitted on genuine grounds provided he/she has taken permission before the mid-term examination from the Head of the Department. Moreover, he/she has to apply for makeup examinations within a week after completion of mid-term examinations. A subcommittee will be constituted with the following composition to look into such cases.

Subcommittee-composition:

S.No	Faculty Member	Designation
1	Concern Head of the Department	Chairman
2	Senior faculty nominate by Principal	Member
3	One Senior faculty member of the concern department	Member
4	One faculty member of the other department	Member
5	Additional Controller of Examinations	Convener

7.7 The details of the Question Paper pattern for Semester End Examination (Theory) are given below:

The Semester End Examination will be conducted for 70 marks. It consists of two parts. i).Part A for 20 marks, ii). Part B for 50 marks.

- Part A is compulsory and consists of 5 questions, one from each unit and carrying 4 marks each.
- Part-B consists of five questions carrying 10 marks each. Each of these questions is from one unit and may contain sub-questions. For each question there will be an "either" "or" choice, which means that there will be two questions from each unit and the student should answer either of the two questions.

7.8 For practical subjects, 70 marks shall be awarded for performance in the Semester End Examinations and 30 marks shall be awarded as Internal Marks. Out of the 30 marks for internal evaluation, day-to-day work in the laboratory is evaluated for 20 marks and internal practical examination is evaluated for 10 marks conducted by the laboratory teacher concerned.

7.9 The semester end examination is conducted with an external examiner and the laboratory teacher. The external examiner is selected and appointed by the Principal from the list submitted by Head of the Department.

7.10 There shall be a Seminar presentation during II Year I semester. For Seminar student under the supervision of a faculty member shall collect literature on a topic and critically review the literature and submit a report to the Department. Upon acceptance of the report by the Department committee candidate shall make an oral presentation before the Department Commitee. The Department Committee comprising of Head of The Department, supervisor, and two other senior faculty members of the Department shall evaluate for 50 marks. There is no external Evaluation for the Seminar.

7.11 There shall be a mini project preferably suggested by the industry of their specialization. The mini project shall be carried out during the summer vacation between I Year II Semester and II year I Semester is evaluated for 50 marks in the II Year I Semester by the Head, Supervisor/ mentor and a senior faculty of the department. A candidate has to secure a minimum of 50% of marks (*25 out of 50*) to be declared successful. If he fails to obtain the minimum marks, he has to reappear for the same during the supplementary examinations as and when conducted, subject to item 3.2.

7.12 There shall be a dissertation/major project work of one-year duration which contributes strong weightage in the curriculum in the II year. It is expected to undertake industrially relevant problem to develop an optimal solution through extensive research work. The students and faculty can design the research project in consultation with industry preferably in the region. The planning of laboratory work/modelling/computational work with execution schedule is suggested at the beginning of the programme to ensure expected outcome. This will lead to creation of patents from the result of the programme.

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

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

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

7.16 After satisfying 7.15, a candidate has to present in Project Work Review I, in consultation with his Project Supervisor, the title, objective and plan of action of his project work to then Project Work Review Committee (PRC) for approval within four weeks from the commencement of Second Year First Semester. Only after obtaining the approval of the PRC can the student initiate the Project work.

7.17 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.

7.18 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 approval 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.

7.19 The major project work shall be carried out in two stages: Project Stage – I during II Year I Semester, Project Stage – II during II Year II Semester. Each stage will be evaluated for 100 marks. Student has to submit project work report at the end of each semester. First report includes project work carried out in II Year I semester and second report includes project work carried out in II Year I & II Semesters. SEE for both project stages shall be completed before the commencement of SEE Theory examinations.

7.20 For Project Stage – I, the Project Review Committee shall evaluate the project work for 50 marks and project supervisor shall evaluate for 50 marks. The student is deemed to have failed, if he (i) does not submit a report on Project Stage - I or does not make a presentation of the same before the evaluation committee as per schedule, or (ii) secures less than 50% marks in the sum total of the CIE and SEE taken together.

A student who has failed may reappear once for the above evaluation, when it is scheduled again; if he fails in such 'one reappearance' evaluation also, he has to reappear for the same in the next subsequent semester, as and when it is scheduled.

7.21 For Project Stage – II, the external examiner shall evaluate the project work for 50 marks and the project supervisor shall evaluate it for 50 marks. The student is deemed to have failed, if he (i) does not submit a report on Project Stage - II, or does not make a presentation of the same before the external examiner as per schedule, or (ii) secures less than 50% marks in the sum total of the CIE and SEE taken together. For conducting viva-voce of project stage – II, Principal selects an external examiner from the panel of experts in the relevant branch submitted by the HOD.

A student who has failed may reappear once for the above evaluation, when it is scheduled again; if student fails in such 'one reappearance' evaluation also, he has to reappear for the same in the next subsequent semester, as and when it is scheduled.

7.22 After approval from the PRC, the soft copy of the thesis should be submiitted to the Department 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 30%, then only thesis will be accepted for submission.

7.23 Three copies of the Project Thesis certified by the supervisor shall be submitted to the College, after submission of a research paper related to the project work in a UGC approved journal. A copy of the submitted research paper shall be attached to thesis.

7.24 The Project Viva-Voce External examination marks must be submitted to the Exam Branch on the same day of the examination.

8.0 Re-Admission/Re-Registration

8.1 Re-Admission for Discontinued Student

A student, who has discontinued the M.Tech. degree programme due to any reason whatsoever, may be considered for '**readmission**' into the same degree programme (with the same specialization) with the academic regulations of the batch into which he gets readmitted, with prior permission from the authorities concerned, subject to item 6.6.

9.0 Examinations and Assessment - The Grading System

9.1 Grades will be awarded to indicate the performance of each student in each Theory Subject, or Lab/Practicals, or Seminar, or Technical Paper Writing or Project, etc., based on the % of marks obtained in CIE + SEE (Continuous Internal Evaluation + Semester End Examination,

both taken together) as specified in Item 7 above, and a corresponding Letter Grade shall be given.

9.2 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 in a subject/Course (Class Intervals)	**Letter Grade (UGC Guidelines)**	**Grade Points**
90% and above (≥90% , ≤ 100%)	O (Outstanding)	10
Below 90% but not less than 80% (≥80% , <90%)	A^+ (Excellent)	9
Below 80% but not less than 70% (≥ 70% , <80%)	A (Very Good)	8
Below 70% but not less than 60% (≥60% , <70%)	B^+ (Good)	7
Below 60% but not less than 50% (≥50% , <60%)	B (above Average)	6
Below 50% (< 50%)	F (FAIL)	0
Absent	**Ab**	**0**

9.3 A student obtaining F Grade in any Subject is deemed to have 'failed' and is required to reappear as 'Supplementary Candidate' for the Semester End Examination (SEE), as and when conducted. In such cases, his Internal Marks (CIE Marks) in those subjects will remain as obtained earlier.

9.4 If a student has not appeared for the examinations, 'Ab' Grade will be allocated to him for any subject and shall be considered 'failed' and will be required to reappear as 'Supplementary Candidate' for the Semester End Examination (SEE), as and when conducted.

9.5 A Letter Grade does not imply any specific marks percentage; it is only the range of percentage of marks.

9.6 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'.

9.7 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) are computed by multiplying the Grade Point with Credits for that particular Subject/ Course.

Credit Points (CP) = Grade Point (GP) x Credits …. For a Course

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

9.9 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 :

$$\text{SGPA} = \{ \sum_{i=1}^{N} C_i G_i \} / \{ \sum_{i=1}^{N} C_i \} \text{ .... For each semester,}$$

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 Gi represents the grade points (GP) corresponding to the letter grade awarded for that i^{th} subject.

9.10 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 I Year Second Semester onwards, at the end of each Semester, as per the formula mentioned below:

$$\text{CGPA} = \{ \sum_{j=1}^{M} C_j G_j \} / \{ \sum_{j=1}^{M} C_j \} \text{ ... for all S semesters registered}$$

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

Illustration of calculation of SGPA

Course/Subject	Credits	Letter Grade	Grade points	Credit Points
Course 1	4	A	8	4*8 = 32
Course 2	4	O	10	4*10 = 40
Course 3	4	B	6	4*6 = 24
Course 4	3	B	6	3*6 = 18
Course 5	3	A+	9	3*9 = 27
Course 6	3	B	6	3*6 = 18
	21			159

Illustration of calculation of CGPA

Semester	Credits	SGPA	Credits * SGPA
Semester I	24	7	24*7 = 168
Semester II	24	6	24*6 = 144
Semester III	24	6.5	24*6.5 = 156
Semester IV	24	6	24*6 = 144
	96		612

CGPA = 612/96 = 6.37

10.0 Award of Degree and Class

10.1 If 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 **68** Credits (with CGPA 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 the specialization that he was admitted into.

10.2 Award of Class

After a student has earned 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	$6.75 \leq$ CGPA < 7.75
Second Class	$6.00 \leq$ CGPA < 6.75

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

11 Withholding of Results

If the student has not paid the dues, if any, to the Institution 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.

12.0. Transitory Regulations

12.1 A student who has been detained in any semester of I Year of Previous Regulations due to lack of attendance, shall be permitted to join the same semester of I Year of R20 Regulations and he is required to complete the study of M.Tech programme within the stipulated period of

four academic years from the date of first admission in I Year I semester. The R20 Academic Regulations under which a student has been readmitted shall be applicable to that student from that semester.

12.3 For student readmitted to R20 Regulations, the maximum credits that a student acquires for the award of the degree, shall be the sum of the total number of credits secured in previous regulations of his/her study including R20 Regulations.

12.4 If a student readmitted to R20 Regulations, has any subject with 80% of syllabus common with his/her previous regulations, that particular subject in R20 regulations will be substituted by another subject to be suggested by the Concerned Board Of Studies (BOS).

13 General

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

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

13.6 The Institution may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the Institution.

MALPRACTICE RULES
DISCIPLINARY ACTION FOR CONDUCT IN EXAMINATION

	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 subject of the examination).	Expulsion from the examination hall and cancellation of the performance in that subject only.
1.(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 subject 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 the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to 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 subjects of the examination (including practical's and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all end semester examinations. The continuation of the course 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 subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all end semester examinations. The continuation of the course 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 subject.
6	Refuses to obey the orders of the Chief Superintendent/Assistant – Superintendent / 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 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.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is 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 subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all end semester examinations. The continuation of the course 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 subject and all other subjects the candidate has already appeared including practical examinations and project work

		and shall not be permitted for the remaining examinations of the subjects of that semester/year. 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.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. 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 subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the Examination Result Processing Committee (ERPC) for further action to award suitable punishment.	

J.B. INSTITUTE OF ENGINEERING AND TECHNOLOGY

(UGC AUTONOMOUS)

Bhaskar Nagar, Moinabad Mandal, R.R. District, Hyderabad -500075

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

M.Tech - ELECTRICAL POWER SYSTEMS (EPS): R-20

CHOICE BASED CREDIT SYSTEM (CBCS)

COURSE STRUCTURE (2020-2021)

SEMESTER-I							
Sl. No	**Code**	**Core/ Elective**	**Course Title**	**L**	**T**	**P**	**C**
1.	JM21A	Core1	Advanced Power System Analysis	3	0	0	3
2.	JM21B	Core2	Flexible AC Transmission Systems	3	0	0	3
3.	JM21C JM21D JM21E	PE 1	1. Energy Auditing Conservation & Management 2. Smart-Grids 3. EHVAC Transmission	3	0	0	3
4.	JM21F JM21G JM21H	PE 2	1. Electrical Power Distribution System 2. Power System Dynamics & Stability 3. Distribution Automation	3	0	0	3
5.	JM21I	Lab1	Electrical Simulation Lab-1	0	0	4	2
6.	JM21J	Lab2	Power Systems Lab-1	0	0	4	2
7.	JM01A	MC-I	Soft Skills	2	0	0	0
			TOTAL CREDITS				**16**
SEMESTER-II							
Sl. No	**Code**	**Core/ Elective**	**Course Title**	**L**	**T**	**P**	**C**
1.	JM22A	Core3	Advanced Power System Protection	3	0	0	3
2.	JM22B	Core4	Power System Operation and Deregulation	3	0	0	3
3.	JM22C JM22D JM22E	PE 3	1. High Voltage Engineering 2. Power Quality 3. HVDC Transmission	3	0	0	3
4.	JM22F JM22G JM22H	PE 4	1. Voltage Stability 2. AI Techniques in Electrical Engineering 3. Reactive Power Compensation and Management	3	0	0	3
5.	JM92A	Core	Research Methodology and IPR	2	0	0	2
6.	JM22I	Lab3	Electrical Simulation Lab-2	0	0	4	2
7.	JM22J	Lab4	Power Systems Lab-2	0	0	4	2
8.	JM92B	MC-II	Personality Development and Professional Values	2	0	0	0
			TOTAL CREDITS				**18**

SEMESTER-III							
Sl. No.	**Code**	**Core/ Elective**	**Course Title**	**L**	**T**	**P**	**C**
1.	JM23A JM23B JM23C	PE 5	1. Electric Vehicles 2. Modern Control Theory 3. Advanced Digital Signal Processing	3	0	0	3
2.	JM20A JM20B	OE	1. Renewable Energy Technologies and Battery Storage 2. Power Plant Engineering	3	0	0	3
3.	JM23D		Mini Project	0	0	4	2
4.	JM23E		Technical Seminar	0	0	2	1
5.	JM23F	Major	Phase-I Dissertation	0	0	20	09
			TOTAL CREDITS				**18**
SEMESTER-IV							
Sl. No.	**Code**	**Core/ Elective**	**Course Title**	**L**	**T**	**P**	**C**
1.	JM24A	Major	Phase-II Dissertation	0	0	32	16
			TOTAL CREDITS				**16**
GRAND TOTAL CREDITS							**68**

PE: Program Elective
OE: Open Elective

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	L	T	P	C
M.Tech. EPS				
I Year -I Semester	**3**	**0**	**0**	**3**

CORE1: ADVANCED POWER SYSTEM ANALYSIS

Pre-requisite: Computer Methods in Power Systems

Course Objectives

- To model the power system under steady state operating condition.
- To construct bus admittance and impedance matrices using numerical methods.
- To solve Load Flow problem using Gauss Seidal, N-R and FDLF methods.
- To analyse single contingency and multiple contingencies using Z_{BUS} Method.
- To examine short circuit analysis using Z_{BUS}.

Course Outcomes

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

- Construct network bus admittance matrix using successive elimination, node elimination, and triangular factorization.
- Construct network bus impedance matrix using Y_{BUS}, bus building algorithm and power invariant transformations with mutually coupled branches.
- Solve Load Flow problem using Gauss Seidal, N-R and FDLF methods.
- Analyse single contingency and multiple contingencies using Z_{BUS} method.
- Make use of Z_{BUS} for symmetrical and unsymmetrical fault calculations.

UNIT-I: Formation of Y_{BUS}: 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.

UNIT-II: Formation of Z_{BUS}: Impedance model and network calculations, 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}.

UNIT-III: Load Flow Analysis: Gauss Seidel method, N-R Method, Decoupled method, Fast decoupled method, Comparison between power flow solutions, DC load flow.

UNIT-IV: Contingency Analysis: Z_{BUS} method in Contingency Analysis, Adding and removing multiple lines, Piece-wise solution of interconnected Systems, Analysis of single contingencies, Analysis of multiple contingencies, Contingency analysis of DC Model, System reduction for contingency and fault studies.

UNIT-V: 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. Pai M A, "Computer Techniques in Power System Analysis", Tata McGraw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2007.
2. Hadi Saadat, "Power System Analysis", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.
3. John J. Grainger and W.D. Stevenson Jr., "Power System Analysis", Tata McGraw-Hill, Sixth reprint, 2010.
4. Nagrath I.J. and Kothari D.P., "Modern Power System Analysis", Tata McGraw-Hill, Fourth Edition, 2011.

REFERENCE BOOKS:

1. C.A. Gross, "Power System Analysis," Wiley India, 2011.
2. Olle. I. Elgerd, "Electric Energy Systems Theory – An Introduction", Tata McGraw Hill Publishing Company Limited, New Delhi, Second Edition, 2012.
3. Kundur P., "Power System Stability and Control", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 10th reprint, 2010.

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	L	T	P	C
M.Tech. EPS				
I Year -I Semester	**3**	**0**	**0**	**3**

CORE 2: FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS)

Prerequisite: Power Electronics and Power Systems-II

Course Objectives:

- To understand the fundamentals of FACTS Controllers, Importance of controllable parameters and types of FACTS controllers & their benefits.
- To recall the objectives of Shunt and Series compensation.
- To explain control of STATCOM and SVC and their comparison and the regulation of STATCOM.
- To analyze the functioning and control of GCSC, TSSC and TCSC.

Course Outcomes:

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

- Understand the basic concept and types of FACTS controllers.
- Summarize the operation of voltage source and current source converters.
- Explain the objectives of shunt compensation, applications of shunt controllers and methods of controllable VAR generation.
- Demonstrate the applications of SVC and STATCOM.
- Illustrate the basic concept and applications of series FACTS controllers.

UNIT-I: 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 of FACTS controllers.

UNIT-II: 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.

UNIT-III: 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.

UNIT-IV: 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.

UNIT-V: 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. Narain G. Hingorani, Laszio. Gyugyl, "Understanding FACTS Concepts and Technology of Flexible AC Transmission System", Standard Publishers, Delhi, First Edition, 2001.
2. Mohan Mathur, R., Rajiv. K. Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, First Edition, 2002.

REFERENCE BOOKS:

1. A.T. John, "Flexible AC Transmission System", Institution of Electrical and Electronic Engineers (IEEE), First Edition, 1999.
2. V.K. Sood, "HVDC and FACTS controllers- Applications of Static Converters in Power System", Kluwer Academic Publishers, First Edition, 2004.
3. K.R. Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International Publishers, New Delhi, Reprint, 2008.

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M.Tech. EPS	**L**	**T**	**P**	**C**
I Year -I Semester	**3**	**0**	**0**	**3**

PROGRAM ELECTIVE – 1: ENERGY AUDITING, CONSERVATION AND MANAGEMENT

Prerequisite: Electrical Distribution Systems

Course Objectives:

- To know the necessity of conservation of energy.
- To generalize the methods of energy management.
- To illustrate the factors to increase the efficiency of electrical equipment.
- To detect the benefits of carrying out energy audits.

Course Outcomes:

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

- Tell energy audit of industries.
- Predict management of energy systems.
- Sequence the methods of improving efficiency of electric motor.
- Analyze the power factor and to design a good illumination system.
- Determine pay back periods for energy saving equipment.

UNIT-I: Basic principles of energy audit: Energy audit - Definitions, Concept, Types of audit, Energy index, Cost index, Pie charts, Sankey diagrams, Load profiles, Energy conservation schemes - Energy audit of industries - Energy saving potential, Energy audit of process industry, Thermal power station, Building energy audit.

UNIT-II: Energy management: Principles of energy management, Organizing energy management program, Initiating, Planning, Controlling, Promoting, Monitoring, Reporting, Energy manger, Qualities and functions, Language, Questionnaire – Check list for top management.

UNIT-III: Energy efficient motors: Energy efficient motors, Factors affecting efficiency, Loss distribution, Constructional details, Characteristics - Variable speed , Variable duty cycle systems, RMS HP- Voltage variation - Voltage unbalance - Over motoring - Motor energy audit

UNIT-IV: Power factor improvement, lighting and energy instruments: Power factor – Methods of improvement, Location of capacitors, Pf with non linear loads, Effect of harmonics on power factor, Power factor motor controllers - Good lighting system design and practice, Lighting control , Lighting energy audit - Energy instruments - Wattmeter, Data loggers, Thermocouples, Pyrometers, Lux meters, Tongue testers, Application of PLC's.

UNIT-V: Economic aspects and analysis: Economics analysis - Depreciation methods, Time value of money, Rate Of return, Present worth method , Replacement analysis, Life cycle costing analysis - Energy efficient motors - Calculation of simple payback method, Net present worth method - Power factor correction, Lighting - Applications of life cycle costing analysis, Return on investment.

TEXT BOOKS:

1. W.R. Murphy & G. Mckay, “Energy Management” Butter worth, Heinemann Publications, Second Edition, 2009.
2. Paul o’ Callaghan, “Energy Management”, Tata Mc-Graw Hill Book Company - First Edition, 1998.
3. W.C. Turner, “Energy Management Hand Book”, CRC Press, First Edition, 2004.

REFERENCE BOOKS:

1. John .C. Andreas, “Energy Efficient Electric Motors”, CRC Press, Third Edition, 1992.
2. Great Britain, “Energy Management and Good Lighting Practice: Fuel Efficiency - Booklet Volume 12-EEO, 1989.

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	L	T	P	C
M.Tech. EPS				
I Year -I Semester	**3**	**0**	**0**	**3**

PROGRAM ELECTIVE – 1: SMART GRID

Course Objectives:

- The concepts of SCADA communication systems. Analyze the power factor and to design a good illumination system.
- Integration of smart devices for substation automation.
- The concepts of SCADA communication systems.
- Description of Energy management systems and framework.
- Exposure on Distribution automation and management systems.

Course Outcomes:

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

- Apply the concepts of smart grid architecture, dynamic energy systems, energy port in real time applications Integration of smart devices for substation automation.
- Apply smart grid policies and programs to encourage end – use energy efficiency.
- Explore the SCADA communication systems.
- Extend knowledge of substation automation functions and benefits of data warehousing.
- Interpret the load forecasting and transmission operations and management in real time applications.
- Integrate DMS framework and real time DMS applications.

UNIT–I: Introduction to smart grid - Electricity network - Local energy networks - Electric transportation - Low carbon central generation - Attributes of the smart grid - Alternate views of a smart grid.

Smart grid to evolve a perfect power system: Introduction - Overview of the perfect power system configurations- Device level power system - Building integrated power systems - Distributed power systems - Fully integrated power system - Nodes of innovation.

UNIT–II: DC distribution and smart grid: AC vs DC sources - Benefits of and drives of DC power delivery systems - Powering equipment and appliances with DC-Data centers and information technology loads - Future neighbourhood - Potential future work and research.

Intelligrid architecture for the smart grid: Introduction- Launching intelligrid - Intelligrid today- Smart grid vision based on the intelligrid architecture - Barriers and enabling technologies.

UNIT–III: Dynamic Energy Systems Concept: Smart energy efficient end use devices - Smart distributed energy resources - Advanced whole building control systems - Integrated communications architecture - Energy management - Role of technology in demand response- Current limitations to dynamic energy management - Distributed energy resources - Overview of a dynamic energy management - Key characteristics of smart devices - Key characteristics of advanced whole building control systems - Key characteristics of dynamic energy management system.

UNIT–IV: Energy port as part of the smart grid: Concept of energy - Port, Generic features of the energy port.
Policies and programs to encourage end – Use energy efficiency: Policies and programs in action - Multinational – National – State - City and corporate levels.
Market implementation: Framework - Factors influencing customer acceptance and response - program planning-monitoring and evaluation.

UNIT–V: Efficient Electric End – Use Technology Alternatives: Existing technologies – lighting - Space conditioning - Indoor air quality - Domestic water heating- hyper efficient appliances - Ductless residential heat pumps and air conditioners – Variable refrigerant flow air conditioning - Heat pump water heating - Hyper efficient residential appliances - Data center energy efficiency - LED street and area lighting - Industrial motors and drives -Equipment retrofit and replacement - Process heating - Cogeneration, Thermal energy storage - Industrial energy management programs - Manufacturing process - Electro-technologies, Residential, Commercial and industrial sectors.

TEXT BOOKS:

1. Clark W Gellings, "The Smart Grid, Enabling Energy Efficiency and Demand Side Response", CRC Press, 2009.
2. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong.Wu, Akihiko.Yokoyama, Nick Jenkins, "Smart Grid: Technology and Applications"- Wiley, 2012.

REFERENCE BOOKS:

1. James Momoh, "Smart Grid: Fundamentals of Design and Analysis"- Wiley, IEEE Press, First Edition, 2012.
2. Fereidoon P. Sioshansi, "Smart Grid: Integrating Renewable, Distributed and Efficient Energy", Academic Press, First Edition, 2011.
3. Stuart Borlase "Smart Grid: Infrastructure, Technology and Solutions", CRC Press, First Edition, 2012.

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M.Tech. EPS				
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PROGRAM ELECTIVE –1: EHV AC TRANSMISSION

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.

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.
- Construct commercial transmission system.

UNIT- I: 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.

UNIT- II: 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.

UNIT- III: Electrostatic induction in unenergized lines – Measurement of field and voltage gradients for three phase single and double circuit lines – Unenergized 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.

UNIT - IV: Corona in E.H.V. lines – Corona loss formulae - Attenuation 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.

UNIT- V: 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, Revised Third Edition, 2006.
2. S. Rao, "HVAC and DC Transmission", Khanna Publishers, New Delhi, Third Edition.
3. Subir Ray, "An Introduction to High Voltage Engineering", Prentice Hall of India Private Limited, Seventh Printing, Second Edition, 2013.

REFERENCE BOOKS:

1. Luces M. Fualkenberry, Walter Coffer, "Electrical Power Distribution and Transmission", Pearson Education, Third Edition, 2008.
2. B.R.Gupta, "Power System Analysis and Design", A H Wheeler Publishing Company Limited, third Edition, 1998.
3. S.N. Singh, "Electric Power Generation, Transmission and Distribution", Prentice Hall of India Pvt. Ltd, New Delhi, second Edition, 2011.
4. Edison, "EHV Transmission line"- Electric Institution (GEC 1968).
5. Kimbark E.W. "Direct Current Transmission", Wiley Interscience, Vol.I, Wiley, 1971.

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M.Tech. EPS	**L**	**T**	**P**	**C**
I Year -I Semester	**3**	**0**	**0**	**3**

PROGRAM ELECTIVE – 2: ELECTRIC POWER DISTRIBUTION SYSTEM

Prerequisite: Electric Distribution Systems

Course Objectives:

- Learning about power distribution system.
- Learning of SCADA System.
- Understanding distribution automation.

Course Outcomes:

Students will be able to:

- Knowledge of power distribution system.
- Study of distribution automation and its application in practice.
- Learn SCADA system.

UNIT-I: Distribution of power, Management, Power loads, Load forecasting short-term & long-term, power system loading, Technological forecasting.

UNIT-II: Advantages of Distribution Management System (D.M.S.) Distribution automation: Definition, Restoration / Reconfiguration of distribution network, Different methods and constraints power factor correction.

UNIT-III: Interconnection of distribution, control & communication systems, Remote metering, Automatic meter reading and its implementation. SCADA: Introduction, Block Diagram, SCADA applied to distribution automation, Common functions of SCADA, Advantages of distribution automation through SCADA.

UNIT-IV: Calculation of optimum number of switches, Capacitors, Optimum switching device placement in radial, Distribution systems, Sectionalizing switches – Types, Benefits, Bellman's optimality principle, Remote terminal units, Energy efficiency in electrical distribution & monitoring.

UNIT-V: Maintenance of automated distribution systems, Difficulties in implementing distribution-Automation in actual practice, Urban/Rural distribution, Energy management, AI techniques applied to distribution automation.

TEXT BOOKS

1. A.S. Pabla, "Electric Power Distribution", Tata McGraw Hill Publishing Co. Ltd., New Delhi, Sixth Edition, 2017.
2. M.K. Khedkar, G.M. Dhole, "A Text Book of Electrical Power Distribution Automation", University Science Press, New Delhi, First Edition, 2010.

REFERENCE BOOKS:

1. Anthony J Panseni, “Electrical Distribution Engineering”, CRC Press, Third Edition, 2006
2. James Momoh, “Electric Power Distribution, Automation, Protection & Control”, CRC Press. First Edition, 2007.
3. Turan Gonen, “Electric Power Distribution”, CRC Press. Third Edition, 2014.

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M.Tech. EPS				
I Year -I Semester	**3**	**0**	**0**	**3**

PROGRAM ELECTIVE – 2: POWER SYSTEM DYNAMICS AND STABILITY

Pre-requisite: Computer Methods in Power Systems

Course objectives

- To remember the dynamic characteristics of power system equipment.
- To recognize dynamic performance of power systems.
- To illustrate the system stability and controls.

Course Outcomes:

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

- Choose the fundamental dynamic behaviour and controls of power systems to perform basic stability analysis.
- Comprehend concepts in modelling of excitation systems.
- Interpret results of system stability studies.
- Analyze the concepts of dynamic stability, voltage stability and the factors affecting these voltage instability and voltage collapse.

UNIT-I: Basic concepts: Power system stability status of operation and system security, System dynamics problems, System model analysis of steady state stability and transient stability, Simplified representation of excitation control.

UNIT-II: Modeling of excitation systems: Excitation system requirements, Elements of an excitation system, Types of excitation systems - Type-2 system: Rotating rectifier system, Type-3 system: Static with terminal potential and current supplies, Type-4 system: Non – continuous acting - Block diagram representation – State space modeling equations of these types.

UNIT-III: Dynamic stability: Concept of Dynamic stability – State space model of one machine system connected to infinite bus – Effect of excitation on Dynamic stability – Examination of dynamic stability by Routh's criterion.

UNIT-IV: Voltage stability: Voltage stability – Voltage collapse, Voltage security, Physical relation indicating dependence of voltage and reactive power flow, Factors affecting voltage instability and collapse – Previous case of voltage collapse incidences.

UNIT-V: Voltage stability analysis: PV curve - QV curve - Control of voltage instability, Voltage stability analysis - Static & dynamic analysis - The continuation power flow analysis - Prevention of voltage collapse.

TEXT BOOKS:

1. K.R. Padiyar, "Power System Dynamics: Stability and Control"- B.S. Publications, 2nd Edition, 2002.
1. Kundur P., 'Power System Stability and Control, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 10th reprint, 2010.
2. Abhijit Chakrabarti, "Power System Dynamics and Simulation", PHI Publications, 1st Edition, 2013.

REFERENCE BOOKS:

1. P.M. Anderson and A.A. Fouad, "Power System Control and Stability", IEEE Presss,2nd Edition, 2002.
2. R. Ramanujam, "Power Systems Dynamics: Analysis and Simulation", PHI Publications, 1st Edition, 2010.
3. Harry G. Kwatny and Karen Miu-Miller, "Power System Dynamics and Control", Birkhauser Publications, 1st Edition, 2016.

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	L	T	P	C
M.Tech. EPS				
I Year -I Semester	**3**	**0**	**0**	**3**

PROGRAM ELECTIVE – 2: DISTRIBUTION AUTOMATION

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.

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.
- Have knowledge on management of different electrical parameters.

UNIT-I: 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.

UNIT-II: Distribution automation functions: DA capabilities, Automation system computer facilities, Management processes, Information management, System reliability management, System efficiency management, Voltage management, Load management.

UNIT-III: 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.

UNIT-IV: 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.

UNIT-V: 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. James. North cote – Green Robert Wilson, "Control and Automation of Electrical Distribution Systems", CRC Press, First Edition, 2007.
2. Biswarup Das, "Power Distribution Automation", Institution of Engineering and Technology (IET) Publishers, Volume 2, 2016.
3. James A. Momoh, "Electric Power Distribution, Protection and Control", CRC Press, First Edition, 2007.

REFERENCE BOOKS:

1. Dr. M. K. Khedkar, Dr. G.M. Dhole, "Electric Power Distribution Automation", University Science press, First Edition, 2010.
2. Jan De Kock, Cobus Strauss, "Practical Power Distribution for Industry", Elsevier Publication, First Edition, 2004.

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	L	T	P	C
M.Tech. EPS				
I Year -I Semester	**0**	**0**	**4**	**2**

LABORATORY – 1: ELECTRICAL SIMULATION LAB-1

Prerequisites: Power system analysis, power system reliability, voltage stability

Course Objectives:

- Develop programs for power system analysis.
- Design models for power systems and power electronics.
- Develop programs of power system reliability and power electronics.

Course outcomes:

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

- Understand/simulate/analyse power system analysis using software.
- Models of power systems and power electronics.
- Programs of power system reliability and power electronics.

List of the Experiments:

1. Simulation program for Y_{BUS} formation.
2. Simulation program for G-S load flow analysis.
3. Simulation program for N-R load flow analysis.
4. Simulation program for FDLF load flow analysis.
5. Simulation program for short circuit analysis.
6. Transient stability analysis for single machine connected to infinite bus by point by point method.
7. Simulation program for generation system reliability analysis.
8. Simulation program for distribution system reliability analysis.
9. Simulink model for a single area load frequency problem and simulate the same.
10. Simulink model for a two area load frequency problem and simulate the same.

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	L	T	P	C
M.Tech. EPS				
I Year -I Semester	**0**	**0**	**4**	**2**

LABORATORY – 2: POWER SYSTEMS LAB – I

Prerequisites: Power system, Photovoltaic Systems

Course Objectives:

- To have knowledge on line – line and line to ground faults (L-G,L-L, L-L-G,L-L-L-G) and its analysis on synchronous machine.
- To evaluate the behaviour of generator protection system.
- To analyze power angle characteristics of salient pole alternator
- To understand the principles and concepts on various solar systems.

Course outcomes:

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

- Have knowledge on short circuit analysis..
- Ability to conduct experiments on synchronous machine to find the characteristics.
- Able to understand the performance evaluation of various solar equipments.

List of Experiments:

1. Determination of sequence impedance of cylindrical rotor synchronous machine.
2. Single line to ground fault (L-G) analysis of cylindrical rotor synchronous machine.
3. Line to line fault (L-L) analysis of cylindrical rotor synchronous machine.
4. Double line to ground fault (L-L-G) analysis of cylindrical rotor synchronous machine.
5. Triple line to ground fault (L-L-L-G) analysis of cylindrical rotor synchronous machine.
6. Determination of sub-transient reactance of a salient pole synchronous machine.
7. Power angle characteristics of salient pole alternator.
8. Determination of Variation in Tilt Angle on PV Module.
9. Performance evaluation of a solar flat plate thermo syphon water heating system.
10. Operational characteristics of series and parallel combination of photo voltaic System.

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	L	T	P	C
M.Tech. EPS				
I Year -II Semester	**3**	**0**	**0**	**3**

CORE 3: ADVANCED POWER SYSTEM PROTECTION

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.

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 schemes.
- Identify operation and control of microprocessor based relays.

UNIT-I: 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.

UNIT-II: 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.

UNIT-III: 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.

UNIT-IV: 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 length and source impedance on distance relays.

UNIT-V: 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", Tata McGraw Hill Publication, New Delhi, 1995.
2. T.S. Madhava Rao, "Power system protection: Static relays", Tata McGraw Hill Publication, New Delhi, Second edition, 1989.

REFERENCE BOOKS:

1. Bhavesh Bhalja, R. P. Mahesheari, Nilesh G. Chothani, "Protection and Switchgear", Oxford University Press, First Edition, 2011.
2. C. Christopoulos and A. Wright, "Electrical Power System Protection", Springer International, Second Edition, 1999.
3. Russel Mason, "Art and Science of protective relays", Wiley – Blackwell Publications, First Edition, 1966.

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M.Tech. EPS	**L**	**T**	**P**	**C**
I Year -II Semester	**3**	**0**	**0**	**3**

CORE 4: POWER SYSTEM OPERATION AND DEREGULATION

Prerequisite: Power System Operation and Control

Course objectives:

- To find OPF with security constraints.
- To generalize modelling of load frequency control of a power system.
- To compute reactive power control of a power system.
- To apply the concept of deregulation and ATC.

Course Outcomes:

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

- Know the optimal scheduling of power plants.
- Outline the modeling of turbine and generator.
- Compute the steady state behavior of the power system for voltage and frequency fluctuations. Analyze ATC and the cost of transmission.

UNIT- I: Optimal power flow: 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.

UNIT-II: Power system security: 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.

UNIT-III: State estimation in power systems: 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

UNIT-IV: Power system deregulation: 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.

UNIT-V: Available transfer capability: 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. P.Venkatesh. B.V.Manikandan, S.Charles Raja- A.Srinivasan, "Electrical Power Systems: Analysis, Security, Deregulation", PHI Publications, First Edition, 2012.
2. Loi, Lei, Lai, "Power System Restructuring and Deregulation", John Wiley Publications, First Edition, 2001.

REFERENCE BOOKS

1. A.J. Wood & B.F. Woollenberg, "Power Generation, Operation and Control", John Wiley Publications, Second Edition, 2006.
2. Geoffrey S Rothwell, Tomás Gómez, "Electricity Economics: Regulation and Deregulation", John Wiley Publications, First Edition, 2003.

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	L	T	P	C
M.Tech. EPS				
I Year -II Semester	**3**	**0**	**0**	**3**

PROGRAM ELECTIVE – 3: HIGH VOLTAGE ENGINEERING

Prerequisite: Power Systems and Electrical & Electronics Instrumentation

Course Objectives:

- To distinguish the gaseous, liquid and solid dielectric behaviour under High Voltage (HV)
- 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.

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 voltage.

UNIT- I: Introduction to high voltage engineering: Electric field stresses, Gas / Vacuum as insulator, Liquid dielectrics, Solids and composites, Estimation and control of electric stress, Numerical methods for electric field computation, Surge voltages their distribution and control, Applications of insulating materials in transformers, Rotating machines, Circuit breakers, Cable power capacitors and bushings.

UNIT- II: Break down in dielectric materials: Gases as insulating media, Collision process, Ionization process, Townsend's criteria of break down in gases, Paschen's law. Liquid as Insulator, pure and commercial liquids, Breakdown in pure and commercial liquids. Intrinsic breakdown, Electromechanical breakdown, Thermal breakdown, Breakdown of solid dielectrics in practice, Breakdown in composite dielectrics, Solid dielectrics used in practice.

UNIT-III: Generation & measurement of high voltages & currents: Generation of high direct current voltages, Generation of high alternating voltages, Generation of impulse voltages, Generation of impulse currents, Tripping and control of impulse generators. Measurement of high DC voltages,

Measurement of high voltages alternating and impulse, Measurement of direct- alternating and impulse, Oscilloscope for impulse voltage and current measurements.

UNIT-IV: Over voltages & insulation co-ordination: Natural causes for over voltages – Lightning phenomenon, Overvoltage due to switching surges, System faults and other abnormal conditions, Principles of insulation coordination on high voltage and extra high voltage power systems.

UNIT- V: Testing of materials & electrical apparatus: Measurement of D.C Resistivity, Measurement of dielectric constant and loss factor, Partial discharge measurements. Testing of insulators and bushings, Testing of isolators and circuit breakers, testing of cables, Testing of transformers, Testing of surge arresters, and Radio interference measurements.

TEXT BOOKS:

1. M.S. Naidu and V. Kamaraju, "High Voltage Engineering" Tata McGraw Hill Publications, Fifth Edition, 2013.
2. E. Kuffel, W.S. Zaengl, J. Kuffel, "High Voltage Engineering: Fundamentals", Elsevier, Second Edition, 2000.

REFERENCE BOOKS:

1. C.L.Wadhwa, "High Voltage Engineering", New Age Internationals (P) Limited, Third Edition, 1997.
2. Ravindra Arora, Wolfgang Mosch, "High Voltage and Electrical Insulation Engineering", Wiley Publications, 2011.
3. Mazen Abdel Salam, Hussein Anis, Ahdan El-Morshedy, Roshdy Radwan, "High Voltage Engineering, Theory and Practice" Marcel Dekker Publications, Second Edition, 2001.

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	L	T	P	C
M.Tech. EPS				
I Year -II Semester	**3**	**0**	**0**	**3**

PROGRAM ELECTIVE – 3: POWER QUALITY

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.

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.

UNIT-I: 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.

UNIT-II: Long & short interruptions: Long 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.

UNIT III: 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.

UNIT-IV: 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.

UNIT-V: 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 immunity, Different events and mitigation methods. System equipment interface – Voltage source converter, Series voltage controller, Shunt controller, Combined shunt and series controller.
PQ and EMC standards: Introduction to standardization, IEC electromagnetic compatibility standards, European voltage characteristics standards, PQ surveys.

TEXT BOOKS:

1. Math H J Bollen, "Understanding Power Quality Problems" Wiley Publications, Volume 5, 2000.
2. C. Sankaran, "Power Quality", CRC Presss, First Edition, 2002.
3. Alexander Kusko, Marc Thompson, "Power Quality in Electrical Systems", Tata McGraw Hill Publishing Co. Ltd., New Delhi, First Edition, 2007.
4. Surajit Chattopadhyay, Madhuchhanda Mitra, Samarjit Sengupta, "Electric Power Quality", Springer, First Edition, 2007.

REFERENCE BOOKS:

1. R. Sastry Vedam Mulukutla S.Sarma, "Power Quality VAR Compensation in Power Systems", CRC Press, First Edition, 2008.
2. Roger C. Dugan , Mark F. Mc Granaghan, Surya Santoso, H. Wayne Beaty, "Electrical Power Systems Quality", Tata McGraw Hill Education Private Ltd, New Delhi, Second Edition, 2003.

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	L	T	P	C
M.Tech. EPS				
I Year -II Semester	**3**	**0**	**0**	**3**

PROGRAM ELECTIVE – 3: HVDC TRANSMISSION

Prerequisite: Power Transmission Systems

Course Objectives:

- Evaluation of technical and economical aspects of HVDC transmission.
- Development of HVDC converter analysis.
- Know about VSC HVDC control.
- Impact of AC system performance on DC system.
- Analysis of harmonics and their rectification.

Course Outcomes:

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

- Compare the differences between HVDC and HVAC transmission.
- Analyze the rectifier and inverter commutating circuits.
- Identification of valve firing control schemes.
- Estimate the requirement of HVDC filters.
- Address the role of AC system faults on HVDC system.
- Know about VSC transmission advantages.

UNIT-I: Introduction: General consideration, Power handling capabilities of HVDC Lines, Basic Conversion principles, Static converter configuration.

UNIT-II: Static power converters: 3-pulse, 6-pulse, and 12-pulse converters, Converter station and Terminal equipment, Commutation process, Rectifier and inverter operation, Equivalent circuit for converter – Special features of converter transformers. Harmonics in HVDC Systems, Harmonic elimination, AC and DC filters.

UNIT-III: Control of HVDC converters and Systems: Constant current, Constant extinction angle and constant ignition angle control, Individual phase control and equi-distant firing angle control DC power flow control. Interaction between HV AC and DC systems – Voltage interaction, Harmonic instability problems and DC power modulation.

UNIT-IV: MTDC systems & over voltages: Series parallel and series parallel systems their operation and control. Over voltages due to disturbances on DC side, Over voltages due to DC and AC side line faults.

UNIT-V: Converter faults & protection: Converter faults, Over current protection – Valve group, and DC line protection over voltage protection of converters, Surge arresters.

TEXT BOOKS:

1. E.W. Kimbark, “Direct Current Transmission”, Wiley Inter Science, New York, Volume 1, 1971.
2. KR Padiyar, “High Voltage Direct current Transmission”, New Age International Publishers, First Edition Reprint, 1992.

REFERENCE BOOKS:

1. J. Arillaga, “HVDC Transmission”, Institution of Electrical Engineers, Second Edition, 1998..
2. E. Uhlman, “Power Transmission by Direct Current”, Springer Verlag, Berlin Helberg, First Edition, 1985.

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	L	T	P	C
M.Tech. EPS				
I Year -II Semester	**3**	**0**	**0**	**3**

PROGRAM ELECTIVE – 4: VOLTAGE STABILITY

Prerequisite: Computers Methods in Power Systems

Course Objectives:

- To expose to theoretical background of voltage stability.
- To illustrate voltage stability analysis using P-V and Q-V curves.
- To be familiar with the analytical methods of voltage stability analysis.
- To understand the basic concept and types of reactive power compensation.
- To infer the computation of voltage stability margin and methods of voltage stability improvement.

Course Outcomes:

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

- Summarize theoretical background of voltage stability.
- Illustrate voltage stability analysis using P-V and Q-V curves.
- Apply analytical methods for voltage stability analysis.
- Understand the basic concept and types of reactive power compensation.
- Compute voltage stability margin for voltage stability improvement.

UNIT–I: Introduction to voltage stability: Definitions: Voltage stability, Voltage collapse, Voltage security; Physical relation indicating dependency of voltage on reactive power flow; Factors affecting voltage collapse and in stability; Previous cases of voltage collapse incidences.

UNIT–II: Graphical analysis of voltage stability: 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.

UNIT–III: Analysis of voltage stability: 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.

UNIT–IV: Power system loads: 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, SVCs; OLTCs; Booster Transformers.

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

TEXT BOOKS:

1. T.V. Cutsem and C.Vournas, "Voltage Stability of Electric Power Systems", Kluwer publishers,1998.
2. P. Kundur, "Power System Stability and Control", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1993.
3. Carson W. Taylor, "Power System Voltage Stability", McGraw-Hill Ryerson, Limited, 1994.

REFERENCE BOOKS:

1. R. Ramnujam, "Power System Dynamics Analysis and Simulation", PHI Learning Private Limited, New Delhi, 2009
2. Mir Sayed Shah Danish, "Voltage Stability in Electric Power System: A Practical Introduction", Logos Verlag Berlin Gmbh, 2015.
3. Carson W. Taylor, "Reactive Power Compensation and Voltage Stability: Removing Transmission Limitations", Carson Taylor Seminars, 1989.

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	L	T	P	C
M.Tech. EPS				
I Year -II Semester	**3**	**0**	**0**	**3**

PROGRAM ELECTIVE – 4: AI TECHNIQUES IN ELECTRICAL ENGINEERING

Course Objectives

- The concepts of learning methods.
- Knowledge on the artificial neural networks and their architecture.
- Applications of artificial neural networks.
- The concepts of the fuzzy logic control and their real time applications.
- Design concepts of associative memories.

Course Outcomes

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

- Define the advances in neural networks.
- Evaluate the design and control of fuzzy systems.
- Evaluate the design of various models in neural networks.
- Analyze the techniques of various types of neural networks.
- Design fuzzy logic system.

UNIT – I: Artificial neural networks: Introduction - Models of neural network - Architectures – Knowledge representation – Artificial intelligence and neural networks – Learning process – Error correction learning – Hebbian learning – Competitive learning – Boltzman learning – Supervised learning – Unsupervised learning– Reinforcement learning.

UNIT- II: ANN Paradigms: Multi – layer perceptron using Back propagation algorithm, Self – organizing Map – Radial basis function network – Functional link, network – Hopfield network.

UNIT – III: Fuzzy logic: Introduction – Fuzzy versus crisp – Fuzzy sets - Membership function – Basic fuzzy set operations – Properties of fuzzy sets – Fuzzy cartesion product – Operations on fuzzy relations – Fuzzy logic – Fuzzy quantifiers - Fuzzy inference - Fuzzy rule based system - Defuzzification methods.

UNIT – IV: Genetic Algorithms: 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.

UNIT–V: Applications of AI techniques: 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 BOOKS:

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

REFERENCE BOOKS:

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,” Genetic Algorithms”, Addison Wesley, 1999.

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M.Tech. EPS	**L**	**T**	**P**	**C**
I Year -II Semester	**3**	**0**	**0**	**3**

PROGRAM ELECTIVE – 4: REACTIVE POWER COMPENSATION AND MANAGEMENT

Prerequisite: Reactive Power Compensation and Management

Course Objectives:

- A deep insight in load compensation with respect to their characteristics.
- Analysis of steady state and transient state reactive power compensation in transmission system.
- Knowledge on reactive power coordination.
- Knowledge on demand side and distribution side reactive power management.
- Information on typical layout of traction systems.

Course Outcomes:

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

- Evaluate the design and control of different types of compensation.
- Articulate User side reactive power management.
- Articulate steady state and transient state reactive power compensation.
- Techniques for analyzing of reactive power management.
- Evaluate reactive power control requirements

UNIT-I: Load Compensation: 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.

UNIT-II: Steady **s**tate reactive power compensation in transmission system: 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

UNIT-III: Reactive Power Coordination**:** Objective – Mathematical modeling – Operation planning – Transmission benefits – Basic concepts of quality of power supply – Disturbances- steady – State Variations – Effects of under voltages – Frequency – Harmonics, RF and electromagnetic interferences.

UNIT-IV: Demand side management: 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.

UNIT-V: User side reactive power management: 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.

TEXT BOOKS:

1. T.J.E. Miller, "Reactive Power Control in Electric Power Systems", John Wiley and Sons, 1982.
2. D.M. Tagare, "Reactive Power Management", Tata McGraw Hill, F8irst Reprint, 2007.

REFERENCE BOOKS:

1. Wolf Gang Hofman, "Reactive Power Compensation: A Practical Guide", John Wiley and Sons—1st Edition, 2012.
2. Abhijit Chakrabarthi, "Introduction to Reactive Power Control and Voltage Stability in Power Transmission Scheme" PHI, Eastern Economy, 1st Edition, 2010.

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M.Tech. EPS	**L**	**T**	**P**	**C**
I Year -II Semester	**2**	**0**	**0**	**2**

CORE: RESEARCH METHODOLOGY AND IPR

Course Objectives:

- To identify the research problem.
- To investigate and interpret the solutions to the research problem.
- To know the research ethics.
- To understand patent rights and procedure for grants of patent.

Course Outcomes:

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

- Understand research problem formulation.
- Analyze research related information and follow research ethics.
- Understand that today's world is controlled by Computer, Information technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right (IPR) to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT-I: Meaning of research problem, Sources of research problem, Criteria characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, Data collection, Analysis, Interpretation, Necessary instrumentations

UNIT-II: Effective literature studies, Approaches, Analysis, Plagiarism, and Research ethics. Effective technical writing, How to write report paper, Developing a research proposal, Format of research proposal, Presentation and assessment by a review committee

UNIT-III: Nature of Intellectual Property: Patents, Designs, Trade and copyright. Process of patenting and development: Technological research, Innovation, Patenting, Development. International Scenario: International cooperation on intellectual property. Procedure for grants of patents, Patenting under PCT.

UNIT-IV: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT-V: New Developments in IPR: Administration of patent system. New developments in IPR; IPR of biological systems, Computer software etc. Traditional knowledge, Case Studies, IPR and IITs.

TEXT BOOKS:

1. Stuart Melville and Wayne Goddard, "Research Methodology: An Introduction for Science & Engineering Students'', Juta & Co. Ltd Publishers, Revised Second Edition, 2006.
2. Halbert, "Resisting Intellectual Property", Routledge, Taylor & Francis Ltd, First Edition, 2007.
3. C. R. Kothari, "Research Methodology: Methods and Techniques", New Age International Publications, Revised Second Edition, 2004.

REFERENCE BOOKS:

1. Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners", British Library Publishers, Fourth Edition, 2014.
2. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", Wolters Kluwer Law & Business Publishers, 2016.
3. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand Publications, First Edition, 2008.

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	L	T	P	C
M.Tech. EPS				
I Year -II Semester	**0**	**0**	**4**	**2**

LABORATORY – 3: ELECTRICAL SIMULATION LAB-2

Course Objectives:

- To have the knowledge of optimization techniques used in the power system and Load Frequency Control (LFC).
- To provide a solid foundation in mathematical and engineering fundamentals required to control the governing system in Turbine models.
- To analyze the effects of faults on single machine system connected to infinite bus.
- To simulate the single and three phase converters with RLE loads.

Course Outcomes:

- Express economic operation of power system and importance of LFC control.
- Improve student's ability in solving problems related to Economic Load Dispatch, Load Frequency Control and reactive power control.
- Ability to discuss single area load frequency control and two area load frequency control.
- Ability to model and design turbine and automatic controller.

List of Experiments:

1. Modelling of single area and multi-line Load frequency control in MATLAB SIMULINK.
2. Modelling AVR in MATLAB SIMULINK .
3. Modelling IEEE excitation systems in MATLAB SIMULINK.
4. Study of effect of Faults (LG, LL, LLG, 3 phase) on a single machine connected to infinite Bus.
5. Representation of Sequence Networks.
6. Modelling of Turbine and Governor System
7. Solution of Swing Equation by any one method.
8. Simulation of Single phase full converter using RL and E loads.
9. Simulation of Three phase full converter using RL and E loads.
10. Simulation of Single phase AC Voltage controller using RL load.
11. Simulation of Three phase inverter with PWM controller.

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M.Tech. EPS				
I Year -II Semester	**0**	**0**	**4**	**2**

LABORATORY – 4: POWER SYSTEMS LAB – II

Prerequisites: Power System Analysis, Power System Protection

Course Objectives:

- To understand the Performance of Transformers and Synchronous Machines.
- To select the Transmission Lines, UG Cables, String Insulators, CTs and PTs.
- To analyze the characteristics of OC, UV/OV, negative sequence relays.

Course Outcomes:

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

- Test and evaluate the performance of Power Transformers and Synchronous Machines.
- Test and evaluate the performance of Transmission lines, UG Cables, Insulators and other Auxiliary Power Systems Equipment Test.
- Evaluate/Choose the various types of Relays (Electromagnetic, Static and Microprocessor based relays).

List of Experiments:

1. Determination of Equivalent circuit of a 3-Winding Transformer.
2. Determination of Sequence Impedances of Three Phase Transformer.
3. Characteristics of Over Current Relays i. IDMT Electromagnetic Relay (7051 A). ii. Microprocessor based Relay (7051 B).
4. Characteristics of Percentage biased Differential Relay. i. Electromagnetic Relay (7054 A).
5. Characteristics of Over Voltage Relay. I. Electromagnetic Relay (7053 A). II. Microprocessor based Relay (7053 B).
6. Characteristics of Under Voltage (UV) and Negative sequence Relays i. UV Electromagnetic Relay (7052 A). ii. UV Microprocessor Based Relay (7052 B). iii. Static Negative Sequence Relay (7055 B).
7. Performance and Testing of Transformer Protection System.
8. Performance and Testing of Feeder Protection System.
9. Performance and Testing of Transmission Line Model.
10. Differential protection on Single Phase Transformer.

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M.Tech. EPS				
II Year -I Semester	**3**	**0**	**0**	**3**

PROGRAM ELECTIVE - 5: ELECTRIC VEHICLES

Prerequisite: Power Systems, Electrical Machines and Power Electronics

Objectives: Students will be able to

1. To understand upcoming technology of hybrid system.
2. To understand different aspects of drives application.
3. Learning the electric Traction

Outcomes: Students will be able to

1. Acquire knowledge about fundamental concepts, principles, analysis and design of hybrid and electric vehicles.
2. To learn electric drive in vehicles / traction.

UNIT-I:

History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies, Basics of vehicle performance, vehicle power source characterization Transmission characteristics, Mathematical models to describe vehicle performance

UNIT-II:

Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis.

UNIT-III:

Introduction to electric components used in hybrid and electric Vehicles, Configuration and control of DC Motor drives, Configuration and control of Introduction Motor drives configuration and control of Permanent Magnet Motor drives Configuration and control of Switch Reluctance, Motor drives, drive system efficiency

UNIT-IV:

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics Selecting the energy storage technology, Communications, supporting subsystems

UNIT-V:

Introduction to energy management and their strategies used in hybrid and electric vehicle, Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies

TEXT BOOKS:

1. Sira -Ramirez, R. Silva Ortigoza, “Control Design Techniques in Power Electronics Devices”, Springer.

2. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, “Sliding mode control of switching Power Converters”

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design fundamentals, CRC Press, 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
4. Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

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M.Tech. EPS				
II Year -I Semester	**3**	**0**	**0**	**3**

PROGRAM ELECTIVE - 5: MODERN CONTROL THEORY

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 apply concepts of state variables analysis.
- To study and analyze non-linear systems.
- To gain the knowledge of phase plane methods.
- To analyze the concept of stability of nonlinear systems and categorization.

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.
- Design the real time control systems.
- Understand the concepts of state variables analysis.
- Analyze the concept of stability of nonlinear systems.
- Get the knowledge on phase plane methods.

UNIT–I: State variable analysis: 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. 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.

UNIT-II: State variable analysis & design: 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.

UNIT-III: Non - linear systems: Introduction – Non-linear systems - Types of non linearities – Saturation – Dead-Zone - Backlash – Jump phenomenon etc;– Singular points – Introduction to linearization of non-linear systems, Properties of non-linear systems – Describing function– Describing function analysis of non-linear systems – Stability analysis of non-linear systems through describing functions.

UNIT-IV: Phase plane methods: Introduction to phase-plane analysis, Method of isoclines for constructing trajectories, Singular points, Phase-plane analysis of non-linear control systems.

UNIT-V: 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.

TEXT BOOKS:

1. M.Gopal, "Modern Control System Theory", New Age International, Revised Second Edition, 1993.
2. Ogata Katsuhiko, "Modern Control Engineering", Pearson Education Publication, Fifth Edition, 2010.

REFERENCE BOOKS:

1. Richard C. Dorf, Robert H. Bishop "Modern Control Systems", Prentice Hall Publications, Second Edition, 2001.
2. A. Nagoorkani, "Advanced Control Theory" RBA Publications, Second Edition, 1999.

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M.Tech. EPS	**L**	**T**	**P**	**C**
II Year -I Semester	**3**	**0**	**0**	**3**

PROGRAM ELECTIVE - 5: ADVANCED DIGITAL SIGNAL PROCESSING

Prerequisite: Digital Signal Processing

Course 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

Course Outcomes:

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

- 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.

UNIT–I: Digital filter structures: Block diagram representation – Equivalent structures – FIR and IIR digital filter structures All pass Filters-tenable IIR Digital sine-cosine generator- Computational complexity of digital filter structures.

UNIT–II: 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.

UNIT-III: DSP algorithm implementation: Computation of the discrete Fourier transform - Number representation – Arithmetic operations – Handling of overflow – Tenable digital filters – Function approximation.

UNIT-IV: 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.

UNIT-V: Power spectrum estimation: Estimation of spectra from finite duration observations signals - Nonparametric 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. John G. Proakis, "Digital Signal Processing Principles – Algorithms and Applications", PHI Publications, Third Edition, 2002.
2. Alan V. Oppenheim, Ronald W, Shafer, "Digital Time Signal Processing", PHI Publications, st Edition reprint, 1996.
3. Glenn Zelniker, Fred J. Taylor, "Advanced Digital Signal Processing – Theory and Applications" First Edition, 1994.

REFERENCE BOOKS

1. S Salivahanan. A Vallavaraj C. Gnanapriya, "Digital Signal Processing", Tata Mc Graw Hill Second Edition Reprint, 2001.
2. Sanjit K. Mitra, "Digital Signal Processing", Tata Mc Graw Hill, Fourth Edition, 2010.
3. J.S. Chitode, "Digital Signal Processing", Technical Publications, First Edition, 2008.

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M.Tech. EPS	**L**	**T**	**P**	**C**
II Year -I Semester	**3**	**0**	**0**	**3**

OPEN ELECTIVE - RENEWABLE ENERGY TECHNOLOGIES AND BATTERY STORAGE SYSTEMS

Objectives:

1. To explain the concepts of Non-renewable and renewable energy systems.
2. To outline utilization of renewable energy sources for both domestic and industrial applications.
3. To analyze the environmental and cost economics of renewable energy sources in comparison with fossil fuels.
4. To enable the student to understand the need for energy storage.

Outcomes:

1. An understanding of renewable energy sources.
2. Knowledge of working principle of various energy systems.
3. A capability to carry out basic design of certain renewable energy systems.
4. Analyze the characteristics of energy from various sources and need for storage.

UNIT - I

Fundamentals of Energy: Energy consumption and standard of living, Oil crisis, Classification of energy resources, Consumption trend of primary energy resources, conventional energy sources and their distribution, Energy chain, common forms of energy, importance and salient features of nonconventional energy resources, environmental aspects of energy, Environment-economy-energy and sustainable development, Energy densities of various fuels, World energy status, Energy scenario in India.

UNIT - II

Solar energy: Solar energy basics, Sun-Earth relation spectrum, Terrestrial and extra-terrestrial radiation, spectral energy distribution of solar radiation, Depletion of solar radiation, measurement of solar radiation, solar radiation data, Solar time, Solar radiation geometry, Solar day length, Empirical equations for estimation of solar radiation on horizontal surfaces, Global, diffused and beam radiation, Solar radiation on inclined surface (Problems on energy availability on surfaces)

UNIT - III

Wind Energy: Wind origin, nature, types, Wind data and wind rose, wind speed variation, Wind siting Wind turbine classification and types of rotors, Wind turbine aerodynamics, power extraction from wind, Betz criteria, Axial thrust on the turbine, torque developed by the turbine, Dynamic matching, speed control strategies, Wind turbine operational characteristics, wind energy conversion systems, environmental aspect, Wind energy potential and installation in India (Problems on energy Conversion)

UNIT - IV

Biomass Energy: Biomass resources and their classification**,** Biomass conversion technologies: Thermochemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion – operational parameters of biogas plants, Types of biogas Plants and biogas plant design – Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy program in India (Problems on biogas plant design)

UNIT – V

Electrical Energy Storage Technologies: Characteristics of electricity, Electricity and the roles of EES, High generation cost during peak-demand periods, Need for continuous and flexible supply, Long distance between generation and consumption, Congestion in power grids, Transmission by cable.

TEXT BOOKS:

1. Renewable Energy Sources, Twidell, J.W. and Weir, A., EFN Spon Ltd., 1986.
2. Renewable Energy Engineering and Technology, Kishore VVN, Teri Press, New Delhi, 2012
3. "James M. Eyer, Joseph J. Iannucci and Garth P. Corey ", "Energy Storage Benefits and Market Analysis", Sandia National Laboratories, 2004.

REFERENCE BOOKS:

1. Solar Energy - Principles of thermal collection and storage, S. P. Sukhatme
2. Solar Engineering of Thermal Processes, J. A. Duffie and W. A. Beckman
3. Principles of Solar Engineering, Kreith, F and Kreider, J. F., McGraw-Hill, 1978.
4. Power Plant Technology, J Wakil
5. Non-Conventional Energy Sources, G.D Rai
6. "Jim Eyer, Garth Corey", Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Report, Sandia National Laboratories, Feb 2010.

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M.Tech. EPS	**L**	**T**	**P**	**C**
II Year -I Semester	**3**	**0**	**0**	**3**

OPEN ELECTIVE – POWER PLANT ENGINEERING

Objectives:

- To provide the knowledge on principles of solar radiation & solar energy collection & storage and applications.
- To prepare graduates to express the Knowledge on wind energy, geo-thermal energy, and ocean energy plants.
- To understand the behaviour of different power plants.

Outcomes:

- Analyze different types of steam cycles and it's efficiencies in a steam power plant.
- Describe basic working principles of gas turbine and diesel engine power plants. Define the performance characteristics and components of such power plants.
- List the principal components and types of nuclear reactors.
- List types, principles of operations, components and applications of steam turbines, steam generators, condensers, feed water and circulating water systems.
- Estimate different efficiencies associated with power plant systems.

UNIT I: Thermal power plants: Basic thermodynamic cycles, Various components of steam power plant- Layout- Pulverized coal burners- Fluidized bed combustion - Coal Handling systems - Ash handling systems - Forced draft and induced draft fans- Boilers- Feed pumps- Super heater- Regenerator - Condenser- Dearearators - Cooling tower.

UNIT II: Hydroelectric power plants: Layout- Dams -Selection of water turbines – types - Pumped storage hydel plants

UNIT III: Nuclear power plants: Principles of nuclear energy- Fission reactions - Nuclear reactor- Nuclear power plants

UNIT IV: Gas and diesel power plants: Types, Open and closed cycle gas turbine, Work output & thermal efficiency, Methods to improve performance-reheating, Inter-coolings, Regeneration- Advantage and disadvantages - Diesel engine power plant, Component and layout.

UNIT V: Non-conventional power generation: Solar energy collectors, OTEC, Wind power plants, Tidal power plants and geothermal resources, Fuel cell, MHD power generation - Principle, Thermoelectric power generation, Thermionic power generation.

TEXT BOOKS

1. Arora and Domkundwar, "A Course in Power Plant Engineering" Dhanpat Rai and Co.Pvt. Ltd., New Delhi.
2. P.K. Nag, "Power Plant Engineering", Tata McGraw Hill, Second Edition, Fourth reprint 2003.

REFERENCE BOOKS:

1. Bernhardt G.A. Skrotzki and William A. Vopat, "Power Station Engineering and Economy", Tata McGraw Hill Publishing Company Ltd., New Delhi, 20th reprint 2002.
2. G.D. Rai, "An Introduction to Power Plant Technology", Khanna Publishers, Delhi- 110 005.
3. M.M. El-Wakil, "Power Plant Technology", Tata McGraw Hill, New Delhi, 1984.