ACADEMIC REGULATIONS

COURSE STRUCTURE AND DETAILED SYLLABUS

FOR

M.Tech **(Electrical Power Systems)**

(APPLICABLE FOR THE BATCHES ADMITTED FROM ACADEMIC YEAR 2015-16)

REGULATION: R15

JB INSTITUTE OF ENGINEERING AND TECHNOLOGY

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ACADEMIC REGULATIONS
COURSE STRUCTURE AND DETAILED SYLLABUS
FOR
M.Tech
Electrical Power Systems
FOR M.TECH.TWO YEAR POST GRADUATE COURSE
(APPLICABLE FOR THE BATCHES ADMITED FROM 2015-2016)

REGULATION:R15

J.B.INSTITUTE OF ENGINEERING & TECHNOLOGY
UGC AUTONOMOUS
(Permanently Affiliated to JNTUH,Approved By AICTE,New Delhi and Accredited By NBA,NAAC)

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J.B.INSTITUTE OF ENGINEERING AND TECHNOLOGY
UGC AUTONOMOUS

(BHASKAR NAGAR, MOINABAD MANDAL,R.R.DIST,HYDERABAD-500075,TELANGANA,INDIA)

R 15 - ACADEMICREGULATIONS (CBCS) FORM. Tech. (REGULAR) DEGREE PROGRAMMES

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

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

1. ELIGIBILITY FORADMISSIONS

Admission to the above programme shall be made subject to eligibility, qualification and specialization as prescribed by the University from time to time.

Admissions shall be made on the basis of merit/rank obtained by the candidates at the qualifying Entrance Test conducted by the University or on the basis of any other order of merit as approved by the University, subject to reservations as laid down by the Govt. from time to time.

AWARD OFM. Tech. DEGREE

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

The student shall register forall88 creditsandsecureallthe88credits.

The minimum instruction days in each semester are90.

3.0 COURSESOFSTUDY

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

1. CAD / CAM
2. Computer Science and Engineering
3. Electrical Power Systems
4. Energy Systems
5. Software Engineering
6. Structural Engineering
7. VLSI System Design

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

CIVIL ENGINEERING	STRUCTURAL ENGINEERING
COMPUTER SCIENCE & ENGINEERING	COMPUTER SCIENCE & ENGINEERING SOFTWARE ENGINEERING
ELECTRONICS & COMMUNICATION ENGINEERING	VLSI SYSTEM DESIGN
ELECTRICAL & ELECTRONICS ENGINEERING	ELECTRICAL POWER SYSTEMS ENERGY SYSTEMS
MECHANICAL ENGINEERING	CAD / CAM

4 Course Registration

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

4.2 Academic Section of the College invites 'Registration Forms' from students with in 15 days from the commencement of classwork through 'ON-LINE SUBMISSIONS', ensuring 'DATE and TIME Stamping'. The ON-LINE 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 ON-LINE Registration, ONLY AFTER obtaining the 'WRITTEN APPROVAL' from his Faculty Advisor, which should be submitted to the College Academic Section through the Head of Department (a copy of it being retained with Head of Department, Faculty Advisor and the Student).

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

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

5. ATTENDANCE

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

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

Condonation of shortage of attendance in each subject up to 10% (65% and above and below75%) in each semester shall be granted by the College Academic Committee.

Shortage of Attendance below65% in each subject shall not be condoned.

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

A prescribed fee shall be payable towards condonation of shortage of attendance.

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

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

6 EVALUATION

The performance of the candidate in each semester shall be evaluated subject-wise, with a maximum of 100 marks for theory and 100 marks for practicals, on the basis of Internal Evaluation and End Semester Examination.

6.1 For the theory subjects 75 marks shall be awarded for the performance in the Semester End Examination and 25 marks shall be awarded for Continuous Internal Evaluation (CIE). The Continuous Internal Evaluation shall be made based on the average of the marks secured in the two Mid Term-Examinations conducted, one in the middle of the Semester and the other, immediately after the completion of Semester instructions. Each mid-term examination shall be conducted for a total duration of 120 minutes with Part A as compulsory question (10 marks) consisting of 5 sub-questions carrying 2 marks each, and Part B with 3 questions to be answered out of 5 questions, each question carrying 5 marks. The details of the Question Paper pattern for End Examination (Theory) are given below:

- The Semester End Examination will be conducted for 75 marks. It consists of two parts. i).Part-A for 25 marks, ii). Part-B for 50 marks.

- Part-A is a compulsory question consisting of 5 questions, one from each unit and carries 5 marks each.

- Part-B to be answered 5 questions carrying 10 marks each. There will be two questions from each unit and only one should be answered.

6.2 For practical subjects, 75 marks shall be awarded for performance in the Semester End Examinations and 25 marks shall be awarded for day-to-day performance as Internal Marks.

6.3 For conducting laboratory end examinations of all PG Programmes, one internal examiner and one external examiner are to be appointed by the Principal of the College and the same to be informed to the Director of Evaluation in two weeks before for commencement of the lab end examinations. The external examiner should be selected from outside the College concerned but within the cluster. No external examiner should be appointed from any other College in the same cluster/any other cluster which is run by the same Management.

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

6.5 There shall be a Comprehensive Viva-Voce in II year I Semester. The Comprehensive Viva-Voce is intended to assess the students' understanding of various subjects he has studied during the M. Tech. course of study. The Head of the Department shall be associated with the conduct of the Comprehensive Viva-Voce through a Committee. The Committee consisting of Head of the Department, one senior faculty member and an external examiner. The external examiner shall be appointed by the Director of Evaluation. For this, the Principal of the College shall submit a panel of 3 examiners. There are no internal marks for the Comprehensive Viva-Voce and evaluates for maximum of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful. If he fails to fulfill minimum marks, he has to reappear during the supplementary examinations.

6.6 A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the Semester End Examination and a minimum aggregate of 50% of the total marks in the Semester End Examination and Continuous Internal

Evaluation taken together.

6.7 In case the candidate does not secure the minimum academic requirement in any subject (as specified in 6.6) he has to reappear for the Semester End Examination in that subject.

6.8 A candidate shall be given one chance to re-register for the subjects if the internal marks secured by a candidate is less than 50% and failed in that subject for maximum of two subjects and should register within four weeks of commencement of the class work. In such a case, the candidate must re-register for the subjects and secure the required minimum attendance. The candidate's attendance in the re-registered subject(s) shall be calculated separately to decide upon his eligibility for writing the Semester End Examination in those subjects. In the event of the student taking another chance, his Continuous Internal Evaluation (internal) marks and Semester End Examination marks obtained in the previous attempt stands cancelled.

6.9 In case the candidate secures less than the required attendance in any subject, he shall not be permitted to write the Semester End Examination in that subject. He shall re-register for the subject when next offered.

7. Examinations and Assessment - The Grading System

7.1 Marks will be awarded to indicate the performance of each student in each Theory Subject, or Lab/Practicals, or Seminar, or Project, etc., based on the % marks obtained in CIE + SEE (Continuous Internal Evaluation + Semester End Examination, both taken together) as specified in Item6above, and a corresponding Letter Grade shall be given.

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

% of Marks Secured (Class Intervals)	*Letter Grade (UGC Guidelines)*	*Grade Points*
80% and above (≥80% , ≤ 100%)	O (Outstanding)	10
Below 80% but not less than 70% (≥70% , < 80%)	A^+ (Excellent)	9
Below 70% but not less than 60% (≥60% , < 70%)	A (Very Good)	8
Below 60% but not less than 55% (≥55% , < 60%)	B^+ (Good)	7
Below 55% but not less than 50% (≥ 50% , < 55%)	B (above Average)	6
Below 50% (< 50%)	F (FAIL)	0
Absent	**Ab**	**0**

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

7.4 A student not appeared for examination then 'Ab' Grade will be allocated in any Subject shall be considered 'failed' and will be required to reappear as 'Supplementary

Candidate' in the Semester End Examination (SEE), as and when offered.

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

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

7.7 A student earns Grade Point (GP) in each Subject/ Course, on the basis of the Letter Grade obtained by him in that Subject/ Course. The corresponding 'Credit Points' (CP) 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

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

7.9 The Semester Grade Point Average (SGPA) is calculated by dividing the Sum of Credit Points (□ CP) secured from ALL Subjects/ Courses registered in a Semester, by the Total is the no. of Subjects 'REGISTERED' for the Semester . SGPA is rounded off to **TWO** decimal places. SGPA is thus computed as

$$\textbf{SGPA} = \frac{\left\{\sum_{i=1}^{N} C_i G_i\right\}}{\left\{\sum_{i=1}^{N} C_i\right\}}$$ **……. For each semester.**

Where **'i'** is the subject indicator index (takes into account aii subjects in a semester), 'N' is the number of subjects **'registered'** for the semester (as specially required and listed under the course structure of the department). $\mathbf{G_i}$ is the number of credits allotted to the $\mathbf{i^{th}}$ subject, and $\mathbf{G_i}$ represents the grade points (GP) corresponding to the letter grade awarded for that $\mathbf{i^{th}}$ subject.

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

$$\textbf{CGPA} = \frac{\left\{\sum_{j=1}^{M} C_j G_j\right\}}{\left\{\sum_{j=1}^{N} C_j\right\}}$$ **…….. For all S semester registered**

(i.e., up to and inclusive of S semester, S ≥ 2)

Where **'M'** is the total number of subjects (as specially required and listed under the course structure of the parent department) the student has **'registered'** i.e. from the first semester onwards upto and exclusive of the forth semester, "j" is the subject indicator index (takes in to account all subjects for one to four semester), C_j is the number of credits allotted to the j^{th} subject, G_i represents the grade points(GP) corresponding to the letter grade awarded for the j^{th} subject. After registration and completion of first year first semester, the SGPA of that semester itself may be taken as the CGPA, as there are no cumulative effects.

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

8. EVALUATION OF PROJECT/DISSERTATION WORK

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

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

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

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

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

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

8.6 The work on the project shall be initiated at the beginning of the II year and the duration of the project is two semesters. A candidate is permitted to submit Project Thesis only after successful completion of all theory and practical courses with the approval of PRC not earlier than 40 weeks from the date of registration of the project work. For the approval of PRC the candidate shall submit the draft copy of thesis to the Head of the Department and make an oral presentation before the PRC.

8.7 After approval from the PRC, the soft copy of the thesis should be submitted to the University for ANTI-PLAGIARISM for the quality check and the plagiarism report should be included in the final thesis. If the copied information is less than 24%, then only thesis will be accepted for submission.

8.8 Three copies of the Project Thesis certified by the supervisor shall be submitted to the College/School/Institute.

8.9 For Project work Review I in II Year I Sem. there is an internal marks of 50, the evaluation should be done by the PRC for 25 marks and Supervisor will evaluate for 25 marks. The Supervisor and PRC will examine the Problem Definition, Objectives, Scope of Work, Literature Survey in the same domain. A candidate has to secure a minimum of 50% of marks to be declared successful for Project Work Review I. If he fails to fulfill minimum marks, he has to reappear during the supplementary examination.

8.10 For Project work Review II in II Year II Sem. there is an internal marks of 50, the evaluation should be done by the PRC for 25 marks and Supervisor will evaluate for 25 marks. The PRC will examine the overall progress of the Project Work and decide the Project is eligible for final submission or not. A candidate has to secure a minimum of 50% of marks to be declared successful for Project Work Review II. If he fails to fulfill minimum marks, he has to reappear

during the supplementary examination.

8.11 For Project Evaluation (Viva Voce) in II Year II Sem. there is an external marks of 150 and the same evaluated by the External examiner appointed by the University. The candidate has to secure minimum of 50% marks in Project Evaluation (Viva-Voce) examination.

8.12 If he fails to fulfill as specified in 8.11, he will reappear for the Viva-Voce examination only after three months. In the reappeared examination also, fails to fulfill, he will not be eligible for the award of the degree.

8.13 The thesis shall be adjudicated by one examiner selected by the University. For this, the Principal of the College shall submit a panel of 3 examiners, eminent in that field, with the help of the guide concerned and Head of the Department.

8.14 If the report of the examiner is not favourable, the candidate shall revise and resubmit the Thesis. If the report of the examiner is unfavourable again, the thesis shall be summarily rejected.

8.15 If the report of the examiner is favourable, Project Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the external examiner who adjudicated the Thesis.

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

9. AWARD OFDEGREEAND CLASS

9.1 A Student who registers for all the specified Subjects/ Courses as listed in the Course Sthe entire PG Programme (PGP), and secures the required number of **88** 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 specialization as he admitted.

9.2 **Award of Class**

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

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

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

10. WITHHOLDING OFRESULTS

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

11. TRANSITORY REGULATIONS

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

11.2 The candidate who fails in any subject will be given two chances to pass the same subject; otherwise, he has to identify an equivalent subject as per R15 Academic Regulations.

12 GENERAL

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

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

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

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

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

12.6 The College 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 College.

DISCIPLINARY ACTIO N FOR / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractice/Improper conduct	**Punishment**
	If the student:	
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 student is appearing but has not made use of (material shall include any marks on the body of the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other student orally or by any other body language methods or communicates through cell phones with any student or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in the subject only of all the students 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 student is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the student has already appeared including practical examinations and UG major project and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The hall ticket of the student is to be cancelled and sent to the university.
3.	Impersonates any other student in connection with the examination.	The student who has impersonated shall be expelled from examination hall. The student is also debarred and forfeits the seat. The performance of the original student, who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and UG major project) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The student is also debarred for two consecutive semesters from class work and all university examinations. The continuation of the course by the student is subject to the academic regulations in connection with forfeiture of sea. If the imposter is and 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 our 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 the subject and all the other subjects the student has already appeared including practical examinations and UG major project and shall not be permitted for the remaining examinations of the subjects of that semester year. The student is also debarred for two consecutive semesters from class work and all university examinations. The continuation of the course by the student 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 organizers 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 writer or by signs or by 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 disruptthe 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 student(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The students 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 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 student has already appeared including practical examinations and UG major project and shall not be permitted for the remaining examinations of the subjects of that semester/year. The student is also debarred for two consecutive semesters from class work and all university examinations. The continuation of the course by the student 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 performance in that subject and all other subjects the student has already appeared including practical examinations and UG major project and

		shall not be permitted for the remaining examinations of the subjects of that semester/year. The student is also debarred and forfeiture of seat.
9.	If student of the college, who is not a student 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 the other subjects the student has already appeared including practical examinations and UG major project and shall not be permitted for the remaining examinations of the subjects of that semester/year. The student is also debarred and forfeiture of 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 performance in that subject and all other subjects the student has already appeared including practical examinations and UG major project 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 performance in that subject and all other subjects the student has appeared including practical examinations and UG major project 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 university for further action to award suitable punishment.	

Malpractices identified by squad or special invigilators

1. Punishments tothecandidates aspertheaboveguidelines.
2. Punishment for institutions: (if the squad reports that the college is also involved inencouraging malpractices)
   (i) Ashow causenoticeshall beissuedtothecollege.
   (ii) Imposeasuitablefineonthecollege.
   (iii) Shifting the examination centre from the college to another college for a specificperiodofnotlessthanoneyear.

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M.Tech (Electrical Power Systems)

COURSE STRUCTURE – R15

I Year – I Semester

S.No	Code	Course Title	L	P	C
1	DM21A	**Core Course I**			
		Advanced Power System Analysis	4	--	4
2	DM21B	**Core Course II**			
		Advanced Power System Protection	4	--	4
3	DM21C	**Core Course III**			
		Modern Control Theory	4	--	4
4		**Core Elective-I**			
	DM21D	EHV AC Transmission	4	--	4
	DM21E	High Voltage Engineering			
	DM21F	Advanced Digital Signal Processing			
5		**Core Elective-II**			
	DM21G	Power Quality	4	--	4
	DM21H	Microcontrollers and applications			
	DM21I	Distribution Automation			
6		**Open Elective-I**			
	DM21J	Optimization Techniques	4	--	4
	DM21K	Digital control systems			
	DM21L	Renewable energy systems			
	DM21M	HVDC Transmission			
	DM21N	Analysis of power converters			
	DM21O	Embedded Systems			
7	DM21P	Power Systems Lab-I	----	4	2
	DM21Q	Seminar-I	----	4	2
Total Credits			24	8	28

I Year II Semester

S.No	Code	Course Title	L	P	C
1	DM22A	**Core Course IV**			
		Power System Dynamics	4	--	4
2	DM22B	**Core Course V**			
		Flexible AC Transmission Systems (FACTS)	4	--	4
3	DM22C	**Core Course VI**			
		Power System Operation and Deregulation	4	--	4
4		**Core Elective-III**			
	DM22D	Gas Insulated Systems(GIS)	4	--	4
	DM22E	Programmable Logic Controllers and their applications			
	DM22F	High frequency magnetic components			
5		**Core Elective-IV**			
	DM22G	Reactive Power Compensation and Management	4	--	4
	DM22H	Power System Reliability			
	DM22I	Voltage Stability			
6		**Open Elective-II**			
	DM22J	Instrumentation & Control	4	--	4
	DM22K	Intelligent Control			
	DM22L	Smart grid technologies			
	DM22M	AI Techniques in Electrical Engineering			
	DM22N	Reliability Engineering			
	DM22O	Energy Auditing, Conservation & Management			
7	DM22P	Power Systems Lab-II	----	4	2
8	DM22Q	Seminar-II	----	4	2
Total Credits			24	8	28

II Year I Semester

S.No	Code	Course Title	L	P	C
1	DM23A	Comprehensive Viva - Voce	-	-	4
2	DM23B	Project Work Review - I	-	24	12
Total Credits			-	24	16

II Year II Semester

S.No	Code	Course Title	L	P	C
1	DM24A	Project Work Review-II	-	8	4
2	DM24B	Project Evaluation(Viva Voce)	-	16	12
Total Credits			-	24	16

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M.Tech. Electrical Power Systems	**L**	**T-P-D**	**C**
I Year I Semester	**4**	**0-0-0**	**4**

ADVANCED POWER SYSTEM ANALYSIS (Core Course I)

UNIT – I

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

UNIT – II

Impedance Model and Network Calculations, the BUS Admittance and Impedance Matrices, Thevenin‟s Theorem and ZBUS ,Algorithms for building ZBUS Modification of existing ZBUS, Calculation of ZBUS elements from YBUS, Power Invariant Transformations, Mutually Coupled Branches in ZBUS.

UNIT – III

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

UNIT – IV

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

UNIT – V

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

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ADVANCED POWER SYSTEM PROTECTION (Core Course II)

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 and 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 “, TMH publication New Delhi 1995.
2. T.S.MadhavaRao , “Static relays”, TMH publication, second edition 1989.

REFERENCE BOOKS:

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

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MODERN CONTROL THEORY (Core Course III)

UNIT – I

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

UNIT – II

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

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 nonlinear systems, Properties of Non-Linear systems – Describing function–describing function analysis of nonlinear systems – Stability analysis of Non-Linear systems through describing functions. Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase-plane analysis of nonlinear control systems.

UNIT – IV

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.

UNIT – V

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

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EHV AC TRANSMISSION (Core Elective- I)

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 – un energized lines. Power Frequency Voltage control and over-voltages in EHV lines: No load voltage – charging currents at power frequency-voltage control – shunt and series compensation – static VAR compensation.

UNIT – IV

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

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

REFERENCE BOOKS:

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

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HIGH VOLTAGE ENGINEERING (Core Elective I)

UNIT – I

Introduction To High Volatge 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 breakdown 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 Direct Current voltages, Measurement of High Voltages alternating and impulse, Measurement of High Currents-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. High Voltage Engineering by M.S.Naidu and V. Kamaraju – TMH Publications, 3rd Edition
2. High Voltage Engineering: Fundamentals by E.Kuffel, W.S.Zaengl, J.Kuffel by Elsevier, 2nd Edition.

REFERENCE BOOKS:

1. High Voltage Engineering by C.L.Wadhwa, New Age Internationals (P) Limited, 1997.
2. High Voltage Insulation Engineering by Ravindra Arora, Wolfgang Mosch, New Age International (P) Limited, 1995.
3. High Voltage Engineering, Theory and Practice by Mazen Abdel Salam, Hussein Anis, Ahdan El-Morshedy, RoshdyRadwan , Marcel Dekker

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ADVANCED DIGITAL SIGNAL PROCESSING (Core Elective-I)

UNIT – I

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

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 AlgorithmeImplémentation : Computation of the discrete Fourier transform- Number representation – Arithmetic operations – handling of overflow – Tunable 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- Non-parametric methods for power spectrum Estimation- parametric method for power spectrum Estimation- Estimation of spectral form-Finite duration observation of signals- Non-parametric methods for power spectrum estimation – Walsh methods – Blackman and torchy method.

TEXT BOOKS:

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

REFERENCE BOOKS:

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

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POWER QUALITY (Core Elective II)

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: 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.

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

REFERENCE BOOKS:

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

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MICROCONTROLLERS AND APPLICATIONS (Core Elective II)

UNIT – I

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

UNIT – II

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

UNIT – III

Real Time Control: Interrupts: Interrupt handling structure of an MCU – Interrupt Latency and Interrupt deadline – Multiple sources of the interrupts – Non-maskable interrupt sources – Enabling or disabling of the sources – Polling to determine the interrupt source and assignment of the priorities among them – Interrupt structure in Intel 8051. **Timers:** Programmable Timers in the MCU‟s – Free running counter and real time control – Interrupt interval and density constraints.

UNIT – IV

Systems Design: Digital and Analog Interfacing Methods: Switch, Keypad and Keyboard interfacings – LED and Array of LEDs – Keyboard-cum-Display controller (8279) – Alphanumeric Devices – Display Systems and its interfaces – Printer interfaces – Programmable instruments interface using IEEE 488 Bus – Interfacing with the Flash Memory – Interfaces – Interfacing to High Power Devices – Analog input interfacing – Analog output interfacing – Optical motor shaft encoders – Industrial control – Industrial process control system – Prototype MCU based Measuring instruments – Robotics and Embedded control – Digital Signal Processing and digital filters.

UNIT – V

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

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

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MICROCONTROLLERS AND APPLICATIONS (Core Elective II)

UNIT – I

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TEXT BOOKS:

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

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DISTRIBUTION AUTOMATION (Core Elective II)

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

REFERENCE BOOKS:

1. IEEE Tutorial Course “Distribution Automation”
2. IEEE Working Group on “Distribution Automation”

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OPTIMIZATION TECHNIQUES (Open Elective I)

UNIT – I

Introduction and Classical Optimization Techniques: Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems. **Classical Optimization Techniques:** Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints. Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraints – Kuhn – Tucker conditions.

UNIT – II

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

UNIT – III

Transportation Problem: Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel‟s approximation method – testing for optimality of balanced transportation problems. **Unconstrained Nonlinear Programming:** One – dimensional minimization methods: Classification, Fibonacci method and Quadratic interpolation method

UNIT – IV

V Unconstrained Optimization Techniques: Univariate method, Powell‟s method and steepest descent method. **Constrained Nonlinear Programming:** Characteristics of a constrained problem, Classification, Basic approach of Penalty Function method; Basic approach of Penalty Function method; Basic approaches of Interior and Exterior penalty function methods. Introduction to convex Programming Problem.

UNIT – V .

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

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DIGITAL CONTROL SYSTEMS (Open Elective I)

UNIT – I

Concept & Representation of Discrete time Systems: Block Diagram of typical control system-advantages of sampling in control systems – examples of discrete data and digital systems – data conversion and quantization – sample and hold devices – D/A and A/D conversion – sampling theorem – reconstruction of sampled signals. **Z-transform:** Definition of Z-transforms – mapping between s-plane and z-plane –inverse z- transform – properties of z-transforms - ROC of z-transforms –pulse transfer function –relation between G(s) and G(z) – signal flow graph method applied to digital control systems.

UNIT – II

State Space Analysis: State space modeling of discrete time systems – state transition equation of discrete time invariant systems – solution of time invariant discrete state equations: recursive method and the Z-Transformation method – conversion of pulse transfer function to the state model & vice-versa – Eigen values – Eigen vectors of discrete time system-matrix (A) – Realization of pulse transformation in state space form, discretization of continuous time systems, Computation of state transition matrix and its properties. Response of sample data system between sampling instants.

UNIT – III

Controllability, Observability & Stability Tests: Concept of controllability, stabilizability, observability and reachability - Controllability and observability tests, Transformation of discrete time systems into controllable and observable forms. Stability: Definition of stability – stability tests – The second method of Liapunov.

UNIT – IV

Design of Discrete Time Controllers and Observers: Design of discrete time controller with bilinear transformation – Realizatiion of digital PID controller-Design of deadbeat controller; Pole placement through state feedback.

UNIT – V

State Observers: Design of - Full order and reduced order observers. Study of observer based control design

TEXT BOOKS:

1. K. Ogata , Discrete-Time Control systems, Pearson Education/PHI, 2nd Edition.
2. V. I. George, C. P. Kurian, Digital Control Systems, Cengage Learning.
3. M.Gopal, Digital Control Engineering, New Age Int. Pvt. Ltd., 2014

REFERENCE BOOKS:

1. Kuo, Digital Control Systems, Oxford University Press, 2nd Edition, 2003.
2. M.Gopal , Digital Control and State Variable Methods, TMH.
3. M. Sami Fadali Antonio Visioli, Digital Control Engineering Analysis and Design, Academic Pres

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M.Tech. Electrical Power Systems	**L**	**T-P-D**	**C**
I Year I Semester	**4**	**0-0-0**	**4**

RENEWABLE ENERGY SYSTEMS (Open Elective I)

UNIT – I

Photo voltaic power generation ,spectral distribution of energy in solar radiation, solar cell configurations, voltage developed by solar cell, photo current and load current, practical solar cell performance, commercial photo voltaic systems, test specifications for PV systems, applications of super conducting materials in electrical equipment systems.

UNIT – II

Principles of MHD power generation, ideal MHD generator performance, practical MHD generator, MHD technology.

Wind Energy conversion: Power from wind, properties of air and wind, types of wind Turbines, operating characteristics.

UNIT – III

Tides and tidal power stations, modes of operation, tidal project examples, turbines and generators for tidal power generation.

Wave energy conversion: properties of waves and power content, vertex motion of Waves, device applications. Types of ocean thermal energy conversion systems Application of OTEC systems examples,

UNIT – IV

Miscellaneous energy conversion systems: coal gasification and liquefaction, biomass conversion, geothermal energy, thermo electric energy conversion, principles of EMF generation, description of fuel cells, Co-generation and energy storage, combined cycle co-generation, energy storage.

Global energy position and environmental effects: energy units, global energy position.

UNIT – V

Types of fuel cells, H2-O2 Fuel cells, Application of fuel cells – Batteries, Description of batteries, Battery application for large power. Environmental effects of energy conversion systems, pollution from coal and preventive measures steam stations and pollution, pollution free energy systems.

TEXT BOOKS:

1. “Energy conversion systems” by Rakosh das Begamudre, New age International publishers, New Delhi - 2000.
2. “Renewable Energy Resources” by John Twidell and Tony Weir, 2nd Edition, Fspon& Co.

REFERENCE BOOKS:

1. “Understanding Renewable Energy Systems” by Volker Quaschning, 2005, UK.
2. “Renewable Energy Systems-Advanced Conversion, Technologies & Applications” by Faner Lin Luo Honer Ye, CRC press, Taylor &Francies group.

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HVDC TRANSMISSION (Open Elective I)

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 equidistant 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, Wiely Inter Science – New York
2. KR Padiyar : High Voltage Direct current Transmission WielyEsatern Ltd New Delhi – 1992.

REFERENCE BOOKS:

J. Arillaga HVDC Transmission Peter Peregrinus ltd. London UK 1983
1. E. Uhlman : Power Transmission by Direct Current , Springer Verlag, Berlin Helberg. 1985.
2. S. Rao “EHVAC and HVDC Transmission Engg. Practice” Khanna publishers.

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ANALYSIS OF POWER ELECTRONIC CONVERTERS (Open Elective I)

UNIT – I

Single Phase AC Voltage Controllers: Single phase AC voltage controllers with Resistive, Resistive-inductive and Resistive-inductive-induced e.m.f. loads - ac voltage controllers with PW Control - Effects of source and load inductances - Synchronous tap changers-Applications - numerical problems.

UNIT – II

Three Phase AC Voltage Controllers: Three phase AC voltage controllers - Analysis of controllers with star and delta Connected Resistive, Resistive-inductive loads - Effects of source and load Inductances - applications - numerical problems.

Cycloconverters: Single phase to single phase cycloconverters - analysis of midpoint and bridge Configurations - Three phase to three phase cycloconverters - analysis of Midpoint and bridge configurations - Limitations - Advantages - Applications- numerical problems.

UNIT – III

Single Phase Converters: Single phase converters - Half controlled and Fully controlled converters -Evaluation of input power factor and harmonic factor - continuous and Discontinuous load current - single phase dual converters - power factor Improvements - Extinction angle control - symmetrical angle control - PWM -single phase sinusoidal PWM - single phase series converters - Applications -Numerical problems.

Three Phase Converters: Three phase converters - Half controlled and fully controlled converters - Evaluation of input power factor and harmonic factor - continuous and Discontinuous load current - three phase dual converters - power factor Improvements - three phase PWM - twelve pulse converters - applications -Numerical problems.

UNIT – IV

D.C. to D.C. Converters: Analysis of step-down and step-up dc to dc converters with resistive and Resistive-inductive loads - Switched mode regulators - Analysis of Buck Regulators - Boost regulators - buck and boost regulators - Cuk regulators - Condition for continuous inductor current and capacitor voltage - comparison of regulators -Multiouput boost converters - advantages - applications - Numerical problems.

UNIT – V .

Pulse Width Modulated Inverters(single phase): Principle of operation - performance parameters - single phase bridge inverter -evaluation of output voltage and current with resistive, inductive and Capacitive loads - Voltage control of single phase inverters - single PWM - Multiple PWM - sinusoidal PWM - modified PWM - phase displacement Control - Advanced modulation techniques for improved performance - Trapezoidal, staircase, stepped, harmonic injection and delta modulation - Advantage - application - numerical problems.

Pulse Width Modulated Inverters(three phase): Three phase inverters - analysis of 180 degree condition for output voltage And current with resistive, inductive loads - analysis of 120 degree Conduction - voltage control of three phase inverters - sinusoidal PWM - Third Harmonic PWM – 60 degree PWM - space vector modulation - Comparison of PWM techniques - harmonic reductions - Current Source Inverter - variable d.c. link inverter - boost inverter - buck and boost inverter - inverter circuit design - advantages -applications - numerical problems.

TEXT BOOKS:

1. Power Electronics - Mohammed H. Rashid - Pearson Education -Third Edition - First Indian reprint 2004. *2.* Power Electronics - Ned Mohan, Tore M. Undeland and William P. Robbins – John Wiley and Sons - Second Edition

REFERENCE BOOKS:

1. Power Electronics Daniel W. Hart
2. Fundamentals of Power Electronis, 2nd Edition. R.W. Erickson
3. The power electronics Hand Book Timothy, L. Skvarenina, Purdue University

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M.Tech. Electrical Power Systems	**L**	**T-P-D**	**C**
I Year I Semester	**4**	**0-0-0**	**4**

EMBEDDED SYSTEMS (Open Elective I)

UNIT – I

Overview of Embedded System: Embedded System, types of Embedded System, Requirements of Embedded System, and Issues in Embedded software development, Applications.

UNIT – II

Processor & Memory Organization: Structural units in a processor, Processor selection, Memory devices, Memory selection, Memory Allocation & Map, Interfacing.

UNIT – III

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

UNIT – IV

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

UNIT – V

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

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M.Tech. Electrical Power Systems	**L**	**T-P-D**	**C**
I Year I Semester	**0**	**0-4-0**	**2**

POWER SYSTEM LAB – I

1. Develop Program for YBUS formation.
2. Develop Program for G-S Load Flow Analysis.
3. Develop Program for N-R Load Flow Analysis.
4. Develop Program for FDLF Load Flow Analysis.
5. Develop Program for Short Circuit Analysis.
6. Develop Program for Transient Stability Analysis for Single Machine connected to Infinite Bus by Point by Point Method.
7. Develop Program for Generation System Reliability Analysis.
8. Develop Program for Distribution System Reliability Analysis.
9. Develop Simulation of RLC Circuit
10. Develop Simulation of Single Phase Full Converter with RLE Load
11. Develop Program model for Closed Loop Speed Control of Separately Excited D.C Motor.
12. Develop Program model for Sinusoidal Pulse Width Modulation.

Note: From the above list minimum 10 experiments are to be conducted using suitable software.

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I Year II Semester	**4**	**0-0-0**	**4**

POWER SYSTEM DYNAMICS

UNIT – I

Basic Concepts

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

UNIT – II

Modeling of Synchronous Machine:

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

UNIT – III

Excitation System

Excitation system modeling-excitation systems block Diagram - system representation by state equations- Dynamics of a synchronous generator connected to infinite bus - system model Synchronous machine model-stator equations rotor equations - Synchronous machine model with
field circuit - one equivalent damper winding on q axis (model 1.1) - calculation of Initial conditions.

UNIT – IV

Analysis of Single Machine System

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

UNIT – V .

Application of Power System Stabilizers

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

TEXT BOOKS:

1. K.R. PADIYAR," Power system dynamics "- B.S. Publications.
2. P.M. Anderson and A.A. Fouad, "Power system control and stability",IEEE Press

REFERENCE BOOKS:

1. R. Ramanujam, "Power Systems Dynamics"- PHI Publications.

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FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS)

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 from 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. Hingorani H G and Gyugyi. L " Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems" New York, IEEE Press, 2000.

2. Padiyar.K.R, " FACTS Controllers in Power Transmission and Distribution" New Age Int. Publishers, 2007

REFERENCE BOOKS:

1. Zhang, Xiao-Ping, Rehtanz, Christian, Pal, Bikash "Flexible AC Transmission Systems: Modeling and Control", Springer, 2012

2. Yong-Hua Song, Allan Johns, "Flexible AC Transmission Systems", IET,1999

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POWER SYSTEM OPERATION AND DEREGULATION

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 decompositiondetection
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 systemtransmission
pricing methods-Incremental cost based transmission pricing.

TEXT BOOKS:

1. A.J.Wood&B.F.Woollenberg- John Wiley Power Generation, "Operation and Control"-2nd edition.
2. P.Venkatesh. B.V.Manikandan, S.Charles Raja- A.Srinivasan, "Electrical power systems: Analysis, security, Deregulation"– PHI 2012

REFERENCE BOOKS:

1. Bhattacharya, Kankar, Bollen, Math, Daalder, Jaap E. "Operation of Restructured Power System", 2001, Springer.

2. Venkatesh P. , Manikandan B. V., Raja S. Charles , Srinivasan A. Electrical Power Systems: Analysis, Security And Deregulation, Phi Learning Pvt Ltd

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I Year II Semester	**4**	**0-0-0**	**4**

GAS INSULATED SYSTEMS (GIS)
(Core Elective–III)

UNIT – I

Introduction to GIS and Properties Of Sf6

Characteristics of GIS- Introduction to SF6 - Physical properties-Chemical properties - Electrical properties-Specification of SF6 gas for GIS application - Handling of SF6 gas before use - Safe handling of Sf6 gas in electrical equipment - Equipment for handling the SF6 Gas - SF6 and environment.

UNIT – II

Layout of GIS Stations

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

UNIT – III

Design and Construction of GIS Station

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

UNIT – IV

Fast Transient Phenomena in GIS

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

UNIT – V

Special Problems in GIS and GIS Diagnostics

Introduction - particles their effects and their control- Insulating Spacers and their Reliability - SF6 Gas Decomposition - Characteristics of imperfections in insulation - Insulation Diagnostic methods - PD Measurement and UHF Method.

TEXT BOOKS:

1. M. S. Naidu," Gas Insulated Substations"- IK International Publishing House.
2. Hermann J. Koch, "Gas Insulated Substations", June 2014, Wiley-IEEE Press

REFERENCE BOOKS:

1. Olivier Gallot-Lavellee, "Dielectric materials and Electrostatics" , Wiley-IEEE Press
2. Jaun Martinez, "Dielectric Materials for Electrical Engineering", Wiley-IEEE Press

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M.Tech. Electrical Power Systems	**L**	**T-P-D**	**C**
I Year II Semester	**4**	**0-0-0**	**4**

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

UNIT – I

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

UNIT – II

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

UNIT – III

PLC Registers: Characteristics of Registers module addressing holding registers input registers, output registers. PLC Functions Timer functions and industrial applications counters counter function
industrial applications, Architecture functions, Number comparison functions, number conversion
functions.

UNIT – IV

Data handling functions: SKIP, Master control Relay Jump Move FIFO, FAL, ONS, CLR and Sweep
functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and
applications, controlling of two axes and three axis Robots with PLC, Matrix functions.

UNIT – V

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

TEXT BOOKS:

1) Programmable Logic Controllers – Principle and Applications by John W. Webb & Ronald A.
Reiss, Fifth Edition, PHI
2)Digital Design by Morris Mano, PHI, 3rd Edition 2006.

REFERENCE BOOKS:

1. Programmable logic Controllers, Frank D. Petruzella, 4th Edition, McGraw Hill Publishers.
2. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth & F.D
Hackworth Jr. – Pearson, 2004.
3. Programmable logic controllers and their Engineering Applications, 2nd Edition, Alan J. Crispin.

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HIGH FREQUENCY MAGNETIC COMPONENTS
(Core Elective –III)

UNIT – I

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

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

UNIT – II

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

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

UNIT – III

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

Design of Transformers: Introduction, Area Product Method, Optimum Flux Density, Transformer
Design for Fly-back Converter in CCM, Transformer Design for Fly-back Converter in DCM, Transformer Design for Fly-back Converter in CCM, Transformer Design for Fly-back Converter in
DCM.

UNIT – IV

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

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

UNIT – V

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

TEXT BOOKS:

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

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I Year II Semester	**4**	**0-0-0**	**4**

REACTIVE POWER COMPENSATION AND MANAGEMENT
(Core Elective –IV)

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 – State 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, radio frequency 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. Reactive power control in Electric power systems by T.J.E.Miller, John Wiley and sons, 1982.
2. Reactive power Management by D.M.Tagare,Tata McGraw Hill,2004.

REFERENCE BOOKS:

1. Wolfgang Hofmann, JurgenSchlabbach, Wolfgang Just "Reactive Power Compensation: A Practical Guide, April, 2012, Wiely publication.

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I Year II Semester **4** **0-0-0** **4**

POWER SYSTEM RELIABILITY
(Core Elective–IV)

UNIT – I

Generating System Reliability Analysis – I: Generation system model – capacity outage probability tables – Recursive relation for capacitive model building – sequential addition method – unit removal – Evaluation of loss of load and energy indices – Examples.

UNIT – II

Generating System Reliability Analysis – II: Frequency and Duration methods – Evaluation of equivalent transitional rates of identical and non-identical units – Evaluation of cumulative probability and cumulative frequency of non-identical generating units – 2- level daily load representation - merging generation and load models – Examples.

UNIT – III

Operating Reserve Evaluation: Basic concepts - risk indices – PJM methods – security function approach – rapid start and hot reserve units – Modelling using STPM approach.

Bulk Power System Reliability Evaluation: Basic configuration – conditional probability approach – system and load point reliability indices – weather effects on transmission lines – Weighted average rate and Markov model – Common mode failures.

UNIT – IV

Inter Connected System Reliability Analysis: Probability array method – Two inter connected systems with independent loads – effects of limited and unlimited tie capacity - imperfect tie – Two connected Systems with correlated loads – Expression for cumulative probability and cumulative frequency.

Distribution System Reliability Analysis – I (Radial configuration): Basic Techniques – Radial networks –Evaluation of Basic reliability indices, performance indices – load point and system reliability indices – customer oriented, loss and energy oriented indices – Examples.

UNIT – V

Distribution System Reliability Analysis - II (Parallel Configuration): Basic techniques – inclusion of bus bar failures, scheduled maintenance – temporary and transient failures – weather effects – common mode failures –Evaluation of various indices – Examples

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

TEXT BOOKS:

1. Reliability Evaluation of Power systems by R. Billinton, R.N.Allan, BS Publications, 2007.
2. Reliability Modeling in Electric Power Systems by J. Endrenyi, John Wiley and Sons, 1978

REFERENCE BOOKS:

1. Reliability Engineering: Theory and Practice by Alessandro Birolini, Springer Publications.
2. An Introduction to Reliability and Maintainability Engineering by Charles Ebeling, TMH Publications.
3. Reliability Engineering by E. Balaguruswamy, TMH Publications.
4. Reliability Engineering by Elsayed A. Elsayed, Prentice Hall Publications.

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M.Tech. Electrical Power Systems **L** **T-P-D** **C**

I Year II Semester **4** **0-0-0** **4**

VOLTAGE STABILITY
(Core Elective–IV)

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 instability;

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, SVC s; OLTC s; 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. "Performance, operation and control of EHV power transmission system"- A.CHAKRABARTHY,
D.P.KOTARI and A.K.MUKOPADYAY, A.H.Wheeler Publishing, I Edition, 1995.
2. "Power System Dynamics: Stability and Control" – K.R.PADIYAR, II Edition, B.S.Publications.

REFERENCE BOOKS:

1. "Power System Voltage Stability"- C.W.TAYLOR, Mc Graw Hill, 1994.

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I Year II Semester **4** **0-0-0** **4**

INSTRUMENTATION AND CONTROL
(Open Elective – II)

UNIT – I

Instrumentation: Introduction to mechanical systems and their structure and function, Performance
Characteristics – Static and Dynamic, Fundamentals of signals acquisition, conditioning and processing,

UNIT – II

Measurement of temperature, pressure, flow, position, velocity, acceleration, force, torque etc.

UNIT – III

Control: Introduction to control systems, mathematical model of physical systems in transfer function
and state space forms, response of dynamic systems, concept of pole & zero of a system,

UNIT – IV

Realization of transfer functions, stability analysis. Introduction of discrete time system. Controllers: P,
PI, PD, PID, Feed forward etc., tuning of controller parameters, disturbance rejection, implementation
of controller using digital computer.

UNIT – V

Control components: Actuator (ac & dc servomotors, valve), AC, DC tacho-generators, servo amplifier.

TEXT BOOKS:

1. Jhon P Bently, "Principles of Measurement Systems" 3rd. Edition, Pearson
2. AlokBarua, "Fundamentals of Industrial Instrumentation' Wiely India, 2011
3. William Bolton, "Instrumentation and Control Systems"Elsevier, 2015

REFERENCE BOOKS:

1.William Bolton, "Industrial Control and Instrumentation" University Press, 1991
2.Norman A Anderson," Instrumentation for Process Measurement and Control" CRC, 1997
3.A. K, Ghosh, " Introduction to Instrumentation and Control" Prentice Hall of India, 2005

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INTELLIGENT CONTROL
(Open Elective-II)

UNIT – I

Introduction and motivation. Approaches to intelligent control. Architecture for intelligent control.

Symbolic reasoning system, rule-based systems, the AI approach. Knowledge representation. Expert systems.

UNIT – II

Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feedforward Multilayer Perceptron. Learning and Training the neural network. Data Processing: Scaling, Fourier transformation, principal-component analysis.

UNIT – III

Networks: Hopfield network, Self-organizing network and Recurrent network. Neural Network based controller Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox. Stability analysis of Neural-Network interconnection systems.

UNIT – IV

Genetic Algorithm: Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems.

UNIT – V

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Fuzzy logic control for nonlinear time-delay system. Implementation of fuzzy logic controller using Matlabfuzzylogic toolbox. Stability analysis of fuzzy control systems.

TEXT BOOKS:

1. Simon Haykins, Neural Networks: A comprehensive Foundation, Pearson Edition, 2003.
2. T.J.Ross, Fuzzy logic with Fuzzy Applications, Mc Graw Hill Inc, 1997.
3. David E Goldberg, Genetic Algorithms.
4. John Yen and Reza Langari, Fuzzy logic Intelligence, Control, and Information, Pearson Education, Indian Edition, 2003.

REFERENCE BOOKS:

1. M.T.Hagan, H. B. Demuth and M. Beale, Neural Network Design, Indian reprint, 2008.
2. Fredric M.Ham and Ivica Kostanic, Principles of Neurocomputing for science and Engineering, McGraw Hill, 2001.
3. N.K. Bose and P.Liang, Neural Network Fundamentals with Graphs, Algorithms and Applications, Mc - Graw Hill, Inc. 1996.
4. Yung C. Shin and Chengying Xu, Intelligent System - Modeling, Optimization and Control, CRC Press, 2009.
5. N.K.Sinha and Madan M Gupta, Soft computing & Intelligent Systems - Theory & Applications, Indian Edition, Elsevier, 2007.

6. WitoldPedrycz, Fuzzy Control and Fuzzy Systms, Overseas Press, Indian Edition, 2008.

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SMART GRID TECHNOLOGIES
(Open Elective–II)

UNIT – I

Introduction: 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 neighborhood-Potential future work and research.

Intelligrid Architecture for the Smartgrid: 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 Efficiencyand Demand Side Response”-

CRC Press, 2009.
2. Jean Claude Sabonnadière, NouredineHadjsaïd, “Smart Grids”, Wiley-ISTE, IEEE Press,May
2012

REFERENCE BOOKS:

1. JanakaEkanayake, KithsiriLiyanage,Jianzhong.Wu, Akihiko Yokoyama, Nick Jenkins, “Smart
Grid: Technology and Applications”- Wiley, 2012.
2. James Momoh, “Smart Grid :Fundamentals of Design and Analysis”-Wiley, IEEE Press, 2012.

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AI TECHNIQUES IN ELECTRICAL ENGINEERING
(Open Elective-II)

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- learning tasks.

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,VanNostrandReinhold,"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,"Fuzzysets,Uncertainty and Information"-PHI, Pvt.Ltd,1994.
4. D.E.Goldberg," Genetic Algorithms"- Addison Wesley 1999.

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I Year II Semester	**4**	**0-0-0**	**4**

RELIABILITY ENGINEERING
(Open Elective –II)

UNIT – I

Rules for combining probabilities of events, Definition of Reliability. Significance of the terms

appearing in the definition. Probability distributions: Random variables, probability density and distribution functions. Mathematical expectation, Binominal distribution, Poisson distribution, normal
distribution, weibull distribution.

UNIT – II

Hazard rate, derivation of the reliability function in terms of the hazard rate. Failures: Causes of failures, types of failures (early failures, chance failures and wear-out failures). Bath tub curve. Preventive and corrective maintenance. Modes of failure. Measures of reliability: mean time to failure
and mean time between failures.

UNIT – III

Classification of engineering systems: series, parallel and series-parallel systems- Expressions for
the reliability of the basic configurations.
Reliability evaluation of Non-series-parallel configurations: Decomposition, Path based and cutest
based methods, Deduction of the Paths and cutsets from Event tree.

UNIT – IV

Discrete Markov Chains: General modelling concepts, stochastic transitional probability matrix, time
dependent probability evaluation and limiting state probability evaluation of one component repairable
model. Absorbing states.
Continuous Markov Processes: Modelling concepts, State space diagrams, Stochastic Transitional
Probability Matrix, Evaluating time dependent and limiting state Probabilities of one component
repairable model. Evaluation of Limiting state probabilities of two component repairable model.

UNIT – V

Approximate system Reliability analysis of Series systems, parallel systems with two and more than
two components, Network reduction techniques. Minimal cutest/failure mode approach.

TEXT BOOKS:

1. “Reliability evaluation of Engineering systems”, Roy Billinton and Ronald N Allan, BS Publications.
2. “Reliability Engineering”, Elsayed A. Elsayed, Prentice Hall Publications.

REFERENCE BOOKS:

1. “Reliability Engineering: Theory and Practice”, By Alessandro Birolini, Springer Publications.
2. “An Introduction to Reliability and Maintainability Engineering”, Charles Ebeling, TMH Publications.
3. “Reliability Engineering”, E. Balaguruswamy, TMH Publications.

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ENERGY AUDITING, CONSERVATION AND MANAGEMENT
(Open Elective –II)

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. Energy management by W.R. Murphy AND G. Mckay Butter worth, Heinemann publications.
2. Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998

REFERENCE BOOKS:

1. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd-2nd edition, 1995-
2. Energy management hand book by W.C.Turner, John wiley and sons

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M.Tech. Electrical Power Systems	**L**	**T-P-D**	**C**
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POWER SYSTEM LAB – II

1. Determination of Equivalent circuit of a 3-Winding Transformer.
2. Determination of Sequence Impedances of a Cylindrical Rotor Synchronous Machine.
3. Fault Analysis:
i. Single Line to Ground fault (L-G).
ii. Line to Line fault (L-L).
iii. Double Line to Ground fault (L-L-G).
iv. Triple Line to Ground fault (L-L-L-G).
4. Determination of Sub-transient reactance's of a Salient Pole Synchronous Machine.
5. Determination of Sequence Impedances of Three Phase Transformer
6. Characteristics of Over Current Relays
i. IDMT Electromagnetic Relay (7051 A).
ii. Microprocessor based Relay (7051 B)
7. Characteristics of Percentage biased Differential Relay.
i. Electromagnetic Relay (7054 A).
ii. Static Relay (7054 B).
8. Characteristics of Over Voltage Relay.
i. Electromagnetic Relay (7053 A).
ii. Microprocessor based Relay (7053 B).
9. 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).
10. Performance and Testing of Generator Protection System.
11. Performance and Testing of Transformer Protection System.
12. Performance and Testing of Feeder Protection System.
13. Performance and Testing of Transmission Line Model.
14. Differential protection on Single Phase Transformer.
Note: From the above list minimum 10 experiments are to be conducted