# PROGRAMME : M.E.
## POWER SYSTEMS
### CURRICULUM

#### SEMESTER 1

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**TOTAL CREDITS** 27

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**TOTAL CREDITS** 19

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**ELECTIVE COURSES**

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COURSE OBJECTIVE
• The ability to identify, reflect upon, evaluate and apply different types of information and knowledge to form independent judgments.

UNIT 1 MATRIX THEORY  11 Hrs.
QR decomposition – Eigen values using shifted QR algorithm- Singular Value Decomposition - Pseudo inverse- Least square approximations

UNIT 2 CALCULUS OF VARIATIONS  13 HRS.
Concept of Functionals - Euler’s equation – functional dependent on first and higher order derivatives – Functionals on several dependent variables – Iso perimetric problems - Variational problems with moving boundaries

UNIT 3 TRANSFORM METHODS  12 Hrs.

UNIT 4 ELLIPTIC EQUATIONS  11 Hrs.

UNIT 5 LINEAR AND NON-LINEAR PROGRAMMING  13 HRS.

TEXT / REFERENCE BOOKS
COURSE OBJECTIVES
- To have an understanding in the availability of generation and its economic dispatch
- To study about the distributed generation and its coordination
- To have a knowledge in importance of reactive power which relates with power factor improvement

UNIT 1  ECONOMIC LOAD DISPATCH  12 Hrs.

UNIT 2  UNIT COMMITMENT  12 Hrs.
Constraints in unit commitment – Spinning reserve, thermal unit constraints, and other Constraints – Solution techniques-Priority List method, Dynamic programming method, Forward DP approach, Lagrangian relaxation method – adjusting \( \lambda \) – Economic load dispatch vs Unit commitment.

UNIT 3  HYDRO -THERMAL COORDINATION  12 Hrs.
Long Range Hydro Scheduling – Short Range Hydro Scheduling - Hydro Electric plant models – Scheduling problems – The Short term Hydrothermal Scheduling using gradient method, dynamic and linear programming

UNIT 4  ACTIVE POWER AND FREQUENCY CONTROL  12 Hrs.
Fundamentals of speed governing-control of generating unit power output-composite regulating characteristics of power systems-Response rates of turbine governing systems-Fundamentals of automatic generation control-Implementation of AGC-under frequency load shedding.

UNIT 5  REACTIVE POWER AND VOLTAGE CONTROL  12 Hrs.
Production and absorption of reactive power-Methods of voltage control-shunt reactors, shunt capacitors, series capacitors, synchronous condensers, static VAR systems-principles of transmission system compensation – Modelling of reactive compensation devices-Application of tap-changing transformers to transmission systems-Distribution System Voltage Regulation-Modelling of transformer ULTC control system.

TEXT / REFERENCE BOOKS

END SEMESTER EXAM QUESTION PAPER PATTERN
Max. Marks : 70  Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice  20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks  50 Marks
COURSE OBJECTIVE

- To gain knowledge in detailed modelling of power system elements
- To implement Numerical methods in power flow problem
- To have a detailed knowledge in fault analysis and contingency analysis.

UNIT 1 NETWORK MATRICES AND THEIR SOLUTION TECHNIQUES 12 Hrs.
Formation of network matrix by Singular transformation – Non Singular transformation - Sparse Matrix techniques for large scale power systems - Optimal ordering schemes for preserving sparsity - Flexible packed storage scheme for storing matrix as compact arrays - Factorization by Bifactorization and Gauss elimination methods - Repeat solution using - Left and Right factors and L and U matrices.

UNIT 2 MODELING 12 Hrs.

UNIT 3 POWER FLOW STUDIES 12 Hrs.

UNIT 4 FAULT STUDIES 12 Hrs.
Fault calculations using sequence networks for different types of faults. Bus impedance matrix (ZBUS) construction using Building Algorithm for lines with mutual coupling; Simple numerical problems. Computer method for fault analysis using ZBUS and sequence components. Derivation of equations for bus voltages, fault currents and line currents, both in sequence and phase domain using Thevenins’ equivalent and ZBUS matrix for different faults.

UNIT 5 CONTINGENCY ANALYSIS 12 Hrs.
Adding and removing multiple lines – Piecewise solution of interconnected systems – Analysis of single contingencies and multiple contingencies – contingency by DC model – System reduction for contingencies and fault studies.

TEXT / REFERENCE BOOKS

END SEMESTER EXAM QUESTION PAPER PATTERN
Max. Marks : 70
Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice 20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks 50 Marks
COURSE OBJECTIVES

- To have an understanding in various Reactive power Compensators
- To model and implement the FACTS controllers in enhancement of power system performance
- To have a knowledge in coordination of FACTS controllers

UNIT 1 INTRODUCTION 12 Hrs.


UNIT 2 STATIC VAR COMPENSATOR (SVC) 12 Hrs.

Thyristor Controlled Reactor (TCR) - Thyristor Switched Reactor (TSR) - Thyristor Switched Capacitor (TSC) - Fixed Capacitor - Thyristor Controlled Reactor (FC-TCR) - Thyristor Switched Capacitor - Thyristor Controlled Reactor (TSC -TCR) – V-I Characteristics of Static Var Compensator (SVC) - Advantages of slope in dynamic Characteristic – Voltage control by SVC – Design of SCV voltage regulator. Applications: Increase in power transfer capacity – Enhancement of transient stability – Prevention of voltage instability.

UNIT 3 THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) 12 Hrs.


UNIT 4 EMERGING FACTS CONTROLLER 12 Hrs.


UNIT 5 SUB SYNCHRONOUS RESONANCE (SSR) 12 Hrs.

NGH-SSR damping scheme – Thyristor controlled braking resistor (TCBR) – Coordination of Multiple Controllers using Linear Control Techniques – Approximate multimodal decomposition method for the design of FACTS controllers.

Max. 60 Hours

TEXT / REFERENCE BOOKS


END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 70  Exam Duration : 3 Hrs.

PART A : 5 questions of 4 marks each – No choice 20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks 50 Marks
COURSE OBJECTIVES
- To design future power system
- Extrapolation of electricity consumption for future expansion
- To schedule power generation pattern

UNIT 1 INTRODUCTION
Objective of system planning - long term and short term planning - stages in planning - policy studies, planning standardization studies, system and network reinforcement studies.

UNIT 2 LOAD FORECASTING
Load forecasting – definitions of basic concepts - characteristics of loads – methodology of forecasting – energy forecasting – peak demand forecasting – non weather and weather forecasting – total forecasting – annual and monthly peak demand forecasting- factors in power system loading.

UNIT 3 GENERATION SYSTEM COST ANALYSIS
Introduction - types of production cost analysis - probability methods and uses in generation planning - probabilistic production cost computations.

UNIT 4 SCHEDULING
Simulating economic scheduling - scheduling procedures - scheduling algorithms for probabilistic production cost computations - aspects of practical implementation - effect of off-peak energy sales on production cost. Pollution - types of pollution - need to assess pollution effects in simulating scheduling.

UNIT 5 EXPANSION PLANNING
Basic concepts on expansion planning-procedure for integrate transmission system planning - Tellegen’s theorem - network sensitivities - network design - formulation of the planning problem - solution using DC method.

TEXT / REFERENCE BOOKS

END SEMESTER EXAM QUESTION PAPER PATTERN
Max. Marks : 70
Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice
PART B : 2 questions from each unit of internal choice, each carrying 10 marks
COURSE OBJECTIVES
- To understand future smart grid concept
- To understand information, communication technique for power system
- To understand smart metering

UNIT 1  INTRODUCTION 12 Hrs.
The Smart Grid – Why to implement smart grid - Ageing assets and lack of circuit capacity-Operational constraints-Security of supply-National initiatives-What is the smart grid-Early smart grid initiatives-Active distribution networks-Virtual power plant-Overview of the technologies required for the smart grid - Communication technologies for smart grid-Standards for smart metering- Modbus-DNP3-61850

UNIT 2  INFORMATION SECURITY FOR SMART GRID 12 Hrs.

UNIT 3  SMART METERING AND DEMAND SIDE INTEGRATION 12 Hrs.
Introduction-Smart metering- Evolution of electricity metering - Key components of smart metering -Smart meters: An overview of hardware used- Communications infrastructure and protocols for smart metering--Demand side integration-Services provided by DSI-Implementations of DSI-Hardware support to DSI implementations-Flexibility delivered by consumers from the demand side.

UNIT 4  DISTRIBUTION MANAGEMENT SYSTEMS 12 Hrs.

UNIT 5  TRANSMISSION SYSTEM OPERATION 12 Hrs.
Introduction-data sources- IEDs and SCADA- Phasor measurement units- energy management systems-wide area applications-online transient stability controller- pole slipping preventive controller-visualisation techniques-visual 2- D presentation-visual 3- D presentation

Max. 60 Hours

TEXT / REFERENCE BOOKS

END SEMESTER EXAM QUESTION PAPER PATTERN
Max. Marks : 70  Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice  20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks  50 Marks
9. Three Phase Matrix Converter
10. Chopper fed DC motor drive
11. Simulation of Single Phase Half Converter with different loads.
12. Three Phase Full Controlled Rectifier with R, RL loads.
13. Simulation of Buck Converter.
14. Simulation of Boost Converter
15. Simulation of Buck-Boost Converter.

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SUGGESTED LIST OF EXPERIMENTS

1. Formation of Y-bus
2. Formation of Z-bus
3. Power Flow analysis by Gauss-seidel method
4. Power Flow analysis by NR method
5. Power Flow analysis by FDLF
6. Continuation power flow method
7. Unit commitment
8. Economic Load Dispatch
9. Automatic Generation Control
10. Fault analysis
11. Contingency Analysis
12. Sparse Matrix techniques

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SUGGESTED LIST OF EXPERIMENTS

1. Power Flow analysis by Gauss-seidel method
2. Power Flow analysis by NR method
3. Power Flow analysis by FDLF
4. Small-signal stability analysis of single machine-infinite bus system using classical machine model
5. Small-signal stability analysis of multi-machine configuration with classical machine model
6. Co-ordination of over-current and distance relays for radial line protection
7. Load flow analysis of two-bus system with FACTS device
8. Transient analysis of two-bus system with FACTS device
9. Available Transfer Capability calculation using an existing load flow program
10. Contingency Analysis
SEE5112  |  OPTIMIZATION TECHNIQUES  
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COURSE OBJECTIVES

- To enhance the creative process of conceptual and detailed design of engineering systems.
- To understand various optimization techniques and its application to engineering problems.

UNIT 1  |  INTRODUCTION TO OPTIMIZATION  12 Hrs.

UNIT 2  |  LINEAR PROGRAMMING  12 Hrs.

UNIT 3  |  NON LINEAR PROGRAMMING  12 Hrs.

UNIT 4  |  GEOMETRIC PROGRAMMING AND INTEGER PROGRAMMING  12 Hrs.

UNIT 5  |  DYNAMIC PROGRAMMING  12 Hrs.
 Dynamic programming: Multistage decision processes – Concept of sub optimization – Principle of optimality – Conversion of a final value problem into an initial value problem – Linear programming as a case of dynamic programming – Continuous dynamic programming – application to unit commitment.

Max. 60 Hours

TEXT / REFERENCE BOOKS


END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 70  |  Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice  |  20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks  |  50 Marks
COURSE OBJECTIVES

- To understand the Stability using the state space representation of the power system.
- To study the security and state estimation of the power system

UNIT 1  STABILITY  12 Hrs.

UNIT 2  SMALL SIGNAL STABILITY  12 Hrs.

UNIT 3  VOLTAGE STABILITY  12 Hrs.

UNIT 4  POWER SYSTEM STATE ESTIMATION  12 Hrs.

UNIT 5  SECURITY ASSESSMENT  12 Hrs.

TEXT / REFERENCE BOOKS

7. Murty P.S.R Power system operation and control Bsp, 2005

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 70  Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice  20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks  50 Marks

M.E. / M. Tech REGULAR  REGULATIONS 2015
9. Three Phase Matrix Converter
10. Chopper fed DC motor drive
11. Simulation of Single Phase Half Converter with different loads.
12. Three Phase Full Controlled Rectifier with R, RL loads.
13. Simulation of Buck Converter.
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SUGGESTED LIST OF EXPERIMENTS

1. Formation of Y-bus
2. Formation of Z-bus
3. Power Flow analysis by Gauss-seidel method
4. Power Flow analysis by NR method
5. Power Flow analysis by FDLF
6. Continuation power flow method
7. Unit commitment
8. Economic Load Dispatch
9. Automatic Generation Control
10. Fault analysis
11. Contingency Analysis
12. Sparse Matrix techniques

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<th>See6533</th>
<th>Power System Simulation Lab – II (for PS)</th>
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SUGGESTED LIST OF EXPERIMENTS

1. Power Flow analysis by Gauss-seidel method
2. Power Flow analysis by NR method
3. Power Flow analysis by FDLF
4. Small-signal stability analysis of single machine-infinite bus system using classical machine model
5. Small-signal stability analysis of multi-machine configuration with classical machine model
6. Co-ordination of over-current and distance relays for radial line protection
7. Load flow analysis of two-bus system with FACTS device
8. Transient analysis of two-bus system with FACTS device
9. Available Transfer Capability calculation using an existing load flow program
10. Contingency Analysis
## COURSE OBJECTIVES

- To have a detailed study of Fuzzy logic, Artificial Neural Networks, Genetic algorithm, Particle Swarm Optimization and Differential Evolutionary algorithms and implementation of the same in Power systems Engineering problems.
- To expose to Multi objective optimization and various solution techniques

### UNIT 1  
**FUZZY LOGIC SYSTEM**  
**12 Hrs.**  
Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modelling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy logic based power system stabilizer.

### UNIT 2  
**ARTIFICIAL NEURAL NETWORKS**  
**12 Hrs.**  

### UNIT 3  
**GENETIC ALGORITHM**  
**12 Hrs.**  
Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. GA implementation to ED with smooth cost function.

### UNIT 4  
**PARTICLE SWARM OPTIMIZATION AND DIFFERENTIAL EVOLUTION**  
**12 Hrs.**  
Basic concept of Particle Swarm Optimization and detail algorithmic steps (PSO) - Basic concept of Differential Evolution (DE) and detail algorithmic steps – PSO for solving Optimal Power Flow.

### UNIT 5  
**PARETO MULTI OBJECTIVE OPTIMIZATION**  
**12 Hrs.**  
Objectives of multi objective optimization – concepts of Pareto optimality – Solution to Pareto multi objective optimization: weighted aggregation – Goal programming.

### TEXT / REFERENCE BOOKS

5. Xin-She- Yang, Engineering Optimization – An introduction with metaheuristic application, A John Wiley & Sons. Inc. Publication. 2010

### END SEMESTER EXAM QUESTION PAPER PATTERN:

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Max. Marks : 70  
Exam Duration : 3 Hrs.
SUGGESTED LIST OF EXPERIMENTS

SEE6534 POWER SYSTEM OPTIMIZATION LAB
(For PS)

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1. Load forecasting using ANN
2. Unit commitment using Genetic Algorithm
3. Economic Load Dispatch using Genetic Algorithm
4. Available Transfer Capacity assessment using Genetic Algorithm
5. Non-convex Economic Load Dispatch using Differential Evolution Algorithm
6. Optimal placement of FACTS devices using DE Algorithm
7. Optimal power flow using PSO
8. Multi-objective OPF using Fuzzy theory

SIC6531 INSTRUMENTATION & PROCESS CONTROL LAB
(For E&C)

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1. Design of PID, P, PI controllers first order system using
   i) Cohen Coon Method
   ii) Ziegler Nicholas Method
2. Design of digital controller using Dalhin’s algorithm.
3. Design of Fuzzy logic controller.
4. Characteristics of current to pressure converter.
5. Characteristics of pressure to current converter.
6. To calculate coefficient of discharge of an ORIFILE meter.
8. Level controller
10. To study the characteristics of flopper nozzle.

SIC6532 ANALOG AND DIGITAL CIRCUIT DESIGN LAB
(For E&C)

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1. Design of Adder and Subtractor.
2. Design of Mux and Demux using NAND gate.
3. Design of Asynchronous counter.
4. Design of parallel Adder and subtractor.
5. Linear application of operational amplifier.
7. Analog to digital converter.
8. Digital to analog converter.
10. Design Adder and subtractor IC74153
11. Design of Encoder and decoder.
COURSE OBJECTIVES

- To understand the concepts, basic operation, steady-state operation of power electronic devices.
- To study the various PWM techniques.
- To analyse the various converters and to apply power electronics to energy systems.

UNIT 1  POWER ELECTRONICS DEVICES IN POWER SYSTEMS  12 Hrs.
Characteristics of Ideal switches, Real switches, Practical Power Switching Devices - Construction, principle of operation and characteristic of SCR, MOSFET, GTO, IGBT - Thermal Design of Power Switching Devices - Intelligent Power Modules

UNIT 2  PWM TECHNIQUES  12 HRS.

UNIT 3  VOLTAGE SOURCE CONVERTER (VSC) 12 Hrs.

UNIT 4  POWER FACTOR CORRECTION (PFC) CIRCUIT  12 Hrs.

UNIT 5  POWER ELECTRONICS IN CLEAN ENERGY  12 Hrs
Clean energy systems - solar energy systems – wind energy systems – fuel cell energy systems – power electronics and energy conversation.

Max. 60 Hours

TEXT / REFERENCE BOOKS
2. V. Ramanarayanan, “Course Material on Switched Mode Power Conversion”, Department of Electrical Engineering, Indian Institute of Science, Bangalore

END SEMESTER EXAM QUESTION PAPER PATTERN
Max. Marks : 70  Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice 20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks 50 Marks
COURSE OBJECTIVES

- To study the power factor correction and harmonic analysis of power system.
- To understand the performance of ground grid.

UNIT 1  MOTOR STARTING STUDIES  12 Hrs..

UNIT 2  POWER FACTOR CORRECTION STUDIES  12 Hrs..

UNIT 3  HARMONIC ANALYSIS  12 Hrs..

UNIT 4  FLICKER ANALYSIS  12 Hrs..
Sources of Flicker-Flicker Analysis-Flicker Criteria-Data for Flicker analysis- Case Study-Arc Furnace Load-Minimizing the Flicker Effects-Summary.

UNIT 5  GROUND GRID ANALYSIS  12 Hrs..

END SEMESTER EXAM QUESTION PAPER PATTERN
Max. Marks : 70  Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice  20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks  50 Marks
COURSE OBJECTIVES

- To understand forthcoming trend in power system
- To understand deregulated power system environment
- To understand pricing, trading and congestion

UNIT 1 INTRODUCTION TO POWER SYSTEM RESTRUCTURING 12 Hrs.

An overview of the restructured power system, difference between integrated power system and restructured power system, transmission open access, wheeling, Power systems operation – Genco’s, Transco’s, Disco’s, customers - Restructuring Models: Pool Co Model, Bilateral Contracts Model, Hybrid Model, Multilateral trade model - Power Exchange (PX): Market Clearing Price(MCP) - Market operations: Day-ahead and Hour-Ahead Markets, Elastic and Inelastic Markets

UNIT 2 ISO AND ELECTRIC UTILITY MARKET 12 Hrs.


UNIT 3 OASIS: OPEN ACCESS SAME-TIME INFORMATION SYSTEM 12 Hrs.

Introduction - Structure of OASIS: Functionality and Architecture of OASIS - Implementation of OASIS Phases: Phase 1, Phase 1-A, Phase 2 - Posting of information: Types of information available on OASIS, Information requirement of OASIS, Users of OASIS.

UNIT 4 ELECTRIC ENERGY PRICING & TRADING 12 Hrs.


UNIT 5 CONGESTION MANAGEMENT 12 Hrs.


Max. No. of Hrs: 60

Max. 60 Hours

TEXT / REFERENCE BOOKS


END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 70

Exam Duration : 3 Hrs.

PART A : 5 questions of 4 marks each – No choice

PART B : 2 questions from each unit of internal choice, each carrying 10 marks
COURSE OBJECTIVES
- The course is designed to familiarize the student with the functions and instrumentation available in a modern power generation plant and provides a technical overview of different methods of power generation and hence bring out the various measurements involved in power generation plants.
- A broad spectrum of knowledge about the different types of devices and control techniques used for analysis is studied in detail.

UNIT 1 INTRODUCTION
Definition of SCADA - Operation and Control using SCADA - Data acquisition systems for Power System applications - Data Transmission and Telemetry - Measurement and error analysis. Object and philosophy of power system instrumentation to measure large currents, high voltages, Torque and Speed - Standard specifications.

UNIT 2 PROGRAMMABLE LOGIC CONTROLLERS

UNIT 3 POWER PLANT INSTRUMENTATION

UNIT 4 DISTRIBUTION AUTOMATION

UNIT 5 ENERGY MANAGEMENT TECHNIQUES AND INSTRUMENTS

Max. 60 Hours

TEXT / REFERENCE BOOKS

END SEMESTER EXAM QUESTION PAPER PATTERN
Max. Marks : 70
Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice 20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks 50 Marks
SEE5613  POWER SYSTEM DYNAMICS  
(For PSE)  

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COURSE OBJECTIVES
- To analyse small signal stability and transient stability
- To study subsynchronous oscillation
- To study the concept of voltage stability.

UNIT 1  SMALL SIGNAL STABILITY ANALYSIS WITHOUT CONTROLLERS  12 Hrs.

UNIT 2  SMALL SIGNAL STABILITY ENCHANCEMENT WITH CONTROLLERS  12 Hrs.

UNIT 3  TRANSIENT STABILITY ANALYSIS  12 Hrs.

UNIT 4  SUBSYNCHRONOUS OSCILLATION (SSR)  12 Hrs.
Turbine-Generator torsional Characteristics – torsional interaction with power system Control-generator excitation control, speed governors, dc converters- sub-synchronous resonance – counter measures to SSR problem – impact of network switching disturbances- torsional interaction between closely coupled units – hydro generator – torsional characteristics.

UNIT 5  VOLTAGE STABILITY  12 Hrs.

Max. 60 Hours

TEXT / REFERENCE BOOKS

END SEMESTER EXAM QUESTION PAPER PATTERN
Max. Marks : 70  Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice 20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks 50 Marks
COURSE OBJECTIVE

- To understand the concept of reliability in generation system, transmission system, bulk power system and interconnected system

UNIT 1 CONCEPTS OF RELIABILITY 12 Hrs.

UNIT 2 GENERATION SYSTEM RELIABILITY ANALYSIS 12 Hrs.
Probabilistic generation and load models – determination of LOLP and expected value of demand not served – determination of reliability of isolated and interconnected generation systems.

UNIT 3 TRANSMISSION SYSTEM RELIABILITY ANALYSIS 12 Hrs.
Deterministic contingency analysis- probabilistic load flow – fuzzy load flow – probabilistic transmission system reliability analysis – determination of reliability indices like LOLP and expected value of demand not served.

UNIT 4 BULK POWER SYSTEM RELIABILITY 12 Hrs.
Service quality criterion - conditional probability approach - single system application - two plant, single load system - two plant, two load system - networked system approach.

UNIT 5 INTERCONNECTED SYSTEM GENERATING CAPACITY RELIABILITY 12 Hrs.
Probability array for two systems - loss of load approach - load forecast uncertainty - interconnection benefits

TEXT / REFERENCE BOOKS

END SEMESTER EXAM QUESTION PAPER PATTERN
Max. Marks : 70
Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice 20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks 50 Marks
COURSE OBJECTIVES
- To understand the linear and non linear load
- To study various measurement and analysis of voltage and current.

UNIT 1 INTRODUCTION 12 Hrs.
Introduction – Characterisation of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

UNIT 2 NON -LINEAR LOADS 12 Hrs.
Single phase static and rotating AC/DC converters, Three phase static AC/DC converters, Battery chargers, Arc furnaces, Fluorescent lighting, pulse modulated devices, Adjustable speed drives.

UNIT 3 MEASUREMENT AND ANALYSIS METHODS 12 Hrs.

UNIT 4 ANALYSIS AND CONVENTIONAL MITIGATION METHODS 12 Hrs..
Analysis of power outages, Analysis of unbalance: Symmetrical components of phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion: On–line extraction of fundamental sequence components from measured samples – Harmonic indices – Analysis of voltage sag: Detorit Edison sag score, Voltage sag energy, Voltage Sag Lost Energy Index (VSLEI)- Analysis of voltage flicker, Reduced duration and customer impact of outages, Classical load balancing problem: Open loop balancing, Closed loop balancing, current balancing, Harmonic reduction, Voltage sag reduction.

UNIT 5 POWER QUALITY IMPROVEMENT 12 Hrs.
Utility-Customer interface –Harmonic filters: passive, Active and hybrid filters –Custom power devices: DSTATCOM, DVR, UPQC –Status of application of custom power devices

Max. 60 Hours

TEXT / REFERENCE BOOKS

END SEMESTER EXAM QUESTION PAPER PATTERN
Max. Marks : 70
PART A : 5 questions of 4 marks each – No choice 20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks 50 Marks

Exam Duration : 3 Hrs.
COURSE OBJECTIVES

- To understand electric power system distribution issues
- Implementation of automation system into electric distribution system
- To understand smart metering and control

UNIT 1 DISTRIBUTION AUTOMATION 12 Hrs.

UNIT 2 SUBSTATION AUTOMATION 12 Hrs.

UNIT 3 SCADA SYSTEMS 12 Hrs.

UNIT 4 FEEDER AUTOMATION 12 Hrs.

UNIT 5 REMOTE METERING 12 Hrs.
Automatic Meter Reading (AMR)system – Components of AMR system – Communication methods for Meter Reading- Services and functions –Financial Analysis – Planning for AMR implementation.

Max. 60 Hours

TEXT / REFERENCE BOOKS

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 70
Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice 20 marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks 50 marks
COURSE OBJECTIVES:
- To provide a insight about the various protective schemes employed in protecting the power systems.
- To study about various protective components and their applications to power systems.

UNIT 1  PROTECTIVE RELAYS

UNIT 2  GENERATOR AND TRANSFORMER PROTECTION

UNIT 3  BUS BAR PROTECTION

UNIT 4  PROTECTION OF REACTORS, BOOSTERS & CAPACITORS

UNIT 5  NUMERICAL PROTECTION

Max. 60 Hours

TEXT / REFERENCE BOOKS

END SEMESTER EXAM QUESTION PAPER PATTERN
Max. Marks : 70
Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice 20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks 50 Marks
COURSE OBJECTIVE

- The course is designed to familiarize the student with the fundamental of power system economics and provides a technical overview of transmission networks and electricity markets.

UNIT 1  FUNDAMENTAL OF COMPETITION AND ECONOMICS  12 Hrs.


UNIT 2  MARKETS FOR ELECTRICAL ENERGY  12 Hrs.

Need for a managed spot market – open electrical energy markets: bilateral trading – electricity pools – managed spot market: balancing resources – gate closure – interaction between the managed spot market and other markets – settlement process

UNIT 3  PARTICIPATING IN MARKETS, SYSTEM SECURITY  12 Hrs.

Consumer’s perspective – producer’s perspective – perspective of plants with very low marginal costs – hybrid participants perspective – need for system security – Ancillary services: obtaining – buying – selling.

UNIT 4  TRANSMISSION NETWORKS AND ELECTRICITY MARKETS  12 Hrs.

Decentralized trading over a transmission network – centralized trading over a transmission network: two bus system – three bus system – mathematical formulation of nodal pricing – managing transmission risks in a centralized trading system

UNIT 5  INVESTING IN GENERATION AND TRANSMISSION  12 Hrs.


Max. 60 Hours

TEXT / REFERENCE BOOKS


END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 70
Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice 20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks 50 Marks
COURSE OBJECTIVES

- To acquire knowledge in various Digital transmission techniques and channelization
- To have an clear understanding in protocols and Standards for PLC system.
- To have an exposure in PLC implementation

UNIT 1 CHANNEL CHARACTERIZATION 12 Hrs.

UNIT 2 DIGITAL TRANSMISSION TECHNIQUES 12 Hrs.
Introduction-Modulation and Coding for Narrowband PLC systems-Modulation and Coding for Broadband PLC systems

UNIT 3 PROTOCOLS FOR PLC SYSTEM 12 Hrs.
Introduction-Broadband PLC Media Access Control Layer-Protocols for PLC supporting Energy Management Systems-Internet Protocol Television Over PLC

UNIT 4 INDUSTRIAL AND INTERNATIONAL STANDARDS ON PLC-BASED NETWORKING TECHNOLOGIES 12Hrs.
Introduction- PLC Standardization by Industrial Alliances-International Standards on PLC-networking Technology- ETSI and CENELEC Standards

UNIT 5 SYSTEMS AND IMPLEMENTATIONS 12 Hrs.
Introduction- PLC Smart Grid Systems-PLC Broadband Access Systems-Multimedia PLC Systems-DC-PLC Systems

Max. 60 Hours

TEXT / REFERENCE BOOKS

END SEMESTER EXAM QUESTION PAPER PATTERN
Max. Marks : 70  Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice 20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks 50 Marks
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**COURSE OBJECTIVE**

- To cover all aspects of distribution engineering from basic system planning and concepts through distribution system protection and reliability

**UNIT 1 GENERAL ASPECTS**


**UNIT 2 DISTRIBUTION SYSTEM PLANNING**

Distribution system expansion planning – load characteristics – load forecasting – design concepts – optimal location of substation – design of radial lines – solution technique.

**UNIT 3 VOLTAGE CONTROL OF DISTRIBUTION SYSTEM**

Voltage control – Application of shunt capacitance for loss reduction – Harmonics in the system – static VAR systems – Optimization for loss reduction and voltage improvement.

**UNIT 4 DISTRIBUTION SYSTEM PROTECTION**

System protection – requirement – fuses and section analyzers over current. Under voltage and under frequency protection – coordination of protective device

**UNIT 5 METERING, BILLING AND COLLECTION**


Max. 60 Hours

**TEXT / REFERENCE BOOKS**


**END SEMESTER EXAM QUESTION PAPER PATTERN**

Max. Marks : 70

- **PART A**: 5 questions of 4 marks each – No choice  
  20 marks
- **PART B**: 2 questions from each unit of internal choice, each carrying 10 marks  
  50 marks

Exam Duration : 3 Hrs.
COURSE OBJECTIVES

- To gain knowledge in designing of State Space Analysis for SISO and MIMO systems
- To have an clear understanding optimal control and its solution methods.
- To have an exposure in stability analysis of Nonlinear Systems.

UNIT 1  STATE SPACE ANALYSIS  12 Hrs.
Definitions concerning state space analysis approach – State model of a single input single output system (SISO)- State model of a multiple input multiple output system (MIMO)- State transition matrix and its properties- Solution of Linear Time invariant continuous time state equations – Solution of Linear Time varying Continuous time state equations.

UNIT 2  ANALYSIS OF STATE SPACE MODEL  12 Hrs.
Similarity Transformation- General Concepts of Controllability and Observability – Controllability and Observability tests for continuous time systems - Time Invariant and Time Varying systems - Controllability and observability canonical forms of state model – Canonical decomposition theorem

UNIT 3  DESIGN OF STATE SPACE MODEL  12 Hrs.

UNIT 4  OPTIMAL CONTROL  12 Hrs.

UNIT 5  STABILITY ANALYSIS OF NON- LINEAR SYSTEMS  12 Hrs.

Max. 60 Hours

TEXT / REFERENCE BOOKS

END SEMESTER EXAM QUESTION PAPER PATTERN
Max. Marks : 70  Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice  20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks  50 Marks
COURSE OBJECTIVES
- To understand bulk power transmission system
- To have an exposure in EHV testing

UNIT 1 INTRODUCTION 12 Hrs.
Introduction to EHV AC and DC transmission - comparison between HVAC and HVDC- overhead and underground transmission schemes - Factors concerning choice of HVAC and HVDC transmission - Role of EHVAC transmission - problems involved in EHVAC transmission.

UNIT 2 EHV AC TRANSMISSION 12 Hrs.
EHV AC Transmission - Properties of bundled conductors- Surface voltage gradient on single, double and multi conductor bundles - Effects of corona-power loss-charge voltage diagram with corona-attenuation of travelling waves due to corona loss-noise generation and their characteristics-corona pulses, their generation and properties (qualitative study only)- Problems of EHV AC transmission at power frequency- High phase order transmission - Comparison of power handling capacity

UNIT 3 HVDC TRANSMISSION 12 Hrs.

UNIT 4 EHV CABLE TRANSMISSION 12 Hrs.
Introduction – Electrical characteristics of EHV Cables – Properties of cable insulation materials – breakdown and withstand Electrical stresses in solid insulation statistical procedure- EHV insulators - their characteristics and pollution performance.- Design basis of cable insulation-Tests on cable characteristics- Surge performance of cable systems – Gas insulated EHV lines.

UNIT 5 EHV TESTING 12 Hrs.
Objectives of multi objective optimization – concepts of Pareto optimality – Solution to Pareto multi objective optimization: weighted aggregation – Goal programming.

Max. 60 Hours

TEXT / REFERENCE BOOKS

END SEMESTER EXAM QUESTION PAPER PATTERN
Max. Marks : 70 Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice 20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks 50 Marks
COURSE OBJECTIVES

- To impart knowledge on operation, modelling and control of HVDC link.

UNIT 1   DC POWER TRANSMISSION TECHNOLOGY  
Introduction - Comparison of AC and DC transmission - Application of DC transmission – Description of DC transmission system - Planning for HVDC transmission - Modern trends in DC transmission.

UNIT 2 ANALYSIS OF HVDC CONVERTERS  
Pulse number, choice of converter configuration - Simplified analysis of Graetz Circuit - Converter bridge characteristics – Characteristics of a twelve pulse converter - Detailed analysis of converters.

UNIT 3 CONVERTER AND HVDC SYSTEM CONTROL  
General principles of DC link control - Converter control characteristics - System control hierarchy - Firing angle control - Current and extinction angle control - Starting and stopping of DC link - Power control - Higher level controllers - Telecommunication requirements.

UNIT 4 MULTITERMINAL DC SYSTEM  

UNIT 5 HARMONICS AND CONVERTER COMPONENT MODEL  
Introduction - Generation of harmonics - Design of AC filters - DC filters - Carrier frequency and RI noise. Converter model - Continuous time model - Discrete time converter model - Detailed model of the converter.

TEXT / REFERENCE BOOKS

END SEMESTER EXAM QUESTION PAPER PATTERN
Max. Marks : 70  Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice 20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks 50 Marks
COURSE OBJECTIVES

- To study the fundamentals of high voltage engineering
- To have an exposure in measurement and testing of high voltages
- To have an exposure in gas insulated sub station.

UNIT 1 INTRODUCTION
Fundamentals of high voltage engineering - voltage stresses - Testing voltages - Testing with power frequency voltages - Testing with lightning impulse voltages - Testing with switching impulse voltages

UNIT 2 MEASUREMENT OF HIGH VOLTAGES
Peak voltage measurement – Sphere gap – Rod gap – Chubb Fortescue method – Active voltage capacitors for measuring circuits, Electrostatic voltmeter, Impulse voltage measurement – generalized voltage generation and measuring circuits – voltage dividers –Dividers voltage arm.

UNIT 3 ELECTROSTATIC FIELDS AND FIELD STRESS CONTROL

UNIT 4 HIGH VOLTAGE TESTING
High voltage testing of electrical equipment - testing of overhead line insulators, cables, bushings, power capacitors - power transformers, circuit breakers - various kinds of test voltages

UNIT 5 GAS INSULATED SUB STATION

Max. 60 Hours

TEXT / REFERENCE BOOKS
5. Alston.L.L “High Voltage Technology” Oxford University Press.1968,

END SEMESTER EXAM QUESTION PAPER PATTERN
Max. Marks : 70
Exam Duration : 3 Hrs.
PART A : 5 questions of 4 marks each – No choice 20 Marks
PART B : 2 questions from each unit of internal choice, each carrying 10 marks 50 Marks
COURSE OBJECTIVE

- To teach students the fundamentals of electrical transients and equip them with the skills to recognize and solve transient problems in power networks and components.

UNIT 1  INTRODUCTION  12 Hrs.

UNIT 2  ANALYSIS OF CONTINUOUS AND DISCRETE SYSTEMS  12 Hrs.
Introduction to continuous system –State variable formulation –Successive differentiation – Controller canonical form – Observer canonical form – Diagonal canonical form - Time domain solution to state equation.

UNIT 3  TRANSMISSION LINES AND CABLES  12 Hrs.
Bergeron’s Model – Multiconductor transmission lines - Frequency dependent transmission lines – Frequency to time domain transformation – Phase domain model – Overhead transmission line parameters – Bundled subconductors – Earth wires – Underground cable parameters.

UNIT 4  APPLICATION OF INSULATORS TO SWITCHING SURGES  12 Hrs.
Necessary data for line insulation Design – Data Derived from Laboratory tests - Data Derived from Network analysis – Switching Surge Laboratory Tests - Influence of wave shape - Influence of contamination on switching surge flashover voltage of insulators – Applications of test results to line design.

UNIT 5  INSULATION COORDINATION  12 Hrs.
Basic requirements of insulation coordination – Reduced Insulation levels – Choice of Surge Diverters – Rated voltage – Protective level – Positioning of Diverters – Effect of system design – substation and transformer feeders - Insulation coordination as applied to a substation – Transformer Insulation level.

Max. 60 Hours

TEXT / REFERENCE BOOKS

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 70
PART A : 5 questions of 4 marks each – No choice
PART B : 2 questions from each unit of internal choice, each carrying 10 marks

Exam Duration : 3 Hrs.
20 Marks
50 Marks
COURSE OBJECTIVES

- To learn the fundamental principles of various peripherals and its operation
- To learn the principles of DAC and ADC conversions
- To discuss about the operation of Asynchronous serial communication
- To apply the basic concept of control system in real time embedded application

UNIT 1  INTRODUCTION  12 Hrs.

Nonlinear controller elements - Controller implementation and testing in Embedded Systems. Controlling the hardware with software – Data lines – Address lines - Ports – Schematic representation – Bit masking – Programmable peripheral interface – Switch input detection – 74 LS 244.

UNIT 2  INPUT-OUTPUT DEVICES  12 Hrs.


UNIT 3  D/A AND A/D CONVERSION  12 Hrs.

R 2R ladder - Resistor network analysis - Port offsets - Triangle waves analog vs. digital values - ADC0809 – Auto port detect - Recording and playing back voice - Capturing analog information in the timer interrupt service routine - Automatic, multiple channel analog to digital data acquisition.

UNIT 4  ASYNCHRONOUS SERIAL COMMUNICATION  12 Hrs.


UNIT 5  CASE STUDIES: EMBEDDED C PROGRAMMING  12 Hrs.

Multiple closure problems – Basic outputs with PPI – Controlling motors – Bi-directional control of motors – H bridge – Telephonic systems – Stepper control – Inventory control systems- Burger alarms- Fire alarms.

Max. 60 Hours

TEXT / REFERENCE BOOKS


END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 70  Exam Duration : 3 Hrs.

PART A : 5 Questions of 4 marks each-No choice  20 Marks
PART B : 2 Questions from each unit with internal choice, each carrying 10 marks  50 Marks
UNIT I  INTRODUCTION  12 Hrs.
History of MEMS development – Intrinsic characteristics - Overview of Micro Fabrication – Silicon and other material based fabrication process – Process selection and design – Points of consideration for deposition process - Points of consideration for etching process.

UNIT II  ELECTROSTATIC SENSING AND ACTUATION  12 Hrs.

UNIT III  THERMAL SENSING AND ACTUATION  12 Hrs.

UNIT IV  PIEZO RESISTIVE SENSORS  12 Hrs.

UNIT V  PIEZO ELECTRIC SENSING AND ACTUATION  12 Hrs.
Piezoelectric effect - Cantilever piezo electric actuator model - Properties of piezoelectric materials - Applications

TEXT / REFERENCE BOOKS

END SEMESTER EXAM QUESTION PAPER PATTERN
Max. Marks : 70  Exam Duration : 3 Hrs.
Part A : 5 questions of 4 marks each – No choice - 20 marks
Part B : 2 Questions from each unit with internal choice, each carrying 10 marks - 50 marks