

ACADEMIC REGULATIONS

M.Tech Programmes

Regulation: R16

Applicable for the students admitted from the Academic year 2016-17 onwards



AUDISANKARA
COLLEGE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute Affiliated to JNTUA, Ananthapuram & Accredited by NAAC with 'A' Grade

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www.audisankara.ac.in

REGULATIONS FOR M. TECH TWO YEAR REGULAR COURSES

R 1.0 Eligibility for Admission:

The admissions for category A and B seats shall be as per the guidelines of APSCHE in consonance with government reservation policy.

- a) Under Category A: 70% of the seats are filled based on GATE/PGCET ranks.
- b) Under Category B: 30% seats are filled on merit basis as per guidelines of APSCHE.

R 2.0 Semester wise Course Break-up:

Sem	Theory	Lab	Total Credits
1 st	6	2+ Technical Seminar	24
2 nd	6	2+ Term Paper + Comprehensive Vive	26
3 rd	7	Internship + Project Work	4 + 0
4 th	4	Project Work	20
Total	23	5+Internship+ Project Work	74

R 2.1 Course wise break-up for the total credits:

Total Theory Courses : 23 @ 3 credits each	= 69
Total Laboratory Courses : 5 @ 2 credits each	= 15
Technical Seminar : 1 @ 2 credits	= 2
Term Paper : 1 @ 2 credits	= 2
Internship : 1 @ 2 credits	= 2
Compre. Vive-Voce : 1 @ 2 credits	= 2
Project work : 1 @ 20 credits	=20

R 3.0 Division of marks for Internal and External assessment:

Course	Marks of Continuous Assessment	Marks of External Assessment	Maximum Marks
Theory	40	60	100
Labs	25	50	75
Term Paper	25	50	75
Comprehensive Viva-Voce	--	75	75
Internship	25	50	75
Project work	Grade	Grade	

R 4.0 Evaluation Methodology:

R 4.1 Theory Course:

Each theory course will be evaluated for a total of 100 marks, consisting of 40 marks for Continuous assessment and 60 marks for semester end examination. Following is the scheme for continuous assessment:

Scheme for Continuous Assessment:

Assessment Component	Marks	Schedule	Final Marks
Assignment Test#1 (AT#1)	5	After and on Unit#1	
Sessional Exam#1 (SE#1)	30	At the end of Unit#1 & 2	
Assignment Test#2 (AT#2)	5	After and on Unit#3	
Sessional Exam#2 (SE#2)	30	At the end of Unit#3 & 4	80% of first best SE + 20% of second best SE (30M) + AT#1 (5M) + AT#2 (5M)

4.1 (a) Scheme for SE Marks:

Two Sessional examinations (SE) each for 30 marks with the duration of 90 minutes each will be conducted for every theory course in a semester. The SE marks shall be awarded giving a weightage of 80% in the SE in which the student scores more marks and 20% in the remaining SE.

4.1 (b) Scheme for Assignment Test Marks:

Assignment test#1 shall be conducted for 5M at the end of Unit#1 covering the syllabus of unit#1. Assignment test#2 shall be conducted for 5M at the end of Unit#3 covering the syllabus of unit#3. Questions for Assignment test shall address the topics covered/ extension of the covered topics/Case Studies.

R 4.2 Laboratory Course:

- Each lab will be evaluated for a total of 75 marks consisting of 25 marks for continuous assessment and 50 marks for semester end lab examination. Out of 25 marks of internal assessment, continuous lab assessment will be done for 15 marks for the day to day performance and 10 marks for the final internal lab assessment. The semester end lab examination for 50 marks shall be conducted by two Examiners, one of them being laboratory class Teacher as internal examiner and an external examiner nominated by the Principal from the panel of experts recommended by HOD.

R 4.3 Technical Seminar

Technical Seminar shall be conducted in 1st semester. The distribution of internal marks for component of Technical seminar is given below:

Table 5: Distribution of Marks for component of Technical seminar

S. No.	Criterion	Marks
1	Seminar Report & Subject content	20
2	Seminar presentation & Viva – Voce Exam	30

A Technical Seminar shall have two components, one chosen by the student from the course work as an extension and approved by the faculty supervisor. The other component is suggested by the supervisor and can be a reproduction of the concept in any standard research paper or an extension of concept from earlier course work. A hard copy of the information on seminar topic in the form of a report is to be submitted for evaluation along with presentation. The presentation of the seminar topics shall be made before a committee consisting of Head of the department, seminar supervisor and a senior faculty member. Each Technical Seminar shall be evaluated for 100 marks. Technical Seminar component-I for 50 marks and component-II for 50 marks making total 100 marks. (**Distribution of marks for 50:** 10 marks for report, 10 marks for subject content, 20 marks for presentation and 10 marks for queries).

R 5.3 Term Paper

The Term Paper is a self study report and shall be carried during 2nd semester along with other lab courses. Every student will take up this term paper individually and submit a report. The scope of the term paper could be an exhaustive literature review choosing any engineering concept with reference to a standard research papers or an extension of the concept of earlier course work in consultation with the term paper supervisor. The term paper reports submitted by the individual students during the second semester will be evaluated for a total of 75 marks consisting of 25 marks for internal assessment and 50 marks for semester end examination. Internal assessment shall be done by the term paper supervisor. Semester end examination for 50 marks shall be conducted by two examiners, one of them being term paper supervisor as internal examiner and an external Examiner nominated by the Principal from the panel of experts recommended by HOD.

R 5.4 Comprehensive Viva-Voce

All the students shall face a Comprehensive viva-voce covering the total courses of first and second semesters. The comprehensive viva-voce will be conducted along with 2nd semester lab examination for 75 marks by a committee consisting of Head of the Department, two senior faculty members nominated by the Head of the Department.

R 4.3 Internship

All the students shall undergo the summer internship during summer break after 2nd semester. The minimum internship period is eight weeks and the students have an option of choosing their own industry/area of interest, which may be related to their respective branch or any other service oriented task. A self study report for the internship shall be submitted and evaluated during the 3rd semester and will be evaluated for a total of 75 marks consisting of 25 marks for internal assessment and 50 marks for semester end examination. Internal assessment shall be done by the internship supervisor. Semester end examination for 50 marks shall be conducted by two examiners, one of them being internship supervisor as internal examiner and an external examiner nominated by the Principal from the panel of experts recommended by HOD.

R 4.6 Project Work

All the students shall take up a project work during 3rd and 4th semesters which carries a total of 20 credits. Every candidate shall be required to submit thesis or dissertation after completion of satisfactory work on a topic approved by the Project Review Committee.

- a) A Project Review Committee (PRC) shall be constituted with the Dean (R&D), Head of the Department and one senior faculty member of the department apart from the Project Supervisor.
- b) Registration of Project Work: A student is permitted to register for the project work in the beginning of the third semester after satisfying all the academic requirements.
- c) A student has to submit the title, objective and plan of action of his project work in consultation with his project supervisor to the Project Review Committee (PRC) for its approval. After obtaining the approval of the Committee the student can initiate the Project work from the beginning of the third semester.
- d) The project work initiated during the third semester shall be completed in duration of 10 months and its progress will be reviewed from time to time by the PRC.

- e) Progress of the project work shall be reviewed in the 3rd semester for two times for satisfactory performance of the student for zero credits. 20 credits shall be awarded based on the successful submission and approval of thesis at the end of the 4th semester.
- f) On the completion of the project work the candidate shall submit the draft copy of thesis to the Head of the Department for the approval of PRC and shall make an oral presentation.
- g) After the final approval by PRC, four copies of the Project Thesis certified by the supervisor shall be submitted to the Department.
- h) Students are allowed to submit the project work/ thesis if s/he clears all the first and second semester courses.
- i) The thesis shall be evaluated by one examiner selected by the Principal/Chief Controller of examinations from a panel of 5 examiners, who are eminent in the field and nominated by the concerned guide and Head of the department.
- j) The following weightage are given for the continuous assessment as well as for the final evaluation of the project work:

i) Weightage for Supervisor evaluation	-	40 %
ii) Weightage for PRC evaluation	-	10%
iii) Weightage for External evaluation	-	50%

R5.0 Attendance Requirements:

- a) It is desirable for a candidate to put on 100% attendance in all the subjects. However, a candidate shall be permitted to appear for the semester end examination provided s/he maintains a minimum of 75% overall attendance in the semester.
- b) The shortage of attendance on medical grounds can be condoned to an extent of 10% provided a medical certificate is submitted to the Head of the Department when the candidate reports back to the classes immediately after the leave. Certificates submitted afterwards shall not be entertained. Condonation fee as fixed by the college for those who put on attendance between $\geq 65\%$ and $<75\%$ shall be charged before the end examinations. Attendance may also be condoned as per the State Government rules for those who participate in sports, co-curricular and extra-curricular activities provided their attendance is in the minimum prescribed limits for the purpose and recommended by the concerned authority.

- c) In case of the students having over all attendance less than 65% after condonation shall be declared detained and has to repeat semester again.

R 6.0 Promotion Policies:

- a) A student shall be promoted to subsequent semester only if s/he fulfills the attendance requirement. In case a student fails to fulfill the attendance requirement, s/he has to repeat the semester in the next academic year.
- b) A Student will be promoted from 2nd semester to 3rd semester if s/he fulfills the academic requirements and earning of minimum of 50% credits up to 2nd semester.

R 6.1 Scheme for the award of Grade

- a) A student shall be deemed to have satisfied the minimum academic requirements and earn the credits for each theory course, if s/he secures
 - i. Not less than 40% marks for each theory course in the semester end exam, and
 - ii. A minimum of 40% marks for each theory course considering both internal and semester end examination.
- i. A student shall be deemed to have satisfied the minimum academic requirements and earn the credits for each Lab/ Technical Seminar/Term Paper/Comprehensive Viva/Internship/Project, if s/he secures not less than 50% marks for each Lab/ Term Paper/Mini Project/ Project course in the semester end exam, and
 - ii. A minimum of 50% marks for each Lab/ Technical Seminar/Term Paper/Comprehensive Viva/Internship/Project course considering both internal and semester end examination.

R 6.2 Graduation requirements:

The following academic requirements shall be met for the award of the MCA. Degree.

- a) Student shall register and acquire minimum attendance in all courses and secure 74 credits. However, the CGPA obtained for the best 71 credits shall be considered for the award of Grade/Class/Division.
- b) A student of a regular program who fails to earn 91 credits within four consecutive academic years from the year of his/her admission with a minimum CGPA of 4.0 shall forfeit his/her degree and his/her admission stands cancelled.

R 6.3 Award of Degree:

a) Classification of degree will be as follows:

1. CGPA ≥ 7.5	: First Class with Distinction
2. CGPA ≥ 6.5 and < 7.5	: Degree with First Class
3. CGPA ≥ 5.5 and < 6.5	: Degree with Second Class
4. CGPA ≥ 4.0 and < 5.5	: Degree with Pass Class

b) Degree with Distinction will be awarded to those students who clear all the subjects in single attempt and secure a CGPA ≥ 8.0 during his/her regular course of study.

c) In case a student takes more than one attempt in clearing a course, the final marks secured shall be indicated by * mark in the marks memo.

All the candidates who register for the semester end examination will be issued memorandum of grades by the Institute. Apart from the semester wise marks memos, the institute will issue the provisional certificate subject to the fulfillment of all the academic requirements.

R7.0 Re-Admission Criteria:

A Candidate, who is detained in a year/semester due to lack of attendance/credits, has to obtain written permission from the Principal for readmission into the same semester after duly fulfilling all the required norms stipulated by the college in addition to paying the required fee.

R8.0 Conduct & Discipline:-

- (a) Students shall conduct themselves within and outside the premises of the Institute in a decent and dignified manner befitting the students of Audisankara College of Engineering & Technology.
- (b) As per the order of the Honorable Supreme Court of India, ragging in any form is considered a criminal offence and is totally banned. Any form of ragging will be severely dealt with.
- (c) The following acts of omission and / or commission shall constitute gross violation of the code of conduct and are liable to invoke disciplinary measures with regard to ragging.
 - (i) Lack of courtesy and decorum; indecent behavior anywhere within or outside the college campus.

- (ii) Damage of college property or distribution of alcoholic drinks or any kind of narcotics to fellow students / citizens.
- (d) Possession, consumption or distribution of alcoholic drinks or any kind of narcotics or hallucinogenic drugs.
- (e) Mutilation or unauthorized possession of library books.
- (f) Noisy and unruly behavior, disturbing studies of fellow students.
- (g) Hacking in computer systems (such as entering into other person's areas without prior permission, manipulation and / or damage of computer hardware and software or any other cyber crime etc.
- (h) Usage of camera /cell phones in the campus.
- (i) Plagiarism of any nature.
- (j) Any other act of gross indiscipline as decided by the college academic council from time to time.
- (k) Commensurate with the gravity of offense, the punishment may be reprimand, fine, expulsion from the institute/ hostel, debarring from examination, disallowing the use of certain facilities of the Institute, rustication for a specified period or even outright expulsion from the Institute, or even handing over the case to appropriate law enforcement authorities or the judiciary, as required by the circumstances.
- (l) For an offence committed in (i) a hostel (ii) a department or in a class room and (iii) elsewhere, the chief Warden, the concern Head of the Department and the Principal respectively, shall have the authority to reprimand or impose fine.
- (m) Cases of adoption of unfair means and/ or any malpractice in an examination shall be reported to the principal for taking appropriate corrective action.
- (n) All cases of serious offence, possibly requiring punishment other than reprimand, shall be reported to the Academic council of the college.
- (o) The Institute Level Standing Disciplinary Action Committee constituted by the academic council shall be the authority to investigate the details of the offence, and recommend disciplinary action based on the nature and extent of the offence committed.
- (p) The Principal shall deal with any problem, which is not covered under these rules and regulations.

- (q) “**Grievance and Redressal Committee**” (General) constituted by the Principal shall deal with all grievances pertaining to the academic / administrative / disciplinary matters.
- (r) All the students must abide by the code and conduct rules prescribed by the college from time to time.

R9.0 Transitory Regulations:

A student, who is detained or discontinued in the year/semester, on readmission shall be required to do all the courses in the curriculum prescribed for such batch of students in which the student joins subsequently.

R9.1 A student who is following the JNTUA, Anantapur curriculum/R13 regulations, detained due to lack of credits/ attendance at the end of the any semester of any year, shall join the forthcoming autonomous/ R13 batch (es) (which ever applicable) after fulfilling the requirements. Such students will study all the courses prescribed for that batch, in which the student joins. The student has to clear all backlog subjects if any by appearing in the supplementary examinations of JNTUA/R13 for the award of degree. The class will be awarded based on the academic performance of a student. Such candidates will be considered on par with R13 stream and will be governed by the regulations applicable.

R9.2 A student who is following the JNTUA, Anantapur curriculum/R13, detained due to lack of credits/ attendance at the end of any semester, shall join the autonomous batch at the appropriate semester. Such candidates shall be required to pass in all the courses in the Programme prescribed by concerned BoS for such batch of students, to be eligible for the award of degree. However, exemption will be given in all those courses of the semester(s) of the batch, which the candidate joins now, which he had passed earlier. The student has to clear all his backlog subjects by appearing in the supplementary examinations, conducted by JNTUA, Anantapur and College (Autonomous Stream) for the Award of Degree. The class will be awarded based on the academic performance of a student in the JNTUA Pattern and academic regulations of JNTUA will be followed.

General:

- a) s/he represents “she” and “he” both
- b) Where the words ‘he’, ‘him’, ‘his’, occur, they imply ‘she’, ‘her’, ‘hers’ also.
- c) The academic regulations should be read as a whole for the purpose of any interpretation.
- d) In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Chairman, Academic Council will be final.

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

Course Structure for M.Tech (Electrical Power Systems) Regular Programme**Applicable for students admitted from 2016-17 Academic Year****M.Tech 1st Semester – Electrical Power Systems**

S.No	Code	Course	L	P	C
1	16EP1101	Modern Control Theory	3	0	3
2	16EP1102	Advanced Computer Methods in Power Systems	3	0	3
3	16EP1103	Power System Stability and Control	3	0	3
4	16EP1104	EHVAC Transmission	3	0	3
5	16EP1105	Restructured Power Systems	3	0	3
ELECTIVE-I					
6	16EP1106	Advanced Digital Signal Processing	3	0	3
	16EP1107	Distribution Automation			
	16EP1108	Advanced Microprocessors and Microcontrollers			
7	16EP2109	Power Systems Lab	0	3	2
8	16EP2110	Simulation Lab-I	0	3	2
9	16EP2111	Technical Seminar	2	0	2
		TOTAL	20	6	24

M.Tech 2nd Semester – Electrical Power Systems

S.No	Code	Course	L	P	C
1	16EP1201	Flexible AC Transmission Systems	3	0	3
2	16EP1202	Applications of AI Techniques	3	0	3
3	16EP1203	Operation and Control of Power System	3	0	3
4	16EP1204	Advanced Power System Protection	3	0	3
5	16EP1205	Renewable Energy Systems	3	0	3
ELECTIVE-II					
6	16EP1206	Programmable Logic Controllers	3	0	3
	16EP1207	Energy Auditing, Conversation and Management			
	16EP1208	Reactive Power Compensation and Management			
7	16EP2209	Renewable Energy Systems Lab	0	3	2
8	16EP2210	Simulation Lab-II	0	3	2
9	16EP2211	Term Paper	2	0	2
10	16EP2212	Comprehensive Viva-Voce	0	0	2
		TOTAL	20	6	26

M.Tech 3rd Semester – Electrical Power Systems

S.No	Code	Course	L	P	C
1	16EP2301	Internship + Project Work	0	0	4
TOTAL			0	0	4

M.Tech 4th Semester – Electrical Power Systems

S.No	Code	Course	L	P	C
1	16EP2401	Project Work	0	0	20
TOTAL			0	0	20

**COURSE OUTCOMES:**

At the end of the course students able to

- 1 Develop mathematical models of dynamic physical systems.
- 2 Design optimal controllers for physical systems including power electronic and power systems.
- 3 Determine the stability of linear and nonlinear control systems.
- 4 Linearize a given nonlinear system

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.

State Variable Analysis: 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

Controllability and Observability: 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 Controllers and Observers: State Feedback Controller design through Pole Assignment – state observers: Full order and reduced order.

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 Lyapunov's instability theorems –Stability Analysis of the Linear Continuous time invariant systems by Lyapunov's second method –Generation of Lyapunov's functions – Variable gradient method – Krasoviski's method.

TEXT BOOKS:

- 1 M. Gopal, Modern Control System Theory, New Age International – 1984
- 2 Ogata. K, Modern Control Engineering Prentice Hall – 1997.
- 3 Kuo, Digital Control Engineering, Oxford University.1980.

REFERENCE BOOKS:

- 1 Stainslaw H. Zak “Systems and Control”, Oxford Press, 2003.
- 2 I.J. Nagarath and M.Gopal “Control Systems Engineering”, New Age International (P) Ltd.


16EP1102 ADVANCED COMPUTER METHODS IN POWER SYSTEMS
COURSE OUTCOMES:

At the end of the course students able to

- 1 Develop proper mathematical models for analysis of a selected problem like load flow study or fault analysis.
- 2 Prepare the practical input data required for load flow or fault calculations.
- 3 Select and identify the most appropriate algorithm for load-flow and short circuit studies.
- 4 Develop power system software for static power system studies

UNIT-I

Network Matrices and Modeling: Introduction, linear transformation techniques (bus, branch, and loop frame of references), single phase modeling of transmission lines, off-nominal transformer tap representation, phase shift representation. Three phase system analysis - use of Compound admittances. Three-phase models of transmission lines and Transformers

UNIT-II

Power flow solutions: Review of power flow equations - GS, NR and FDC methods of solving power flow equations, Comparison of power flow methods

Three Phase Load Flows: Formulation of three phase power flow equations, Fast-decoupled three phase algorithm and computer program structure

UNIT-III

Fault System Studies: (Generators, transformers, cables & systems): Analysis of three phase faults - admittance matrix equation - impedance matrix equation - fault calculations - analysis of unbalanced faults - admittance matrices - fault calculations - short circuit faults - open circuit faults - program description and typical solutions.

UNIT-IV

ZBUS methods in Contingency Analysis: Adding and removing multiple lines (current injection methods), piece wise solution of interconnected systems, analysis of single and multiple contingencies, Contingency analysis by DC Model, System reduction for contingency and fault studies.

TEXT BOOKS:

- 1 J. Arrilaga and C.P. Arnold: Computer modeling of electric power systems, John McGraw Hill, ISE, 1968.
- 2 Stagg G. Ward, El-Abiad: Computer methods in power system analysis
- 3 J.J. Grainger, W.D. Stevenson JR, Power system analysis, TMH, Delhi 2007.

REFERENCE BOOKS:

- 1 Nagarath & Kothari Modern power system analysis 3rd Edition, TMH Wiley & Sons, N.Y. 1983.
- 2 Nagsarkar & Sukhija, Power system analysis, Oxford press

**COURSE OUTCOMES:**

At the end of the course students able to

- 1 Develop mathematical models of power system for dynamic studies
- 2 Analyze the performance of single and multi-machine systems under transient, steady state and dynamic conditions.
- 3 Design stabilizers, dynamic resistors and SMES for the power system.

UNIT-I

The Elementary Mathematical Model: A Classical model of one machine connected to an infinite bus – Classical model of multi machine system –Problems – Effect of the excitation system on Transient stability.

System Response to small Disturbances: The unregulated synchronous Machine – Effect of small changes of speed – modes of oscillation of an unregulated Multi-Machine system – regulated synchronous machine – voltage regulator with one time lag – Governor with one time lag – Problems.

UNIT-II

Dynamic Stability: Concept of Dynamic stability – state space model of one machine system connected to infinite bus– effect of excitation on Dynamic stability – examination of dynamic stability by Routh's criterion.

Power System Stabilizers: Introduction to supplementary stabilizing signals- Block diagram of the linear system-Approximate model of the complete exciter – generator system – Lead compensation – Stability aspect using Eigen value approach.

UNIT-III

Excitation Systems: Excitation system response – Non-continuously regulated systems – continuously regulated systems – Excitation system compensation – state space description of the excitation systems simplified linear model – effect of excitation on generator power limits.

Types of Excitation systems: Type –2 system: rotating rectifier system, Type-3 system: Static with terminal potential and current supplies - Type –4 system: non – continuous acting - Block diagram representation – state space modeling equations of these types.

UNIT-IV

Stability Analysis using Direct Method of Lyapunov: Review of Lyapunov's stability theorems of non-liner systems using energy concept – Method based on first concept – Method based on first integrals – Quadratic forms – Variable gradient method – Zubov's method –

Popov's method, Lyapunov function for single machine connected to infinite bus.

Introduction to Voltage Stability: What is voltage stability –Factors affecting voltage instability and collapse – Comparison of Angle and voltage stability – Analysis of voltage instability and collapse – Integrated analysis of voltage and Angle stability – Control of voltage instability.

TEXT BOOKS:

- 1 P.M.Anderson, A.A.Fouad, "Power System Control and Stability", IOWA State University Press, Galgotia Publications, Vol-I, 1st Edition.
- 2 M.A.Pai, Power System Stability – Analysis by the direct method of Lyapunov. North Holland Publishing Company, Newyork, 1981.

REFERENCE BOOKS:

- 1 K.R. Padiyar, Power System Dynamics (Stability & Control), 2nd Edition B.S.Publications, 2002.

**COURSE OUTCOMES:**

At the end of the course students able to

- 1 understand issues of concern with EHVAC transmission
- 2 identify and calculate the various parameters of EHV line for modeling
- 3 assess the effects of corona and methods to limit the audible noise
- 4 Estimate the over-voltages in EHVAC systems.
- 5 design grounding system for EHVAC systems

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 high electrostatic field on biological organisms and human beings surface voltage gradients and maximum gradients of actual transmission lines – voltage gradients on sub conductor Electrostatic induction in un energized lines – measurements of field and voltage gradients for three phase single and double circuit lines – un energized lines.

UNIT-III

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. 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

UNIT-IV

Measurements of audio noise radio interference due to Corona RF properties of radio noise – frequency spectrum of RI fields – Measurements of RI and RIV. Design of EHV lines based on steady state and transient limits. EHV cables and their characteristics.

TEXT BOOKS:

- 1 Rokosh Das Begamudre, Extra High Voltage AC Transmission Engineering, Wiley Eastern Ltd., New Delhi – 1987.
- 2 Edison Electric Institution, EHV Transmission line reference Books (GEC 1968).

REFERENCE BOOKS:

- 1 TuranGonen: Electric Power Transmission System Engineering Analysis and Design, McGraw Hill (Pub) .
- 2 AP SakisMeliopoulos: Power System Grounding and transients, 1988.
- 3 A Chakraborti, D.P. Kothari and A.K. Mukhopadyay: Performance, Operation and Control of EHV Power Transmission Systems, T.M.H, 1999.


COURSE OUTCOMES:

At the end of the course students able to

- 1 Understand the developments of restructuring worldwide.
- 2 Identify the roles and responsibilities of different entities in power market.
- 3 Explore issues like congestion management, Transmission pricing, Ancillary Services Management.

UNIT-I

Key Issues in Electric Utilities: Introduction – Restructuring models – Independent System Operator (ISO) – Power Exchange - Market operations – Market Power – Standard cost – Transmission Pricing – Congestion Pricing – Management of Inter zonal/Intra zonal Congestion.

Open Access Same-Time Information System (OASIS) & Market Power: Structure of OASIS - Posting of Information – Transfer capability on OASIS. Market Power: Introduction - Different types of market Power – Mitigation of Market Power - Examples.

UNIT-II

Available Transfer Capability (ATC) & Electricity Pricing: Transfer Capability Issues – ATC – TTC – TRM – CBM Calculations – Calculation of ATC based on power flow. Electricity Pricing: Introduction – Electricity Price Volatility Electricity Price Indexes – Challenges to Electricity Pricing – Construction of Forward Price Curves – Short-time Price Forecasting.

UNIT-III

Power System Operation in Competitive Environment: Introduction – Operational Planning Activities of ISO- The ISO in Pool Markets – The ISO in Bilateral Markets – Operational Planning Activities of a GENCO.

UNIT-IV

Transmission Cost Allocation Methods & Ancillary Services Management: Introduction - Transmission Cost Allocation Methods : Postage Stamp Rate Method - Contract Path Method - MW-Mile Method – Unused Transmission Capacity Method - MVA-Mile method – Comparison of cost allocation methods. Ancillary Services Management: Introduction – Reactive Power as an Ancillary Service – a Review – Synchronous Generators as Ancillary Service Providers.

TEXT BOOKS:

- 1 Kankar Bhattacharya, Math H.J. Boller and Jaap E. Daalder, Operation of Restructured Power System, Kulwer Academic Publishers, 2001.
- 2 Mohammad Shahidehpour and Muwaffaqalomoush, Restructured Electrical Power Systems, Marcel Dekker, Inc., 2001.

REFERENCE BOOKS:

- 1 Loi Lei Lai, Power System Restructuring and Deregulation, John Wiley & Sons Ltd., England.

**COURSE OUTCOMES:**

At the end of the course students able to

- 1 Understand basic concepts in signals and systems.
- 2 Gain knowledge on the related mathematical tools in signal processing.
- 3 Design and analyze digital filters for power applications.

UNIT-I

Short introduction, Analog to digital and Digital to Analog conversion, sampled and Hold circuit, Continuous time Fourier Transforms. Discrete-time signals and systems, Discrete-time Fourier transform- its properties and applications, Fast Fourier Transform (in time-domain and Frequency domain), IDFT and its properties.

UNIT-II

Z- Transform: Definition and properties, Rational z-transforms, Region of convergence of a rational z- Transform, The inverse z- Transform, Z-Transform properties, Computation of the convolution sum of finite-length sequences, The transfer function, Digital filter structures: Block Diagram representation, Equivalent structures, Basic FIR Digital Filter structures, Basic IIR Digital Filter structures, Realization of Basic structures using MATLAB, All pass filters, Computational complexity of Digital filter structures.

UNIT-III

IIR Digital Filter Design: Preliminary considerations, Bilinear transformation method of IIR Filter design, Design of low pass IIR Digital filters, Design of High pass, Band pass and band stop IIR digital filters, Spectral Transformations of IIR filter, IIR digital filter design using MATLAB, Computer aided design of IIR digital filters.

FIR Digital Filter Design: Preliminary considerations, FIR filter design based on windowed Fourier series, Computer aided design of Equiripple Linear phase FIR filters, Design of Minimum phase FIR filters, FIR digital filter design using MATLAB, Design of computationally efficient FIR digital filters.

UNIT-IV

Analysis of Finite Word Length Effects: The quantization process and errors, quantization of Fixed point numbers, Quantization of floating point numbers, Analysis of coefficient quantization effects, Analysis of arithmetic round off errors, Low sensitivity digital filters, Reduction of product round off errors using error feedback, Round off errors in FFT algorithms. The basic sample rate alteration devices, Multi rate structures for sampling rate

conversion, Multistage design of decimator and interpolator, The Polyphone decomposition, Arbitrary-rate sampling rate converter, Nyquist Filters and some applications of digital signal processing

TEXT BOOKS:

- 1 S.K. Mitra, Digital Signal Processing Tata McGraw-Hill, Third Edition, 2006.
- 2 B.P. Lathi, Principle of Signal Processing and Linear Systems Oxford International Student Version,2009.

REFERENCE BOOKS:

- 1 M. Mondal and A.Asif, Continuous and Discrete Time Signals and Systems Cambridge, 2007.
- 2 Li Tan, Digital Signal Processing- Fundamentals and Applications Indian reprint, Elsevier, 2008.


COURSE OUTCOMES:

At the end of the course students able to

- 1 Understand and distinguish characteristics of distribution systems from transmission systems
- 2 design, analyze and evaluate distribution system design based on forecasted data
- 3 Identify and select appropriate sub–station location
- 4 Design and evaluate a distribution system for a given geographical service area from alternate design alternatives

UNIT-I

Distribution System Planning and Automation: Power Sector Reforms, Basic Distribution Systems, Short-Term Load Forecasting, Long-Term Energy Forecasting, Technological Forecasting, Problems of existing Distribution System, Need for Distribution Automation, Characteristics of Distribution System, Distribution Automation (Objectives, Functions, Benefits), Feeder Automation, Communication Requirements for DA, Remote Terminal Unit (RTU), Communication Technologies for DA

UNIT-II

SCADA System: Introduction, Block Diagram, Components of SCADA, Functions of SCADA, and SCADA applied to Distribution Automation, Advantages of DA through SCADA, Requirements and Feasibility, DA Integration Mechanisms, Communication Protocols in SCADA Systems.

UNIT-III

Substation Automation: Introduction, Definition of Substation Automation, Functions of Substation Automation System, State and Trends of Substation Automation, Intelligent Affordable Substation Monitoring and Control, Advantages of an EEM (Enterprise Energy Management)

Substation Automation Solution: Feeder Automation : Losses in Distribution Systems, System Losses and Loss Reduction, Network Reconfiguration, Improvement in Voltage Profile, Capacitor Placement in Distribution System for Reactive Power Compensation, Algorithm for location of capacitor.

UNIT-IV

Remote Metering and Energy Management: Background for Automatic Meter Reading (AMR) for Utility, Components of AMR Systems, Communications Methods used for Meter

Reading, AMR System, Services and Functions, Financial Analysis, Planning for AMR Implementation. Energy Management, Need Based Energy Management (NBEM), Demand Side Management (DSM).

TEXT BOOKS:

- 1 Dr M K Khedkar and Dr G M Dhole, “A Textbook of Electric Power Distribution Automation”, University Science Press (Laxmi Publications Pvt. Ltd.), 2011.
- 2 A. Momoh, “Electric Power Distribution, Automation, Protection, and Control”, CRC Press, Taylor and Francis Group, 2007

REFERENCE BOOKS:

- 1 D. Bassett, K. Clinard, J. Grainger, S. Purucker, and D. Ward, “Tutorial Course: Distribution Automation”, IEEE Tutorial Publication 88EH0280-8-PWR, 1988.
- 2 . James Northcote-Green, Robert Wilson, “Control and Automation of Electrical Power Distribution James Systems” CRC Press, Taylor and Francis Group, 2007


16EP1108 ADVANCED MICROPROCESSORS AND MICROCONTROLLERS
COURSE OUTCOMES:

At the end of the course students able to

- 1 Understand the generalized architecture of advanced microprocessors and advanced microcontrollers.
- 2 Develop algorithm/program of the advanced microcontrollers for a particular task.
- 3 Interface advanced microcontrollers with external peripherals.

UNIT-I

High Performance CISC Architecture – PENTIUM: CPU Architecture- Bus Operations – Pipelining – Branch predication – floating point unit- Operating Modes –Paging – Multitasking – Exception and Interrupts – Instruction set – addressing modes – Programming the Pentium processor.

UNIT-II

High Performance RISC Architecture – ARM: Arcon RISC Machine – Architectural Inheritance – Core & Architectures – Registers – Pipeline – Interrupts – ARM organization – ARM processor family – Co-processors – ARM instruction set- Thumb Instruction set – Instruction cycle timings – The ARM Programmer’s model – ARM Development tools – ARM Assembly Language Programming – C programming – Optimizing ARM Assembly Code – Optimized Primitives.

UNIT-III

ARM Application Development: Introduction to DSP on ARM –FIR filter – IIR filter – Discrete fourier transform – Exception handling – Interrupts – Interrupt handling schemes- Firmware and boot loader – Embedded Operating systems – Integrated Development Environment- STDIO Libraries – Peripheral Interface – Application of ARM Processor – Caches – Memory protection Units – Memory Management units – Future ARM Technologies.

UNIT-IV

Motorola 68HC11 Microcontrollers: Instruction set addressing modes – operating modes- Interrupt system- RTC-Serial Communication Interface – A/D Converter PWM and UART.

PIC Microcontroller: CPU Architecture – Instruction set – interrupts- Timers- I2C Interfacing –UART- A/D Converter –PWM and introduction to C-Compilers.

TEXT BOOKS:

- 1 Andrew N.Sloss, Dominic Symes and Chris Wright “ARM System Developer’s Guide: Designing and Optimizing System Software”, First edition, Morgan Kaufmann Publishers, 2004.

REFERENCE BOOKS:

- 1 Steve Furber , “ARM System –On –Chip architecture”, Addison Wesley, 2000.
- 2 Daniel Tabak, “Advanced Microprocessors”, McGraw Hill.Inc., 1995.
- 3 James L. Antonakos, “The Pentium Microprocessor”, Pearson Education, 1997.
- 4 John .B.Peatman, “Design with PIC Microcontroller”, Prentice Hall, 1997.


M.Tech 1st Semester –EPS

L	T	P	C
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16EP2109
POWER SYSTEMS LAB
COURSE OUTCOMES:

At the end of the course students able to

- 1 Carryout experiments ensuring the safety of equipment and personnel.
- 2 Interpret the experimental results and correlating them with the practical power system

LIST OF EXPERIMENTS

- 1 Determination of Sub transient Reactance of Salient Pole Synchronous Machine
- 2 Determination of Sequence Impedances of Cylindrical Rotor Synchronous Machine
- 3 Fault Analysis – I
 - i) LG Fault
 - ii) LL Fault
- 4 Fault Analysis – II
 - i) LLG Fault
 - ii) LLLG Fault
- 5 Equivalent Circuit of a Three Winding Transformer
- 6 Separation of No-Load Losses of Three-Phase Squirrel Cage Induction Motor
- 7 Power Angle Characteristics of Salient Pole Synchronous Machine.
- 8 Scott Connection
- 9 Characteristics of IDMT Over Current Relay (Electromagnetic Type).
- 10 Characteristics of Negative Sequence Relay (Static Type).
- 11 Characteristics of Over Voltage Relay.
 - i) Electromagnetic Type
 - ii) Microprocessor Type
- 12 Characteristics of Percentage Biased Differential Relay.
 - i) Electromagnetic Type
 - ii) Static Type


M.Tech 1st Semester –EPS

L	T	P	C
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16EP2110
SIMULATION LAB-I
COURSE OUTCOMES:

At the end of the course students able to

- 1 Analyze the power system data for load-flow and fault studies.
- 2 Apply computational methods for large scale power system studies
- 3 Develop software for power system industry

LIST OF EXPERIMENTS

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


COURSE OUTCOMES:

At the end of the course students able to

- 1 Analyze and develop a thought process for presentation
- 2 Improve his language and communication skills
- 3 Be conversant with the latest developments in power systems

A Technical Seminar shall have two components, one chosen by the student from the course work as an extension and approved by the faculty supervisor. The other component is suggested by the supervisor and can be a reproduction of the concept in any standard research paper or an extension of concept from earlier course work. A hard copy of the information on seminar topic in the form of a report is to be submitted for evaluation along with presentation. The presentation of the seminar topics shall be made before a committee consisting of Head of the department, seminar supervisor and a senior faculty member. Each Technical Seminar shall be evaluated for 100 marks. Technical Seminar component-I for 50 marks and component-II for 50 marks making total 100 marks. (**Distribution of marks for 50:** 10 marks for report, 10 marks for subject content, 20 marks for presentation and 10 marks for queries).


COURSE OUTCOMES:

At the end of the course students able to

- 1 Understand the role of impedance control, phase angle control and voltage control in controlling real and reactive power in transmission systems
- 2 Identify configuration of FACTS controller required for a given application

UNIT-I

FACTS Concepts: Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters basic types off ACTS controllers, benefits from FACTS controllers. Voltage source converters: Single phase three phase full wave bridge Converters transformer connections for 12 pulse 24 and 48 pulse operation

UNIT-II

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. Static shunt compensation: Objectives of shunt compensation, midpoint voltage regulation voltage instability prevention, improvement of transient stability, Power oscillation damping

UNIT-III

Methods of controllable Var generation, variable impedance type static Var generators switching Converter type Var generators hybrid Var generators.

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-IV

Static Series Compensators: concept of series capacitive compensation, improvement of transient stability, power oscillation damping. Functional requirements, GTO thyristor controlled series capacitors (GSC), thyristor switched series capacitor (TSSC).and thyristor controlled series capacitor (TCSC) control schemes for GSC TSSC and TCSC.

TEXT BOOKS:

- 1 N. G. Hingorani and L. Guygi.“Understanding FACTS Devices” IEEE Press Publications 2000.

REFERENCE BOOKS:

- 1 "Understanding FACTS – Concepts and Technology of Flexible AC Transmission Systems" Narain G. Hingorani, Laszlo Gyugyi, Wiley India publications 2011


COURSE OUTCOMES:

At the end of the course students able to

- 1 Differentiate between Algorithmic based methods and knowledge based methods
- 2 Use the soft computing techniques for power system problems.
- 3 Use appropriate AI framework for solving power system problems.
- 4 Apply GA to power system optimization problems

UNIT-I

Introduction to Neural Networks: Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model, Spiking Neuron Model, Characteristics of ANN, McCulloch-Pitts Model, Historical Developments, Potential Applications of ANN.

Essentials of Artificial Neural Networks: Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN-Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules, Types of Application

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 of the Perceptron Model, Applications.

Multilayer Feed Forward Neural Networks: Credit Assignment Problem, Generalized Delta Rule, Derivation of Back propagation (BP) Training, Summary of Back propagation Algorithm, Kolmogorov Theorem, Learning Difficulties and Improvements.

Associative Memories: Paradigms of Associative Memory, Pattern Mathematics, Hebbian Learning, General Concepts of Associative Memory (Associative Matrix, Association Rules, Hamming Distance, The Linear Associator, Matrix Memories, Content Addressable Memory), Bidirectional Associative Memory (BAM) Architecture, BAM Training Algorithms: Storage and Recall Algorithm, BAM Energy

Function, Proof of BAM Stability Theorem. Architecture of Hopfield Network: Discrete and Continuous versions, Storage and Recall Algorithm, Stability Analysis, Capacity of the Hopfield Network

UNIT-III

Classical & Fuzzy Sets: Introduction to classical sets – properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, Properties, fuzzy relations, cardinalities, membership functions.

Genetic algorithm and Particle swarm optimization.

UNIT-IV

Fuzzy Logic System Components: Fuzzification, Membership Value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.

Applications Neural Network Applications: Process identification, Fraction Approximation, Control and Process Monitoring, Fault diagnosis and Load forecasting, economic load dispatch.

Fuzzy logic applications: Fuzzy logic control and Fuzzy classification.

TEXT BOOKS:

- 1 Rajasekharan and Pai, Neural Networks, Fuzzy logic, Gnenetic algorithms: synthesis and applications - PHI Publication.2003
- 2 JacekM.Zurada, Introduction to Artificial Neural Systems Jaico Publishing House, 1997.

REFERENCE BOOKS:

- 1 N. Yadaiah and S. BapiRaju, Neural and Fuzzy Systems: Foundation, Architectures and Applications Pearson Education.2010.
- 2 BrokKosko, Neural Netwroks and Fuzzy Logic System PHI Publications
- 3 Timothy . J. Ross “Fuzzy logic for engineering applications”,3rd edition , University of New Mexico, John Wiley & Sons Ltd, 2010.


COURSE OUTCOMES:

At the end of the course students able to

- 1 Analyze Thermal and Hydro generator characteristics and their economic operation.
- 2 Solve ELD, UC and AGC problems using Heuristic techniques.

UNIT-I

Economic Operation: Load forecasting - Unit commitment – Economic dispatch problem of thermal units – Gradient method- Newton's method –Base point and participation factor method.

Unit Commitment and Solution Methods: Optimal Unit Commitment, Constraints in unit commitment, spinning reserve, Thermal Unit Constraints, Other constraints, Hydro constraints, Must Run, Fuel constraints, Unit commitment Solution methods: Priority-List methods, Dynamic Programming solution. Backward DP Approach, Forward DP Approach, Restricted Search Ranges, Strategies- Reliability considerations

UNIT-II

Hydro-thermal Co-Ordination: Short-term hydrothermal scheduling problem –gradient approach – Hydro units in series - pumped storage hydro plants-hydro-scheduling using Dynamic Programming and linear programming.

Automatic generation control: Review of LFC and Economic Dispatch control(EDC)using the three modes of control viz. Flat frequency – tie-line control and tie-line bias control

UNIT-III

AGC implementation: AGC features - static and dynamic responses of uncontrolled& controlled two-area system. Interchange of Power & Energy: Economic interchange between interconnected utilities- Inter utility energy evaluation – Power pools – Transmission effects and Issues: Limitation- Wheeling.

UNIT-IV

Power System Security-Contingency Analysis: Linear sensitivity factors – AC power flow methods – contingency selection – concentric relaxation – bounding-security constrained optimal power flow-Interior point algorithm-Bus incremental costs.

State estimation – Maximum likelihood Weighted least squares equation – orthogonal Decomposition estimation method – Algorithm.

TEXT BOOKS:

- 1 Allen J.Wood and Wollenberg B.F., 'Power Generation Operation and control', John Wiley & Sons, Second Edition.2013.
- 2 Nagrath, I.J. and Kothari D.P., 'Modern Power System Analysis', TMH, New Delhi,1980.

REFERENCE BOOKS:

- 1 . D.P.Kothari & J.S.Dhillon, Power System Optimization, PHI,2004.

**COURSE OUTCOMES:**

At the end of the course students able to

- 1 Understand the various types of comparators and their realization using static circuits
- 2 Understand the realization of over current, distance and differential relays using comparators.
- 3 Estimate the current and voltage magnitudes from the sampled measurements
- 4 Realize the various dynamic characteristics of digital relays for protection of transmission lines, transformers
- 5 Identify the new developments in protective relaying and applications

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 comparator.

Amplitude comparators: Circulating current type and opposed voltage type rectifier bridge comparators –Direct and Instantaneous comparators

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

UNIT-II

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

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 a sampling comparator.

UNIT-III

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

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

UNIT-IV

Microprocessor based Protective Relays-I: Over current relays – impedance relays – directional relay – reactance relay (Block diagram and flow chart approach only).

Microprocessor based Protective Relays-II: Generalized mathematical expression for distance relays - measurement of resistance and reactance – MHO and offset MHO relays – Realization of MHO characteristics – Realization of offset MHO characteristics (Block diagram and flow chart approach only) Basic principle of Digital computer relaying.

TEXT BOOKS:

- 1 T.S.Madhava Rao, “Power system Protection static relay”, Tata McGraw Hill Publishing Company limited, second edition, 1989.

REFERENCE BOOKS:

- 1 Badri Ram and D.N.Vishwakarma, “Power system Protection and Switchgear “, Tata McGraw Hill Publication Company limited First Edition -1995.


COURSE OUTCOMES:

At the end of the course students able to

- 1 Understanding of the scope, principles, norms, accountabilities and bounds of contemporary engineering practice in the specific discipline
- 2 Fluent application of engineering techniques, tools and resources

UNIT-I

Introduction: Energy Economics: Simple payback period, Internal (simple) rate of return, Net present value, Internal rate of return (IRR), NPV and IRR with Fuel Escalation.

Solar Resource: Solar spectrum, Altitude angle of sun at solar noon, solar position at any time of day, solar time, sun rise and sunset, solar radiation-direct beam, diffuse radiation, reflected radiation, and radiation measurements.

Semiconductor Physics: Band gap energy, solar spectrum, Band gap impact on Photo voltaic efficiency, P-n junction diode

UNIT-II

PhotoVoltaics: Generic photo voltaic cell- Simple equivalent circuits, accurate equivalent circuit, Cells to modules to arrays, I-V curve under STC, Impacts of temperature & insulation on I-V curves, Shading impacts on i-V curves, Crystalline silicon technologies, thin film photovoltaics.

Photo Voltaic Systems: Introduction to major Photovoltaic systems types, current-voltage curves for loads, Maximum power point trackers.

Grid Connected Systems: Interfacing with utility, DC and AC rated power, Peaks hours approach to estimate PV performance, Grid connected system sizing.

Stand Alone PV Systems: Load estimation, Batteries- storage capacity, Sizing, Coulomb efficiency instead of energy, Blocking diodes, Sizing of PV array, Stand alone system design.

PV Powered Water Pumping: Hydraulic system curves, Hydraulic curves, Hydraulic system curve and pump curve, a simple directly coupled PV-pump design approach.

UNIT-III

Wind and Tidal Power: Wind power-Wind power- Historical development, types of wind turbines, power in wind, Temperature and altitude correction, Impact of tower height, Maximum rotor efficiency, wind turbine generators, Average power in the wind, wind turbine-Aerodynamics.

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

UNIT-IV

Fuel Cells & Wave Energy: Fuel Cells – Historical Development, Basic Operation of Fuel cells, Fuel cell Thermodynamics: Enthalpy, Entropy and theoretical efficiency of Fuel Cells, Gibbs free energy and Fuel cell efficiency, Electrical output of an ideal cell electrical characteristics.

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

TEXT BOOKS:

- 1 Renewable and Efficient Electric Power systems: Gilbert M. Masters, John Wiley & Sons, Inc., Publication.2013.

REFERENCE BOOKS:

- 1 Renewable Energy Sources and Emerging Technologies, D.P. Kothari, K. C. Singal, RakeshRanjan, Kothari D.P., singal K. C., ranjan Rakesh.2011.


COURSE OUTCOMES:

At the end of the course students able to

- 1 Apply basic knowledge in electronics, electrical circuit analysis, electrical machines, microprocessors, and programmable logic controllers.
- 2 demonstrate a working knowledge of drafting and computer usage, including the use of one or more computer software packages for technical problem solving
- 3 apply creativity through the use of project-based work to the design of circuits, systems, or processes

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. **PLC programming:** Input instructions, Outputs, operational procedures, programming examples using contacts and coils, drill press operation.

UNIT-II

Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram constructions and flow charts for spray process system. **PLC registers:** characteristics of registers module addressing, holding registers, Input registers, Output registers.

UNIT-III

PLC Functions: Timer functions and industrial applications, counters, counter function industrial applications, arithmetic functions, number comparison. Data handling functions: SKIP, master control relay, jump, move, FIFO, FAL, ONS, CLR and SWEEP functions and their applications.

UNIT-IV

Bit pattern and changing a bit shift register, sequence functions and applications, controlling of two axis and three axis robots with PLC, matrix functions. **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 John W. Webb and Ronald A. Reiss, Programmable logic controllers-Principle and applications, Fifth edition, PHI.2003.

REFERENCE BOOKS:

- 1 JR Hackworth and F.D Hackworth Jr, Programmable logic controllers- Programming Method and applications - Pearson, 2004.



16EP1207 ENERGY AUDITING, CONSERVATION AND MANAGEMENT

COURSE OUTCOMES:

At the end of the course students able to

- 1 Impart basic knowledge about current energy scenario, energy management, auditing and conservation.
- 2 inculcate systematic knowledge and skill about assessing the energy efficiency, energy auditing and energy management.

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.

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-II

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.

Power Factor Improvement: Lighting Power factor – methods of improvement, location of capacitors, p.f with non linear loads, effect of harmonics on p.f. , p.f motor controllers - Good lighting system design and practice , lighting control ,lighting energy audit

UNIT-III

Energy Instruments: Energy Instruments watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers, application of PLC's

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

UNIT-IV

Computation of Economic Aspects: Calculation of simple payback method , net present worth method - Power factor correction, lighting - Applications of life cycle costing analysis, return on investment.

TEXT BOOKS:

- 1 W.R. Murphy & G. McKay Butter worth, Energy management, Heinemann publications.1982.
- 2 Paul o' Callaghan, Energy management, Mc-Graw Hill Book company-1st edition, 1998
- 3 John C. Andreas &Marcel Dekker Energy efficient electric motors, Inc Ltd-2/e, 1995.

REFERENCE BOOKS:

- 1 W.C.Turner, john Wiley and sons, Energy management hand book.2007.
- 2 Fuel efficiency- booklet12,Energy management and good lighting practice: -EEO.1993.



16EP1208 REACTIVE POWER COMPENSATION AND MANAGEMENT

COURSE OUTCOMES:

At the end of the course students able to

- 1 Distinguish the importance of load compensation in symmetrical as well as un symmetrical loads
- 2 Observe various compensation methods in transmission lines
- 3 Construct model for reactive power coordination
- 4 Distinguish demand side reactive power management & user side reactive power 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.

Steady-State Reactive Power Compensation in Transmission System: Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples.

UNIT-II

Transient State Reactive Power Compensation in Transmission Systems: Characteristic time periods - passive shunt compensation – static compensations- series capacitor compensation -compensation using synchronous condensers – examples.

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-III

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-IV

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 Arc furnaces: Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements –remedial measures –power factor of an arc furnace.

TEXT BOOKS:

- 1 T.J.E.Miller, John Wiley and sons, Reactive power control in Electric power systems by, 1982 (Units I to IV).

REFERENCE BOOKS:

- 1 D.M.Tagare, Reactive power Management, Tata McGraw Hill, 2004. (Units V toVIII).


COURSE OUTCOMES:

At the end of the course students able to

- 1 Analyze the characteristics of a PV system, explain maximum power point tracking algorithm
- 2 Explain and identify different components of a wind power generation systems and analyze the output power characteristics
- 3 Apply engineering techniques, tools and resources.

LIST OF EXPERIMENTS

- 1 The I-V and P-V characteristics of two modules in series and parallel.
- 2 Plot charging and discharging characteristics of battery
- 3 Perform the experiment of manually finding the MPP by varying the resistive load across the PV panel.
- 4 Perform the experiment of finding the MPP by varying the duty cycle of DC-DC converter
- 5 Observation of current for linear & nonlinear loads and voltage waveform at PCC.
- 6 Synchronization of grid tied inverter, observation of current waveform and calculations for distortion, displacement and power factor of grid tied inverter.
- 7 Evaluation of the active, reactive power and net energy flow between grid tied inverter, artificial grid & load.
- 8 MPPT Algorithm for SOLAR PV Panel Testing.
- 9 P, V and F measurement of output of wind generator.
- 10 Impact of load and wind speed on power output and its quality.
- 11 Performance of Frequency drop characteristic of induction generator at different loading conditions.
- 12 Design of DC –DC Converter for different types of variable DC Loads through SIMULINK/MATLAB.
- 13 Design of DC –AC Converter for different types of variable AC Loads through SIMULINK/MATLAB


COURSE OUTCOMES:

At the end of the course students able to

- 1 Apply computational methods for large scale power system studies.
- 2 Develop software for power system industry

LIST OF EXPERIMENTS

- 1 Contingency studies using load flows for generator & line outages
- 2 Solution of Economic load dispatch problem
- 3 Transient stability study of SMIB
- 4 Contingency studies using ZBUS
- 5 State estimation algorithm using WLS method
- 6 Simulation of single area load frequency control
- 7 Simulation of two area load frequency control
- 8 Simulation of power system stabilizer
- 9 Simulation of voltage stability problem
- 10 Design of LQR state feed back for a given system
- 11 Design of State feedback controller and observer through Pole assignment
- 12 Simulation of Three phase full converter using RL & E loads
- 13 Simulation of Three phase inverter with PWM controller
- 14 Simulation of resonant pulse commutation circuit.



The Term Paper is a precursor to the project work done in the 2nd year M.Tech Programme. The paper may be of 8-10 (A4 size) in length and follows the standard IEEE/Technical Journal Format.

The Term Paper helps to supplement the second year Project Work of the M.Tech students. It helps to identify their Research area/topic and complete the groundwork and preliminary research required for it comfortably. It trains the students to make use of Research Tools and Material available both in print and digital formats.

Based on the topic, a hypothesis is to be made by the student, under the supervision of the guide. The student is then required to collect literature and support information for his / her term paper from Standard Reference Books, Journals, and Magazines - both printed and online. Each student should refer to a minimum of 6 reference sources related to the topic. The student also presents his/her paper with the help of Power Point slides / OHP.

The Term Paper contains: The Aim and Objective of the study, The need for Rationale behind the study, Identify the work already done in the field, Hypothesis and Discussion, Conclusion Appendix with support data (Illustrations, Tables, Graphs, etc.).

Page Limit: minimum of eight pages.

Date of evaluation: During the Lab Internal Exam.

Method of Evaluation: Total 50 marks

1. Day to day work - 10 marks
2. Term Paper Report - 20 marks
3. Seminar - 20 marks

**COURSE OUTCOMES:**

At the end of the course students able to

- 1 Test the learning and understanding during the course of under graduate program.
- 2 Face interview both at the academic and the industrial sector.

All the students shall face a Comprehensive viva-voce covering the total courses of first and second semesters. The comprehensive viva-voce will be conducted along with 2nd semester lab examination for 75 marks by a committee consisting of Head of the Department, two senior faculty members nominated by the Head of the Department


COURSE OUTCOMES:

At the end of the course students able to

- 1 develop awareness, understanding and capacity in the specific roles and responsibilities in an industry
- 2 develop and refinement of technical and professional skills

All the students shall undergo the summer internship during summer break after 2nd semester. The minimum internship period is eight weeks and the students have an option of choosing their own industry/area of interest, which may be related to their respective branch or any other service oriented task. A self study report for the internship shall be submitted and evaluated during the 3rd semester and will be evaluated for a total of 75 marks consisting of 25 marks for internal assessment and 50 marks for semester end examination. Internal assessment shall be done by the internship supervisor. Semester end examination for 50 marks shall be conducted by two examiners, one of them being internship supervisor as internal examiner and an external examiner nominated by the Principal from the panel of experts recommended by HOD

**COURSE OUTCOMES:**

At the end of the course students able to

- 1 Identify a problem of current relevance to society
- 2 Formulate the problem and identify suitable modeling paradigm.
- 3 Analyze the problem and identify the solution methodology

Students are required to take up a project work, in which the student can choose any specific problem of Industry or Industry based project work. Alternatively it can be secondary source based or Field based project work. Before the commencement of the project work each student is required to submit a synopsis indicating the objectives, Methodology, Framework for analysis, Action plan with milestones in order to have clarity for the subsequent work. The project should have an internal faculty as guide. The student can initiate the project work in the penultimate semester of the course.