# ACADEMIC REGULATIONS
# COURSE STRUCTURE
# AND
# DETAILED SYLLABUS

**For**
**M.Tech: EEE**

**Common Specializations:**

| |
|---|
| I. POWER SYSTEMS |
| II. POWER SYSTEM CONTROL AND AUTOMATION |
| III. POWER SYSTEM ENGINEERING |
| IV. POWER SYSTEM AND CONTROL |
| V. ADVANCED POWER SYSTEMS |
| VI. ELECTRICAL POWER ENGINEERING |
| VII. POWER ENGINEERING & ENERGY SYSTEMS |

JAWAHARLAL NEHRU TECHNOLOGY UNIVERSITY KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India

## ACADEMIC REGULATIONS R13 FOR M. Tech (REGULAR) DEGREE COURSE

Applicable for the students of M. Tech (Regular) Course from the Academic Year 2013-14 onwards

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

### 1.0 ELIGIBILITY FOR ADMISSIONS

Admission to the above program 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.

### 2.0 AWARD OF M. Tech DEGREE

2.1 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.

2.2 The student shall register for all 80 credits and secure all the 80 credits.

2.3 The minimum instruction days in each semester are 90.

### 3.0 A. COURSES OF STUDY

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

1. M.Tech- Structural Engineering
2. M.Tech- Transportation Engineering
3. M.Tech- Infrastructure Engineering & Management
4. ME- Soil Mechanics and Foundation Engineering
5. M.Tech- Environmental Engineering
6. M.Tech-Geo-Informatics
7. M.Tech-Spatial Information Technology

8. M.Tech- Civil Engineering
9. M.Tech -Geo-Technical Engineering
10. M.Tech- Remote Sensing
11. M.Tech- Power Electronics
12. M.Tech- Power & Industrial Drives
13. M.Tech- Power Electronics & Electrical Drives
14. M.Tech- Power System Control & Automation
15. M.Tech- Power Electronics & Drives
16. M.Tech- Power Systems
17. M.Tech- Power Systems Engineering
18. M.Tech- High Voltage Engineering
19. M.Tech- Power Electronics and Power Systems
20. M.Tech- Power System and Control
21. M.Tech- Power Electronics & Systems
22. M.Tech- Electrical Machines and Drives
23. M.Tech- Advanced Power Systems
24. M.Tech- Power Systems with Emphasis on High Voltage Engineering
25. M.Tech- Control Engineering
26. M.Tech- Control Systems
27. M.Tech- Electrical Power Engineering
28. M.Tech- Power Engineering & Energy System
29. M.Tech- Thermal Engineering
30. M.Tech- CAD/CAM
31. M.Tech- Machine Design
32. M.Tech- Computer Aided Design and Manufacture
33. M.Tech- Advanced Manufacturing Systems
34. M.Tech-Computer Aided Analysis & Design
35. M.Tech- Mechanical Engineering Design
36. M.Tech- Systems and Signal Processing
37. M.Tech- Digital Electronics and Communication Systems
38. M.Tech- Electronics & Communications Engineering
39. M.Tech- Communication Systems
40. M.Tech- Communication Engineering & Signal Processing
41. M.Tech- Microwave and Communication Engineering
42. M.Tech- Embedded Systems

43. M.Tech- Digital Systems & Computer Electronics
44. M.Tech- Embedded System
45. M.Tech- VLSI
46. M.Tech- VLSI Design
47. M.Tech- VLSI System Design
48. M.Tech- Embedded System & VLSI Design
49. M.Tech- VLSI & Embedded System
50. M.Tech- VLSI Design & Embedded Systems
51. M.Tech- Image Processing
52. M.Tech- Digital Image Processing
53. M.Tech- Computers & Communication
54. M.Tech- Computers & Communication Engineering
55. M.Tech- Instrumentation & Control Systems
56. M.Tech – VLSI & Micro Electronics
57. M.Tech – Digital Electronics & Communication Engineering
58. M.Tech- Embedded System & VLSI
59. M.Tech- Computer Science & Engineering
60. M.Tech- Computer Science
61. M.Tech- Computer Science & Technology
62. M.Tech- Computer Networks
63. M.Tech- Computer Networks & Information Security
64. M.Tech- Information Technology
65. M.Tech- Software Engineering
66. M.Tech- Neural Networks
67. M.Tech- Chemical Engineering
68. M.Tech- Biotechnology
69. M.Tech- Nano Technology
70. M.Tech- Food Processing
71. M.Tech- Avionics

and any other course as approved by AICTE/ University from time to time.

**3.0 B. Departments offering M. Tech Programmes with specializations are noted below:**

| | |
|---|---|
| **Civil Engg.** | 1. M.Tech- Structural Engineering<br>2. M.Tech- Transportation Engineering<br>3. M.Tech- Infrastructure Engineering & Management<br>4. ME- Soil Mechanics and Foundation Engineering<br>5. M.Tech- Environmental Engineering<br>6. M.Tech-Geo-Informatics<br>7. M.Tech-Spatial Information Technology<br>8. M.Tech- Civil Engineering<br>9. M.Tech -Geo-Technical Engineering<br>10. M.Tech- Remote Sensing |
| **EEE** | 1. M.Tech- Power Electronics<br>2. M.Tech- Power & Industrial Drives<br>3. M.Tech- Power Electronics & Electrical Drives<br>4. M.Tech- Power System Control & Automation<br>5. M.Tech- Power Electronics & Drives<br>6. M.Tech- Power Systems<br>7. M.Tech- Power Systems Engineering<br>8. M.Tech- High Voltage Engineering<br>9. M.Tech- Power Electronics and Power Systems<br>10. M.Tech- Power System and Control<br>11. M.Tech- Power Electronics & Systems<br>12. M.Tech- Electrical Machines and Drives<br>13. M.Tech- Advanced Power Systems<br>14. M.Tech- Power Systems with Emphasis on High Voltage Engineering<br>15. M.Tech- Control Engineering<br>16. M.Tech- Control Systems<br>17. M.Tech- Electrical Power Engineering<br>18. M.Tech- Power Engineering & Energy System |
| **ME** | 1. M.Tech- Thermal Engineering<br>2. M.Tech- CAD/CAM<br>3. M.Tech- Machine Design<br>4. M.Tech- Computer Aided Design and Manufacture<br>5. M.Tech- Advanced Manufacturing Systems<br>6. M.Tech-Computer Aided Analysis & Design<br>7. M.Tech- Mechanical Engineering Design |

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|---|---|
| **ECE** | 1. M.Tech- Systems and Signal Processing<br>2. M.Tech- Digital Electronics and Communication Systems<br>3. M.Tech- Electronics & Communications Engineering<br>4. M.Tech- Communication Systems<br>5. M.Tech- Communication Engineering & Signal Processing<br>6. M.Tech- Microwave and Communication Engineering<br>7. M.Tech- Telematics<br>8. M.Tech- Digital Systems & Computer Electronics<br>9. M.Tech- Embedded System<br>10. M.Tech- VLSI<br>11. M.Tech- VLSI Design<br>12. M.Tech- VLSI System Design<br>13. M.Tech- Embedded System & VLSI Design<br>14. M.Tech- VLSI & Embedded System<br>15. M.Tech- VLSI Design & Embedded Systems<br>16. M.Tech- Image Processing<br>17. M.Tech- Digital Image Processing<br>18. M.Tech- Computers & Communication<br>19. M.Tech- Computers & Communication Engineering<br>20. M.Tech- Instrumentation & Control Systems<br>21. M.Tech – VLSI & Micro Electronics<br>22. M.Tech – Digital Electronics & Communication Engineering<br>23. M.Tech- Embedded System & VLSI |
| **CSE** | 1. M.Tech- Computer Science & Engineering<br>2. M.Tech- Computer Science<br>3. M.Tech- Computer Science & Technology<br>4. M.Tech- Computer Networks<br>5. M.Tech- Computer Networks & Information Security<br>6. M.Tech- Information Technology<br>7. M.Tech- Software Engineering<br>8. M.Tech- Neural Networks |
| **Others** | 1. M.Tech- Chemical Engineering<br>2. M.Tech- Biotechnology<br>3. M.Tech- Nano Technology<br>4. M.Tech- Food Processing<br>5. M.Tech- Robotics |

**4.0 ATTENDANCE**

4.1 A student shall be eligible to write University examinations if he acquires a minimum of 75% of attendance in aggregate of all the subjects.

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

4.3 Shortage of Attendance below 65% in aggregate shall not be condoned.

4.4 Students whose shortage of attendance is not condoned in any semester are not eligible to write their end semester examination of that class.

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

4.6 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 into the same class.

**5.0 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.

5.1 For the theory subjects 60 marks shall be awarded based on the performance in the End Semester Examination and 40 marks shall be awarded based on the Internal Evaluation. The 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 instruction. Each mid term examination shall be conducted for a total duration of 120 minutes with 4 questions (without choice) each question for 10 marks. End semester examination is conducted for 60 marks for a duration of 3 hours answered out of 8 questions.

5.2 For practical subjects, 60 marks shall be awarded based on the performance in the End Semester Examinations and 40 marks shall be awarded based on the day-to-day performance as Internal Marks.

5.3 There shall be two seminar presentations during III semester and IV 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 Project Review 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 50 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

5.4 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 End semester Examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Evaluation taken together.

5.5 In case the candidate does not secure the minimum academic requirement in any subject (as specified in 5.4) he has to reappear for the End semester Examination in that subject. A candidate shall be given one chance to re-register for each subject provided the internal marks secured by a candidate are less than 50% and has failed in the end examination. In such a case, the candidate must re-register for the subject(s) 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 end examination in those subject(s). In the event of the student taking another chance, his internal marks and end examination marks obtained in the previous attempt stand cancelled. For re-registration the candidates have to apply to the University through the college by paying the requisite fees and get approval from the University before the start of the semester in which re-registration is required.

5.6 In case the candidate secures less than the required attendance in any re registered subject (s), he shall not be permitted to write the End Examination in that subject. He shall again re-register the subject when next offered.

5.7 Laboratory examination for M. Tech. courses must be conducted with two Examiners, one of them being the Laboratory Class Teacher or teacher of the respective college and the second examiner shall be appointed by the university from the panel of examiners submitted by the respective college.

**6.0 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.

6.1 A Project Review Committee (PRC) shall be constituted with Head of the Department and two other senior faculty members.

6.2 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.

6.3 After satisfying 6.2, a candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work for approval. The student can initiate the Project work, only after obtaining the approval from the Project Review Committee (PRC).

6.4 If a candidate wishes to change his supervisor or topic of the project, he can do so with the approval of the Project Review Committee (PRC). However, the Project Review Committee (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.

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

6.6 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 theory and practical course with the approval of PRC not earlier than 40 weeks from the date of registration of the project work. The candidate has to pass all the theory and practical subjects before submission of the Thesis.

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

6.8 The thesis shall be adjudicated by one examiner selected by the University. For this, the Principal of the College shall submit a panel of 5 examiners, eminent in that field, with the help of the guide concerned and head of the department.

6.9 If the report of the examiner is not favourable, the candidate shall revise and resubmit the Thesis, in the time frame as decided by the PRC. If the report of the examiner is unfavorable again, the thesis shall be summarily rejected. The candidate has to re-register for the project and complete the project within the stipulated time after taking the approval from the University.

6.10 If the report of the examiner is favourable, Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the examiner who adjudicated the Thesis. The Board shall jointly report the candidate's work as one of the following:

A. Excellent
B. Good
C. Satisfactory
D. Unsatisfactory

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

6.11 If the report of the Viva-Voce is unsatisfactory, the candidate shall retake the Viva-Voce examination only after three months. If he fails to get a satisfactory report at the second Viva-Voce examination, the candidate has to re-register for the project and complete the project within the stipulated time after taking the approval from the University.

**7.0 AWARD OF DEGREE AND CLASS**

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M. Tech. Degree he shall be placed in one of the following four classes:

| Class Awarded | % of marks to be secured |
|---|---|
| First Class with Distinction | 70% and above (Without any Supplementary Appearance ) |
| First Class | Below 70% but not less than 60% 70% and above (With any Supplementary Appearance ) |
| Second Class | Below 60% but not less than 50% |

The marks in internal evaluation and end examination shall be shown separately in the memorandum of marks.

**8.0 WITHHOLDING OF RESULTS**

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. His degree will be withheld in such cases.

**4.0 TRANSITORY REGULATIONS ( for R09 )**

9.1 Discontinued or detained candidates are eligible for re-admission into same or equivalent subjects at a time as and when offered.

9.2 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 R13 academic regulations.

**10. GENERAL**

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

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

10.3 In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.

10.4 The University 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 University.

## MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

| | Nature of Malpractices/ Improper conduct | Punishment |
|---|---|---|
| | *If the candidate:* | |
| 1. (a) | Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the 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 candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter. | Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him. |
| 2. | Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the paper (information | Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project |

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| | (theory or practical) in which the candidate is appearing. | work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the University. |
| 3. | Impersonates any other candidate in connection with the examination. | The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him. |
| 4. | Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after | Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and |

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| | the examination. | shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. |
| 5. | Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks. | Cancellation of the performance in that subject. |
| 6. | Refuses to obey the orders of the Chief Superintendent/ Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or | In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them. |

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| | outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination. | |
| 7. | Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall. | Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. |
| 8. | Possess any lethal weapon or firearm in the examination hall. | Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining |

| | | |
|---|---|---|
| | | examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. |
| 9. | If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8. | Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them. |
| 10. | Comes in a drunken condition to the examination hall. | Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. |
| 11. | Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny. | Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/ year examinations. |
| 12. | If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award suitable punishment. | |

**Malpractices identified by squad or special invigilators**

1. Punishments to the candidates as per the above guidelines.
2. Punishment for institutions : (if the squad reports that the college is also involved in encouraging malpractices)
   - (i) A show cause notice shall be issued to the college.
   - (ii) Impose a suitable fine on the college.
   - (iii) Shifting the examination centre from the college to another college for a specific period of not less than one year.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA**

**KAKINADA-533003, Andhra Pradesh (India)**
**For Constituent Colleges and Affiliated Colleges of JNTUK**

# Ragging

**Prohibition of ragging in educational institutions Act 26 of 1997**

**Salient Features**

- ⇨ Ragging within or outside any educational institution is prohibited.
- ⇨ Ragging means doing an act which causes or is likely to cause Insult or Annoyance of Fear or Apprehension or Threat or Intimidation or outrage of modesty or Injury to a student

| | Imprisonment upto | | Fine Upto |
|---|---|---|---|
| Teasing, Embarrassing and Humiliation | 6 Months | + | Rs. 1,000/- |
| Assaulting or Using Criminal force or Criminal intimidation | 1 Year | + | Rs. 2,000/- |
| Wrongfully restraining or confining or causing hurt | 2 Years | + | Rs. 5,000/- |
| Causing grievous hurt, kidnapping or Abducts or rape or committing unnatural offence | 5 Years | + | Rs.10,000/- |
| Causing death or abetting suicide | 10 Months | + | Rs. 50,000/- |

In Case of Emergency CALL TOLL FREE NO. : 1800 - 425 - 1288

LET US MAKE JNTUK A RAGGING FREE UNIVERSITY

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA**

**KAKINADA-533003, Andhra Pradesh (India)**
**For Constituent Colleges and Affiliated Colleges of JNTUK**

# Ragging

## ABSOLUTELY NO TO RAGGING

1. Ragging is prohibited as per Act 26 of A.P. Legislative Assembly, 1997.
2. Ragging entails heavy fines and/or imprisonment.
3. Ragging invokes suspension and dismissal from the College.
4. Outsiders are prohibited from entering the College and Hostel without permission.
5. Girl students must be in their hostel rooms by 7.00 p.m.
6. All the students must carry their Identity Card and show them when demanded
7. The Principal and the Wardens may visit the Hostels and inspect the rooms any time.

**Jawaharlal Nehru Technological University Kakinada**
**For Constituent Colleges and Affiliated Colleges of JNTUK**

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## COURSE STRUCTURE

### I SEMESTER

| S.No | Name of the Subject | L | P | C |
|---|---|---|---|---|
| 1 | Microprocessors & Microcontrollers | 4 | — | 3 |
| 2 | HVDC Transmission | 4 | — | 3 |
| 3 | Power System Operation and Control | 4 | — | 3 |
| 4 | Reactive Power Compensation & Management | 4 | — | 3 |
| 5 | Elective – I<br>Electrical Distribution Systems<br>HVAC Transmission<br>Analysis of Power Electronics Converters<br>Renewable Energy Systems<br>Artificial Intelligence Techniques | 4 | — | 3 |
| 6 | Elective – II<br>Power System Security<br>Advanced Digital Signal Processing<br>Generation & Measurement of High Voltages<br>Programmable Logic Controllers & Applications<br>Modern Control Theory | 4 | — | 3 |
| 7 | Simulation Laboratory | — | 4 | 2 |
| | **Total** | | | **20** |

### II SEMESTER

| | | | | |
|---|---|---|---|---|
| 1 | Power System Dynamics and Stability | 4 | — | 3 |
| 2 | Flexible AC Transmission Systems | 4 | — | 3 |
| 3 | Real Time Control of Power Systems | 4 | — | 3 |
| 4 | Advanced Power System Protection | 4 | — | 3 |
| 5 | Elective – III<br>Smart Grid<br>Power Quality<br>Power System Reliability<br>Voltage Stability | 4 | — | 3 |
| 6 | Elective – IV<br>Power System Deregulation<br>High Voltage Testing Techniques | 4 | — | 3 |

| | | | | |
|---|---|---|---|---|
| | Power System Transients<br>Demand Side Energy Management | | | |
| 7 | Power Systems Laboratory | — | 4 | 2 |
| | **Total** | | | **20** |

**III SEMESTER**

| | | | | |
|---|---|---|---|---|
| 1 | Seminar – I | — | — | 2 |
| 2 | Project Work - I | — | — | 18 |
| | **Total** | | | **20** |

**IV SEMESTER**

| | | | | |
|---|---|---|---|---|
| 1 | Seminar – II | — | — | 2 |
| 2 | Project Work - II | — | — | 18 |
| | **Total** | | | **20** |

## SYLLABUS

| I – I | L | P | Credits |
|---|---|---|---|
| | 4 | - | 3 |

**MICROPROCESSORS & MICRO CONTROLLERS**

**UNIT-I**

Register Organization of 8086, Architecture, Signal description of 8086, memory segmentation, addressing modes of 8086. 8086/8088 instruction set and assembler directives, machine language instruction formats, Assembly language Programs.

**UNIT-II**

General Bus Operation, minimum mode operation of 8086 and timing diagrams, Fundamental I/O considerations, Programmed I/O, Interrupt I/O, Block transfers and DMA.

**UNIT-III**

Introduction to stack, stack structure of 8086/8088, Interrupts and Interrupt service routine, interrupt cycle of 8086/8088. Interfacing ROM/ RAM, Interfacing of I/O ports to Micro Computer System, PPI (Programmable Peripheral Interface), 8255 modes of operation, Interfacing A to D converters, Interfacing D to A converters, Interfacing Principles and stepper motor interfacing.

**UNIT-IV**

Programmable Interval timer 8254, Programmable Interrupt Controller 8259A, Key Board or Display Controller 8279, Programmable Communication Interface 8251 USART.

**UNIT-V**

Introduction to 8051/31 Micro Controller, PIN diagram, architecture, Different modes of Operation of timer/counters, addressing modes of 8051 and instruction set. Over view of 16 bit Microcontrollers.

**REFERENCE BOOKS:**

1. Microprocessors and Interfacing: Programming and Hardware by Douglas V. Hall, 2nd edition, TMH, New Delhi, 1999.

2. Advanced Microprocessors and Peripherals, Architecture Programming and Interfacing by A.K. Ray & K.M. Bhurchandi, Forth reprint 2004, TMH

3. The 8051Microcontrollers: Architecture, Programming & Applications by Kenneth J Ayala, Second Edition, Penram International Publishing (India).

4. Micro Computer Systems: The 8086/8088 family by YU-CHENG LIU, GLENN A.GIBSON, 2nd edition, PHI India, 2000.

5. The 8051 Microcontroller and Embedded Systems – Mohammad Ali Mazdi, Janice Gillispie Mazidi, Pearson Education (Singapore) Pvt. Ltd., 2003.

| I – I | L | P | Credits |
|---|---|---|---|
| | 4 | - | 3 |

## H.V.D.C. TRANSMISSION

**UNIT-I**

Limitation of EHV AC Transmission .Advantages of HVDC Technical economical reliability aspects. H.V.D.C. Transmission: General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration. Types of HVDC links-Apparatus and its purpose.

**UNIT II:**

Static Power Converters: 6-pulse bridge circuit and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers. Comparison of the perform of diametrical connection with 6-pulse bridge circuit

**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. Factors responsible for generation of Harmonics voltage and current harmonics effect of variation of á and µ. Filters Harmonic elimination.

**UNIT-IV**

Interaction between HV AC and DC systems – Voltage interaction, Harmonic instability problems and DC power modulation. Development of DC circuit Breakers, Multi-terminal DC links and systems; series, parallel and series parallel systems, their operation and control.

**UNIT-V**

Transient over voltages in HV DC systems : Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults. Converter faults and protection in HVDC Systems: Converter faults, over current protection - valve group, and DC line protection, circuit breaker operation, protection of converters, surge arresters.

**REFERENCE BOOKS:**

1. K.R.Padiyar : High Voltage Direct current Transmission, Wiley Eastern Ltd., New Delhi – 1992.
2. E.W. Kimbark : Direct current Transmission, Wiley Inter Science – New York.
3. J.Arillaga : H.V.D.C.Transmission Peter Peregrinus ltd., London UK 1983
4. E.Uhlman : Power Transmission by Direct Current, Springer Verlag, Berlin Helberg – 1985.
5. HVDC Transmission-S Kamakshaih and V Kamaraju MG hill.

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## POWER SYSTEM OPERATION AND CONTROL

**UNIT-I**

**Unit commitment problem and optimal power flow solution :** Unit commitment : Constraints in UCP,UC solutions. Methods-priority list method, introduction to Dynamic programming Approach.

**UNIT-II**

**Load Frequency Control-I :** Necessity of keeping frequency constant. Definition of control area, single area control, Block diagram representation of an isolated Power System, Steady State analysis, Dynamic response-Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation, steady state response, load frequency control and Economic dispatch control.

**UNIT-III**

**Load Frequency Control-II :** Load frequency control of 2-area system : uncontrolled case and controlled case, tie-line bias control. Optimal two-area LF control-steady state representation, performance Index and optimal parameter adjustment.

**UNIT-IV**

**Generation with limited Energy supply :** Take-or-pay fuel supply contract, composite generation production cost function. Solution by gradient search techniques, Hard limits and slack variables, Fuel scheduling by linear programming.

**UNIT-V**

Interchange Evaluation and Power Pools Economy Interchange, Economy interchange Evaluation, Interchange Evaluation with unit commitment, Multiple Interchange contracts. After-the-fact production costing. Transmission Losses in transaction Evaluation, Wheeling, Pricing of Interchange, power pools.

**REFERENCE BOOKS:**

1 Modern Power System Analysis - by I.J.Nagrath & D.P.Kothari, Tata Mc Graw-Hill Publishing Company ltd, 2nd edition.

2 Power system operation and control PSR Murthy B.S publication.

3 Power Generation, Operation and Control - by A.J.Wood and B.F.Wollenberg,John wiley & sons Inc. 1984.

4 Electrical Energy Systems Theory - by O.I.Elgerd, Tata Mc Graw-Hill Publishing Company Ltd, 2nd edition.

5 Reactive Power Control in Electric Systems - by TJE Miller, John Wiley & sons.

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**REACTIVE POWER COMPENSATION & MANAGEMENT**

**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**

**Reactive power compensation in transmission system:** Steady state - Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples

Transient state - 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**

**Distribution side Reactive power Management:** System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks

**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

**UNIT-V**

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

**REFERENCE BOOKS:**

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

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**(ELECTIVE-I)**
**ELECTRICAL DISTRIBUTION SYSTEMS**

**UNIT-I**

**General :** Introduction to Distribution systems, an overview of the role of computers in distribution system planning-Load modeling and characteristics: definition of basic terms like demand factor, utilization factor, load factor, plant factor, diversity factor, coincidence factor, contribution factor and loss factor-Relationship between the load factor and loss factor - Classification of loads (Residential, Commercial, Agricultural and Industrial) and their characteristics.

**UNIT-II**

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

**UNIT-III**

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

**UNIT-IV**

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

**UNIT-V**

**Capacitive compensation for power factor control:** Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors

(Fixed and switched ) power factor correction, capacitor location. Economic justification. Procedure to determine the best capacitor location. Voltage control : Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop compensation.

**REFERENCE BOOKS :**

1. "Electric Power Distribution System Engineering " by Turan Gonen, Mc.Graw-Hill Book Company,1986.
2. Electric Power Distribution-by A.S.Pabla, Tata Mc Graw-Hill Publishing Company, 4th edition, 1997.
3. Electrical Distribution V.Kamaraju-Mc Graw Hill
4. Handbook of Electrical Power Distribution – Gorti Ramamurthy-Universities press.

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**(ELECTIVE-I)**
**HVAC TRANSMISSION**

**UNIT-I**

E.H.V. A.C. Transmission , line trends and preliminary aspects ,standard transmission voltages – power handling capacities and line losses – mechanical aspects. Calculation of line resistance and inductance : resistance of conductors, temperature rise of conductor and current carrying capacity. Properties of bundled conductors and geometric mean radius of bundle, inductance of two conductor lines and multi conductor lines, Maxwell's coefficient matrix. Line capacitance calculation : capacitance of two conductor line, and capacitance of multi conductor lines, potential coefficients for bundled conductor lines, sequence inductances and capacitances and diagonalization.

**UNIT-II**

Calculation of electro static field of AC lines - Effect of high electrostatic field on biological organisms and human beings. Surface voltage Gradient on conductors, surface gradient on two conductor bundle and cosine law, maximum surface voltage gradient of bundle with more than 3 sub conductors, Mangolt formula.

**UNIT-III**

**Corona :** Corona in EHV lines – corona loss formulae – attenuation of traveling waves due to corona – Audio noise due to corona, its generation, characteristics and limits, measurement of audio noise.

**UNIT-IV**

**Power Frequency voltage control :** Problems at power frequency, generalized constants, No load voltage conditions and charging currents, voltage control using synchronous condenser, cascade connection of components , Shunt and series compensation, Ferranti synchronous resonance in series – capacitor compensated lines

**UNIT–V**

**Static reactive compensating systems :** Introduction, SVC schemes, Harmonics injected into network by TCR, design of filters for suppressing harmonics injected into the system.

**REFERENCE BOOKS :**

1. Extra High Voltage AC Transmission Engineering – Rakesh Das Begamudre, Wiley Eastern ltd., New Delhi – 1987.
2. EHV Transmission line reference book – Edison Electric Institute (GEC) 1986.

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**(ELECTIVE-I)**
**ANALYSIS OF POWER ELECTRONIC CONVERTERS**

**UNIT-I**

**AC voltage Controllers** Single Phase AC Voltage Controllers with RL and RLE loads-ac voltage controller's with PWM control-Effects of source and load inductances –synchronous tap changers –Application-numerical problems

Three Phase AC Voltage controllers-Analysis of Controllers with star and delta connected resistive, resistive –inductive loads-Effects of source and load inductances–Application- numerical problems.

**UNIT –II**

**ac-dc converters** Single phase Half controlled and Fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-Power factor improvements-Extinction angle control-symmetrical angle control-PWM single phase sinusoidal PWM-Single phase series converters-numerical problems. Three Phase ac-dc Converters- Half controlled and fully controlled Converters with RL load– 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- numerical problems

**UNIT-III**

**Power Factor Correction Converters** Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter

**UNIT –IV**

**PWM Inverters** Principle of operation-Voltage control of single phase inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation – numerical problems. Voltage Control of Three-Phase Inverters- Sinusoidal PWM- 60° PWM- Third Harmonic PWM- Space

Vector Modulation- Comparison of PWM Techniques-current source inverters-Variable dc link inverter - numerical problems

**UNIT-V**

**Multi level inverters** Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying-Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter-Switching Device Currents-DC-Link Capacitor Voltage Balancing-Features of Multilevel Inverters- Comparisons of Multilevel Converters

**TEXTBOOKS**

1. Power Electronics-Md.H.Rashid –Pearson Education Third Edition-First Indian Reprint- 2008
2. Power Electronics- Ned Mohan, Tore M.Undelan and William P.Robbins –John Wiley & Sons -2nd Edition.
3. Power Electronics – Lander –Ed.2009
4. Modern power Electronics and AC Drives – B.K.Bose
5. Power Converter Circuits – William Shepherd & Li Zhang-Yes Dee Publishing Pvt Ltd.

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**(ELECTIVE-I)**

**RENEWABLE ENERGY SYSTEMS**

**UNIT-I**

Solar Energy - Availability - Solar radiation data and measurement - Estimation of average solar radiation - Solar water heater types - Heat balance – Flat plate collector efficiency – Efficiency of heat removal - Thermo siphon flow calculation - Forced circulation calculation - Evacuated collectors - Basics of solar concentrators Solar Energy Applications - Solar air heaters – Solar Chimney - Crop driers - Passive solar system - Active solar systems - Water desalination - Output from solar still – Principle of solar ponds.

**UNIT-II**

Wind Energy – Nature of wind – Characteristics – Variation with height and time – Power in wind –Aerodynamics of Wind turbine – Momentum theory – Basics of aerodynamics – Aero foils and their characteristics – HAWT – Blade element theory – Prandtl's lifting line theory (prescribed wake analysis) VAWT aerodynamics – Wind turbine loads – Aerodynamic loads in steady operation – Yawed operation and tower shadow. Wind Energy Conversion System – Siting – Rotor selection – Annual energy output – Horizontal axis wind turbine (HAWT) – Vertical axis wind turbine (VAWT) – Rotor design considerations – Number of blades – Solidity - Blade profile – Upwind/Downwind – Yaw system – Tower – Braking system - Synchronous and asynchronous generators and loads – Integration of wind energy converters to electrical networks – Inverters – Control system – Requirement and strategies – Noise Applications of wind energy

**UNIT-III**

Biomass energy - Bio fuel classification – Examples of thermo chemical, Pyrolysis, biochemical and agrochemical systems – Energy farming – Direct combustion for heat – Process heat and electricity – Ethanol production and use – Anaerobic digestion for biogas – Different digesters – Digester sizing – Applications of Biogas - Operation with

**UNIT-IV**

Ocean Energy - OTEC Principle - Lambert's law of absorption - Open cycle and closed cycle - heat exchanger calculations – Major problems and operational experience. Tidal Power - Principles of power generation - components of power plant – Single and two basin systems – Turbines for tidal power - Estimation of energy – Maximum and minimum power ranges - tidal powerhouse.

Wave Energy – Concept of energy and power from waves – Wave characteristics – period and wave velocities - Different wave energy conservation devices (Saltor duck, oscillating water column and dolphin types) – operational experience.

**UNIT-V**

Geothermal Energy - Classification- Fundamentals of geophysics - Dry rock and hot aquifier energy analysis - Estimation of thermal power - Extraction techniques - Prime movers.

**REFERENCES:**

1. Renewable Energy Resources / John Twidell and Tony Weir / E & F.N.Spon
2. Renewable Energy Resources Basic Principles and Applications / G.N.Tiwari and M.K.Ghosal / Narosa
3. Solar Energy - Principles of thermal collection and storage/ S.P. Sukhatme / TMH
4. Solar Energy Thermal Processes,/Duffie & Beckman
5. Solar Heating and Cooling / Kreith & Kreider
6. Wind Energy Handbook / Tony Burton, David Sharpe, Nick Jenkins and Ervin Bossanyi / WileyWind Electrical Systems / S.N.Bhadra, D.Kastha and S.Banerjee / Oxford
7. Biogas Technology - A Practical Hand Book / K.Khendelwal & S.S. Mahdi / McGraw-Hill

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**(ELECTIVE-I)**

**ARTIFICIAL INTELLIGENCE TECHNIQUES**

**UNIT – I**

**Introduction to Neural Networks** Introduction, Humans and Computers, Biological Neural Networks, Historical development of neural network, Terminology and Topology, Biological and artificial neuron models, Basic learning laws.

**UNIT-II**

**Feed Forward Neural Networks** Introduction, Perceptron models: Discrete, continuous and multi-category, Training algorithms: Discrete and Continuous Perceptron Networks, Perceptron convergence theorem, Limitations and applications of the Pereeptron model, Generalized delta learning rule, Feedforward recall and error back propagation training-Radial basis function algorithms-Hope field networks

**UNIT-III**

**Genetic algorithms & Modelling-**introduction-encoding-fitness function-reproduction operators-genetic operators-cross over and mutation-generational cycle-convergence of genetic algorithm

**UNIT –IV**

**Classical and Fuzzy Sets** Introduction to classical sets - properties, operations and relations; Fuzzy sets, membership, Uncertainty, operations, properties, fuzzy relations, cardinalities, membership functions.

Fuzzy Logic System Components-Fuzzification, Membership value assignment, development of rule base and decision making system, defuzzification to crisp sets, defuzzification methods.

**UNIT-V**

**APPLICATION OF AI TECHNIQUES-**load forecasting-load flow studies-economic load dispatch-load frequency control-reactive power control-speed control of dc and ac motors

**TEXT BOOK:**

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Rai – PHI yPublication.
2. Introduction to Artificial Neural Systems - Jacek M. Zurada, Jaico Publishing House, 1997.

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**(ELECTIVE II)**
**POWER SYSTEM SECURITY**

**UNIT-I**

Short circuit analysis techniques in AC power Systems- Simulation of short circuit and open circuit faults using network theorems- fixed impedance short circuit analysis techniques-time domain short circuit analysis in large scale power systems- analysis of time variation of AC and DC short circuit components

**UNIT-II**

Fixed impedance Short circuit analysis of large scale power systems-general analysis of balanced, unbalanced and open circuit faults- 3-phase short circuit analysis in large scale power systems, Network equivalents and practical short circuit current assessments in large scale Ac power systems-general studies-uncertainties in short circuit current calculations-probabilistic Short circuit analysis

**UNIT-III**

Risk assessment and safety considerations-control and limitation of high short circuit currents-limitation of short circuit currents in power system operation, design and planning, Types of short circuit fault current limiters- earthing resistor or reactor connected to transformer neutral-pyrotechnic fault current limiters- series resonant current limiters- saturable reactor limiters-other types of fault current limiters and their applications.

**UNIT-IV**

Power System Security analysis- concept of security- security analysis and monitoring- factors affecting power system security- detection of network problems –overview, contingency analysis for generator and line outages by ILPF method – fast decoupled inverse Lemma-based approach, network sensitivity factors –contingency selection – concentric relaxation and bounding.

**UNIT-V**

Computer control power systems – need for real time and computer control of power systems- operating states of power system – SCADA- implementation considerations – software requirements for implementing above functions.

**REFERENCE BOOKS:**

1. Allen J. Wood and Bruce Woolenberg: Power System Generation, Operation and Control ,John Willey and sons,1996
2. John J.Grainger and William D Stevenson Jr.: Power System analysis,McGraw Hill,ISE,1994.
3. Nasser D.Tleis : Power System Modelling and fault analysis, Elsevier, 2008.

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**(ELECTIVE II)**
**ADVANCED DIGITAL SIGNAL PROCESSING**

**UNIT-I**

**Digital Filter Structure** Block diagram representation-Equivalent Structures-FIR and IIR digital filter Structures All pass Filters-tunable IIR Digital Filters-IIR tapped cascaded Lattice Structures-FIR cascaded Lattice structures-Parallel-Digital Sine-cosine generator-Computational complexity of digital filter structures.

**UNIT-II**

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

**UNIT-III**

**DSP algorithm implementation** Computation of the discrete Fourier transform- Number representation-Arithmetic operations-handling of overflow-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 ratio in Low -order IIR filters-Low-Sensitivity Digital filters-Reduction of Product round-off errors using error feedback-Limit cycles in IIR digital filters-Round-off errors in FFT Algorithms.

**UNIT -V**

**Power Spectrum Estimation** Estimation of spectra from Finite Duration Observation of 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 & torchy method.

**REFERENCE BOOKS:**

1. Digital signal processing-sanjit K. Mitra-TMH second edition.
2. Discrete Time Signal Processing – Alan V.Oppenheim, Ronald W.Shafer - PHI-1996 1st edition-9th reprint
3 Digital Signal Processing principles, algorithms and Applications – John G.Proakis -PHI –3rd edition-2002
4. Digital Signal Processing – S.Salivahanan, A.Vallavaraj, C. Gnanapriya – TMH - 2nd reprint-2001
5. Theory and Applications of Digital Signal Proceesing-LourensR. Rebinar & Bernold
6. Digital Filter Analysis and Design-Auntonian-TMH

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## (ELECTIVE II)
## GENERATION & MEASUREMENTS OF HIGH VOLTAGES

**UNIT-I**

**Electrostatic fields and field stress control** : Electric fields in homogeneous Isotropic materials and in multi dielectric media-Simple configurations-field stress control. Methods of computing electrostatic fields-conductive analogues-Impedance networks Numerical techniques-finite difference method-finite element method and charge simulation method.

**UNIT-II**

**Generation of High AC & DC Voltages**: Direct Voltages : AC to DC conversion methods electrostatic generators-Cascaded Voltage Multipliers.

**Alternating Voltages :** Testing transformers-Resonant circuits and their applications, Tesla coil.

**UNIT-III**

**Generation of Impulse Voltages** : Impulse voltage specifications-Impulse generations circuits-Operation, construction and design of Impulse generators-Generation of switching and long duration impulses.

**Impulse Currents :** Generation of High impulse currents and high current pulses.

**UNIT-IV**

**Measurement of High AC & DC Voltages :** Measurement of High D.C. Voltages : Series resistance meters, voltage dividers and generating voltmeters.

**Measurement of High A.C. Voltages :** Series impedance meters electrostatic voltmeters potential transformers and CVTS, voltage dividers and their applications.

**UNIT-V**

**Measurement of Peak Voltages :** Sphere gaps, uniform field gaps, rod gaps. Chubb-Fortesque methods. Passive and active rectifier circuits for voltage dividers.

**Measurement of Impulse Voltages :** Voltage dividers and impulse measuring systems-generalized voltage measuring circuits-transfer characteristics of measuring circuits-L.V. Arms for voltage dividers-compensated dividers.

**Measurement of Impulse Currents :** Resistive shunts-current transformers-Hall Generators and Faraday generators and their applications-Impulse Oscilloscopes.

**TEXT BOOKS :**

1. High Voltage Engineering – by E.Kuffel and W.S.Zaengl. Pergaman press Oxford, 1984.
2. High Voltage Engineering – by M.S.Naidu and V.Kamaraju, Mc.Graw-Hill Books Co., New Delhi, 2nd edition, 1995.

**REFERENCE BOOKS :**

1. High Voltage Technology – L.L.Alston, Oxford University Press 1968.
2. High Voltage Measuring Techniques – A. Schwab MIT Press, Cambridge,USA, 1972.
3. Relevant I.S. and IEC Specifications.

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## (ELECTIVE II)
## PROGAMMABLE LOGIC CONTROLLERS & APPLICATIONS

**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, Arithmetic 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 axis 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.

**REFERENCE BOOKS:**

1. Programmable Logic Controllers – Principle and Applications by John W. Webb and Ronald A. Reiss, Fifth Edition, PHI
2. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth and F.D Hackworth Jr. – Pearson, 2004.
3. Introduction to Programmable Logic Controllers- Gary Dunning- Cengage Learning.
4. Programmable Logic Controllers –W.Bolton-Elsevier publisher

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**(ELECTIVE-II)**

**MODERN CONTROL THEORY**

**UNIT–I**

**State Variable Analysis** The concept of state – State Equations for Dynamic systems – State diagram–- - Linear Continuous time model for physical systems – Existence and Uniqueness of Solutions to Continuous – Time State Equations – Solutions – Linear Time Invariant Continuous – Time State Equations – State transition matrix and it's properties

**UNIT – II**

**State Variable Techniques** 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 – State feedback controller design through pole assignment.

**UNIT – III**

**Non Linear Systems – 1** 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.

**UNIT – IV**

**Non Linear Systems – 11** Introduction to phase – plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase – plane analysis of nonlinear control systems.

**UNIT – V**

**Stability Analysis** Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov'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.

**TEXT BOOKS:**

1. Modern Control System Theory by M. Gopal – New Age International – 1984
2. Modern Control Engineering by Ogata. K – Prentice Hall – 1997
3. Nonlinear systems, Hassan K. Klalil, Prentice Hall, 1996
4. Modern control systems, Richard C. Dorf and Robert H. Bishop, 11th Edition, Pearson Edu, India, 2009

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## SIMULATION LABORATORY

**Any 10 of the following experiments are to be conducted**

**List of Experiments:**

1. Y Bus formation for p systems with and without mutual coupling, by Singular transformation.
2. Y Bus formation for p systems with and without mutual coupling, by inspection method.
3. Determination of bus currents, bus power and line flow for a specified system voltage (Bus) Profile
4. Formation of Z-bus, using Z-bus building Algorithm without mutual.
5. ABCD parameters: Formation for symmetric II/I configuration. Verification of AD- BC=1 Determination of coefficient and regulation
6. Determination of power angle diagrams for salient and non-salient pole synchronous m/c s, reluctance power, excitation, emf and regulation.
7. To determine I) Swing curve II) critical clearing time for a single m/c connected to infinity bus through a pair of identical transmission lines, 3-phase fault on one of the lines for variation of inertia constant/ line parameters /fault location/clearing time/pre-fault electrical output.
8. Formation of Jacobian for a system not exceeding 4 buses *(no PV buses) in polar coordinates
9. Write a program to perform load flow using Gauss- Seidel method (only p q bus)
10. To determine fault currents and voltages in a single transmission line systems with star-delta transformers at a specified location for SLGF, DLGF.
11. Load flow analysis using Gauss- Siedel method for both pq and pv buses.

12. Load flow analysis using NR method for both pq and pv buses.
13. Fast decoupled flow method for both pq and pv buses.
14. Optimal Generator Scheduling for Thermal power plants.
15. Economic dispatch using lambda-iteration method

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## POWER SYSTEM DYNAMICS AND STABILITY

**UNIT-I**

**System Dynamics :** Synchronous machine model in state space from computer representation for excitation and governor system –modeling of loads and induction machines.

**UNIT-II**

Steady state stability – steady state stability limit – Dynamics Stability limit – Dynamic stability analysis – State space representation of synchronous machine connected to infinite bus-time response – Stability by eigen value approach.

**UNIT-III**

**Digital Simulation of Transient Stability :** Swing equation machine equations – Representation of loads – Alternate cycle solution method – Direct method of solution – Solution Techniques : Modified Euler method – Runge Kutta method – Concept of multi machine stability.

**UNIT-IV**

Effect of governor action and excite on power system stability effect of saturation, saliency & automatic voltage regulators on stability.

**UNIT-V**

**Excitation Systems :** Rotating Self-excited Exciter with direct acting Rheostatic type voltage regulator – Rotating main and Pilot Exciters with Indirect Acting Rheostatic Type Voltage Regulator – Rotating Main Exciter, Rotating Amplifier and Static Voltage Regulator – Static excitation scheme – Brushless excitation system.

**REFERENCE BOOKS :**

1. Power System Stability by Kimbark Vol. I&II, III
2. Power System control and stability by Anderson and Fund
3. Power systems stability and control by PRABHA KUNDUR
4. Computer Applications to Power Systems–Glenn.W.Stagg & Ahmed. H.El.Abiad
5. Computer Applications to Power Systems – M.A.Pai
6. Power Systems Analysis & Stability – S.S.Vadhera Khanna Publishers

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## FLEXIBLE AC TRANSMISSION SYSTEMS

**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, comparison of current source converters with voltage source converters.

**UNIT-III**

**Static shunt compensation :** Objectives of shunt compensation, midpoint 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 compensation control.

**UNIT-V**

**Static series compensators :** Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, functional requirements. 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 BOOK :**

1. "Understanding FACTS Devices" N.G.Hingorani and L.Guygi, IEEE Press. Indian Edition is available:—Standard Publications
2. Sang.Y.H and John.A.T, "Flexible AC Transmission systems" IEEE Press (2006).
3. HVDC & FACTS Controllers: applications of static converters in power systems- Vijay K.Sood- Springer publishers

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## REAL TIME CONTROL OF POWER SYSTEMS

**UNIT-I**

**State Estimation :** Different types of State Estimations, Theory of WLS state estimation, sequential and non-sequential methods to process measurements. Bad data Observability, Bad data detection, identification and elimination.

**UNIT-II**

**Security and Contingency Evaluation :** Security concept, Security Analysis and monitoring, Contingency Analysis for Generator and line outages by iterative linear power flow method, Fast Decoupled model, and network sensitivity methods.

**UNIT-III**

**Computer Control of Power Systems :** Need for real time and computer control of power systems, operating states of a power system, SCADA - Supervisory control and Data Acquisition systems implementation considerations, energy control centres, software requirements for implementing the above functions.

**UNIT –III**

Voltage Stability, voltage collapse, and voltage security, relation of voltage stability to rotor angle stability. Voltage stability analysis Introduction to voltage stability analysis 'P-V' curves and 'Q-V' curves, voltage stability in mature power systems, long-term voltage stability, power flow analysis for voltage stability, voltage stability static indices and Research Areas.

**UNIT-V**

**Application of AI and ANN in Power System :** Basic concepts and definitions, algorithms for load flow, short term load forecasting, fault diagnosis, and state estimation.

**REFERENCE BOOKS:**

1. John J.Grainger and William D.Stevenson, Jr. : Power System Analysis, McGraw-Hill, 1994, International Edition
2. Allen J.Wood and Bruce F.Wollenberg : Power Generation operation and control, John Wiley & Sons, 1984
3. R.N.Dhar : Computer Aided Power Systems Operation and Analysis, Tata McGraw Hill, 1982
4. L.P.Singh : Advanced Power System Analysis and Dynamics, Wiley Eastern Ltd. 1986
5. Prabha Kundur : Power System Stability and Control -, McGraw Hill, 1994
6. P.D.Wasserman : 'Neural Computing : Theory and Practice' Van Nostrand - Feinhold, New York.

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## ADVANCED POWER SYSTEM PROTECTION

**UNIT-I**

**Static Relays classification and Tools :** Comparison of Static with Electromagnetic Relays, Basic classification, Level detectors and Amplitude and phase Comparators – Duality – Basic Tools – Schmitt Trigger Circuit, Multivibrators, Square wave Generation – Polarity detector – Zero crossing detector – Thyristor and UJT Triggering Circuits. Phase sequence Filters – Speed and reliability of static relays.

**UNIT-II**

**Amplitude and Phase Comparators (2 Input) :** Generalized equations for Amplitude and Phase comparison – Derivation of different characteristics of relays – Rectifier Bridge circulating and opposed voltage type amplitude comparators – Averaging & phase splitting type amplitude comparators – Principle of sampling comparators.

**Phase Comparison :** Block Spike and phase Splitting Techniques – Transistor Integrating type, phase comparison, Rectifier Bridge Type Comparison – Vector product devices.

**UNIT-III**

Static over current (OC) relays – Instantaneous, Definite time, Inverse time OC Relays, static distance relays, static directional relays, static differential relays, measurement of sequence impedances in distance relays, multi input comparators, elliptic & hyperbolic characteristics, switched distance schemes, Impedance characteristics during Faults and Power Swings.

**UNIT-IV**

**Carrier plot protection scheme:** carrier current protection schemes, relative merits & demerits, carrier aided distance protection schemes, transfer schemes, blocking scheme and acceleration schemes.

Differential relay Principle and characteristics, maloperation of differential relay, protection of transformers, protection of generators.

**UNIT-V**

**Numerical Protection:** Introduction , numerical relay, numerical relaying algorithms, mann-morrison technique,Differential equation technique, discrete fourier transform technique, rationalised harr transform technique, wavelet transform technique, numerical overcurrent protection , numerical distance protection , numerical differential protection.

**REFERENCE BOOKS:**

1. Power System Protection with Static Relays – by TSM Rao
2. Protective Relaying Vol-II Warrington
3. Art & Science of Protective Relaying - C R Mason
4. Power System Stability Kimbark Vol-II
5. Power system protection & switchgear by Badri Ram & D.N viswakarma.
6. Electrical Power System Protection –C.Christopoulos and A.Wright-Springer
7. Protection & Switchgear –Bhavesh Bhalaja,R.P Maheshwari, Nilesh G.Chothani-Oxford publisher

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**(ELECTIVE – III)**
**SMART GRID**

**UNIT-I**

**Introduction to Smart Grid:** Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid.

**UNIT-II**

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

**UNIT-III**

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

**UNIT-IV**

**Microgrids and Distributed Energy Resources:** Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuelcells, microturbines, Captive power plants, Integration of renewable energy sources.

**UNIT-V**

**Power Quality Management in Smart Grid:** Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy

Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

**Information and Communication Technology for Smart Grid:** Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN).

**TEXT BOOKS:**

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",CRC Press
3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama,"Smart Grid: Technology and Applications", Wiley
4. Jean Claude Sabonnadière, Nouredine Hadjsaïd, "Smart Grids", Wiley Blackwell 19
5. Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010
6. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
7. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press

**REFERENCE BOOKS:**

1. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011
2. James Northcote, Green, Robert G. Wilson "Control and Automation of Electric Power Distribution Systems (Power Engineering)", CRC Press
3. Mladen Kezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert "Substation Automation (Power Electronics and Power Systems)", Springer
4. R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, "Electrical Power System Quality", 2nd Edition, McGraw Hill Publication
5. Yang Xiao, "Communication and Networking in Smart Grids", CRC Press

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**(ELECTIVE III)**
**POWER QUALITY**

**UNIT-I**

**Introduction** Overview of Power Quality - Concern about the Power Quality - General Classes of Power Quality Problems – Transients - Long-Duration Voltage Variations - Short-Duration Voltage Variations - Voltage Unbalance - Waveform Distortion - Voltage fluctuation - Power Frequency Variations - Power Quality Terms - Voltage Sags and Interruptions - Sources of Sags and Interruptions – Nonlinear loads.

**UNIT-II**

**Transient Over Voltages** Source of Transient Over Voltages - Principles of Over Voltage Protection - Devices for Over Voltage Protection - Utility Capacitor Switching Transients - Utility Lightning Protection - Load Switching Transient Problems - Computer Tools for Transient Analysis

**UNIT-III**

**Harmonic Distortion and solutions** Voltage vs. Current Distortion - Harmonics vs. Transients - Power System Quantities under Nonsinusoidal Conditions - Harmonic Indices – Sources of harmonics - Locating Sources of Harmonics – System Response Characteristics - Effects of Harmonic Distortion – Interharmonics - Harmonic Solutions Harmonic Distortion Evaluation - Devices for Controlling Harmonic Distortion - Harmonic Filter Design - Standards on Harmonics

**UNIT-IV**

**Long Duration Voltage Variations** Principles of Regulating the Voltage - Device for Voltage Regulation - Utility Voltage Regulator Application - Capacitor for Voltage Regulation - End-user Capacitor Application - Regulating Utility Voltage with Distributed Resources –

**UNIT-V**

**Distributed Generation and Power Quality** Resurgence of Distributed Generation - DG Technologies - Interface to the Utility System - Power Quality Issues - Operating Conflicts - DG on Low Voltage Distribution Networks - Interconnection standards - Wiring and Grounding - Typical Wiring and Grounding Problems - Solution to Wiring and grounding Problems

**TEXTBOOKS**

1. Electrical Power Systems Quality, Dugan R C, McGranaghan M F, Santoso S, and Beaty H W, Second Edition, McGraw-Hill, 2002.
2. Power Quality Primer, Kennedy B W, First Edition, McGraw-Hill, 2000.

**REFERENCES**

1. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M H J, First Edition, IEEE Press; 2000.
2. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley & Sons, 2003.
3. Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, Van Nostrad Reinhold, New York.
4. Power Quality c.shankaran, CRC Press, 2001
5. Harmonics and Power Systems –Franciso C.DE LA Rosa-CRC Press (Taylor & Francis)
6. Power Quality in Power systems and Electrical Machines-Ewald F.fuchs, Mohammad A.S. Masoum-Elsevier

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**(ELECTIVE – III)**
**POWER SYSTEM RELIABILITY**

**UNIT-I**

Basic probability theory – rules for combining probabilities of events – Bernoulli's trials – probability density and distribution functions – binomial- distributions – expected value and standard deviation of binomial distribution.

**UNIT -II**

Network Modelling and Reliability Analysis of Series, Parallel, Series-Parallel networks – complex networks – decomposition method

Reliability functions f(t), F(t), R(t), h(t) and their relationship – exponential distributions – Expected value and standard deviation of exponentional distribution – Bath tub curve – reliability analysis of series parallel networks using exponential distribution – reliability measures MTTF, MTTR, MTBF

**UNIT –III**

Markov chains – concept of stochastic transitional probability Matrix, Evaluation of limiting state Probabilities – Markov processes one component repairable system – time dependent probability evaluation using Laplace transform approach – evaluation of limiting state probabililties using STPM – two component repairable models – Frequency and duration concept – Evaluation of frequency of encountering state, mean cycletime, for one, two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering merged states

**UNIT-IV**

Generation system reliability analysis – reliability model of a generation system – recursive relation for unit addition and removal – load modelling – merging of generation load model – evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE.

**UNIT-V**

Composite system reliability analysis decomposition method – distribution system reliability analysis – radial networks – weather effects on transmission lines – Evaluation of load and energy indices.

**REFERENCE BOOKS:**

1. Reliability Evaluation of Engg. System – R.Billinton, R.N.Allan, Plenum Press, New York.
2. Reliability Evaluation of Power System – R.Billinton, R.N.Allam, Plenum Press, New York
3. An Introduction to Realiability and Maintainability Engineering. Sharies E Ebeling, TATA McGraw Hill – Edition

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**(ELECTIVE III)**
**VOLTAGE STABILITY**

**UNIT-I**

Reactive Power flow and voltage stability in power systems: Physical relationship indicating dependency of voltage on reactive power flow - reactive power, transient stability; Q-V curve; definition of voltage stability, voltage collapse and voltage security. Voltage collapse phenomenon, Factors of voltage collapse, effects of voltage collapse; voltage collapse analysis.

**UNIT-II**

**Power system loads :** Load characteristics that influence voltage stability such as – Discharge lighting, Induction motor, Air conditioning and heat pumps, Electronic power supplies, Over Head lines and cables.

**UNIT-III**

**Reactive Power compensation :** Generation and absorption of reactive power – Reactive power compensators & voltage controllers : - shunt capacitors, synchronous phase modifier – static VAR system – on load tap changing transformer, booster transformers.

**UNIT-IV**

**Voltage stability static indices :** Development of voltage collapse index – power flow studies – singular value decomposition – minimum singular value of voltage collapse – condition number as voltage collapse index.

**UNIT-V**

**voltage stability margins & Improvement of voltage stability:** Stability margins, voltage stability margin of uncompensated and compensated power system . Dynamic voltage stability – voltage security , Methods of improving voltage stability and its practical aspects.

**REFERENCES:**

1. Performance operation and control of EHV power transmission Systems A. chakrabarti, D.P.Kothari, A.K. Mukhopadhyay, A.H. Wheeler publishing, 1995.
2. Power system voltage stability - C.W. Taylor , Mc. Graw Hill, 1994

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**(ELECTIVE IV)**
**POWER SYSTEM DEREGULATION**

**UNIT-I**

Need and conditions for deregulation. Introduction of Market structure, Market Architecture, Spot market, forward markets and settlements. Review of Concepts marginal cost of generation, least-cost operation, incremental cost of generation. Power System Operation.

**UNIT-II**

Electricity sector structures and Ownership /management, the forms of Ownership and management. Different structure model like Monopoly model, Purchasing agency model, wholesale competition model, Retail competition model.

**UNIT-III**

FRAMEWORK and methods for the analysis of Bilateral and pool markets, LMP based markets, auction models and price formation, price based unit commitment, country practices.

**UNIT-IV**

Transmission network and market power. Power wheeling transactions and marginal costing, transmission costing. Congestion management methods- market splitting, counter-trading; Effect of congestion on LMPs- country practices

**UNIT-V**

Ancillary Services and System Security in Deregulation. Classifications and definitions, AS management in various markets- country practices. Technical, economic, & regulatory issues involved in the deregulation of the power industry.

**REFERENCE BOOKS:**

1. Power System Economics: Designing markets for electricity - S. Stoft
2. Power generation, operation and control, -J. Wood and B. F. Wollenberg

3. Operation of restructured power systems - K. Bhattacharya, M.H.J. Bollen and J.E. Daalder
4. Market operations in electric power systems - M. Shahidehpour, H. Yamin and Z. Li
5. Fundamentals of power system economics - S. Kirschen and G. Strbac
6. Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry - N. S. Rau
7. Competition and Choice in Electricity - Sally Hunt and Graham Shuttleworth

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**(ELECTIVE IV)**
**HIGH VOLTAGE TESTING TECHNIQUES**

**UNIT-I**

**Non Destructive Testing Techniques :** Measurement of DC Resistivity – Dielectric loss and dielectric constant of insulating materials – Schering bridge method – Transformer ratio arm bridge for high voltage and high current applications – null detectors.

**UNIT-II**

**High Voltage Testing of Power Apparatus :** Need for testing standards – Standards for porcelain/Glass insulators-Classification of porcelain/ glass insulator tests – Tests for cap and pin porcelain/Glass insulators.

**UNIT-III**

High voltage AC testing methods-Power frequency tests-Over voltage tests on insulators, Isolators, Circuit Breakers and power cables. Artificial Contamination Tests : Contamination flashover phenomena-Contamination Severity-Artificial contamination tests-Laboratory Testing versus in-Service Performance-Case study.

**UNIT-IV**

**Impulse Testing :** Impulse testing of transformers, insulators, Surge diverters, Bushings, cables, circuit breakers.

**UNIT-V**

**Partial Discharge Measurement :** PD equivalent model-PD currents-PD measuring circuits-Straight and balanced detectors-Location and estimation of PD in power apparatus-PD measurement by non electrical methods-Calibration of PD detectors. RIV Measurements : Radio Interference – RIV – Measurement of RI and RIV in laboratories and in field. Different test arrangements and their limitations.

**REFERENCE BOOKS:**

1. High Voltage Engineering – by E.KUFFEL and W.S.ZAENGL, Pergamon press, Oxford 1984.
2. High Voltage Engineering – by M.S.Naidu and V.Kamaraju, Tata Mc Graw Hill Publishing Company Limited, New Delhi – 2001.
3. Discharge Detection in H.V. Equipment – by KREUGER, F.H. Haywood London – 1964.
4. Outdoor Insulators – by Gorur & Cherney.
5. H.V. Testing Techniques Halfly

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**(ELECTIVE IV)**
**POWER SYSTEM TRANSIENTS**

**UNIT-I**

**Basic Concepts and Simple Switching Transients;**- Switching an LR,LC,RLC circuits

**Transients Analysis of Three-Phase power Systems:–** Symmetrical components in Three-phase Systems, Sequence Components for Unbalanced Network Impedances, the Sequence Networks , analysis of Unsymmetrical Three-Phase Faults-single line-to-Ground Fault, Three phase-to-ground fault.

**UNIT-II**

**Travelling Waves:**- Velocity of Travelling waves and Characteristic Impedance, Energy Contents of Travelling Waves, Attenuation and Distortion of Electromagnetic Waves, telegraph equations-lossless line, distortion less line, Reflection and Refraction of Travelling Waves, Reflection of Travelling Waves against Transformer-and-Generator-windings, the Origin Transient Recovery voltages, bewley-lattice diagram. travelling waves and multi conductor system.

**UNIT-III**

**Switching Transients:-** arc interruption in circuit breaker , transient recovery voltage, arc-circuit interaction, interruption of capacitive currents, interruption of inverse currents, interruption of fault current in transmission line and transformers.

**UNIT-IV**

**Power System Transient Recovery Voltages:-**Characteristics of the Transient Voltage- Short-circuit test duties based on IEC 60056 (1987),ANSI/IEEE Standards, the Harmonization between IEC and ANSI/IEEE Standards with respect to Short-circuit Test duties, resistance recovery voltage for Different types of faults.

**UNIT-V**

**Lightning –Induced Transients:-**Mechanism of Lightning, wave shape of the lightning current, Direct lighting Stroke to transmission line towers, direct lightening stroke to a line, lightning protection scheme. Numerical simulation of electrical transients, The Electromagnetic Transient Program, principles of numerical techniques used in transient simulation.

**REFERENCE BOOKS:**

1. Electrical Transients in Power System by Allen Greenwood, McGraw Hill 1990
2. Power system grounding & transients by A.P.Sakis Meliopolous.
3. "Transients in power systems" by Lou Van Sluis

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## (ELECTIVE IV)
## DEMAND SIDE ENERGY MANAGEMENT

**UNIT-I**

Energy Audit and Energy management information systems: Energy audit: Definitions-Need-concepts-Types of energy audit; Energy management information systems: Introduction-Need-components-designing-using the system-identifying plant outages

**UNIT-II**

**Energy Economics:** Introduction-Cost benefit risk analysis-Payback period-Straight line depreciation-Sinking fund depreciation—Reducing balance depreciation-Net present value method-Internal rate of return method-Profitability index for benefit cost ratio.

**UNIT-III**

**Energy Conservation in Electric utilities and Industry: Electrical load management:** Energy and load management devices-Conservation strategies; conservation in electric utilities and industry: Introduction-Energy conservation in utilities by improving load factor-Utility voltage regulation-Energy conservation in Industries-Power factor improvement.

**Energy –efficient electric motors:** Energy efficient motors-construction and technical features-case studies of EEMs with respect to cost effectiveness-performance characteristics; Economics of EEMs and system: life cycle-direct savings and payback analysis-efficiency factor or efficiency evaluation factor

**UNIT-IV**

**Electric Lighting:** Introduction-Need for an energy management program-Building analysis-Modification of existing systems-Replacement of existing systems-priorities:

**Illumination requirement :** Task lighting requirements-lighting levels-system modifications-non illumination modifications-lighting for non task areas-reflectances-space geometry ;System elements-Electrical aspects-characteristics of families of lamps-lamp substitution in an existing

systems-selection of Higher efficiency lamps for a new system-Luminaries-ballasts-energy conservation in lighting.

**UNIT-V**

Space Heating ,Ventilation, Air-Conditioning(HVAC) and Water Heating: Introduction-Heating of buildings-Transfer of Heat-Space heating methods-Ventilation and air-conditioning-Insulation-Cooling load-Electric water heating systems-Energy conservation methods.

**Co-generation and storage:** Combined cycle cogeneration-energy storage: pumped hydro schemes-compressed air energy storage(CAES)-storage batteries-superconducting magnetic energy storage (SMES)

**REFERENCES:**

1. Energy management Hand book by Wayne C.Turner,John wiley and sons publications
2. Electric Energy Utilization and Conservation by S C Tripathy,Tata McGraw hill publishing company ltd.New Delhi
3. Energy efficient electric motors selection and application by John C.Andreas
4. Hand book on Energy Audit and Management by Amit kumar Tyagi,published by TERI (Tata energy research Institute)
5. Energy management by Paul W.O' Callaghan McGraw hill book company
6. Energy conversion systems by Rakosh Das Begamudre New age international publishers

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**POWER SYSTEMS LABORATORY**

**List of Experiments:**

1. Determination of Sequence Impedance of an Alternator.
2. Determination of Sequence impedance of an Alternator by fault Analysis.
3. Measurement of Sequence Impedance of a 3 phase Transformer.
4. Power angle characteristics of a salient pole Synchronous Machine.
5. Scott connection of Transformers.
6. ABCD parameter.
7. Break down characteristics of a Sphere gap.
8. Determination of Breakdown strength of transformer oil.
9. Determination of leakage current of pin insulator.
10. Voltage distribution across the string insulator.