M.TECH. ELECTRICAL ENGINEERING (POWER SYSTEM)
(1ST SEMESTER)
TOTAL CONTACT HRS. = 22, TOTAL MARKS = 600, TOTAL CREDITS = 21

Course		Contact Hrs.			Marks			Credits
Code	**Name**	**L**	**T**	**P**	**Int**	**Ext**	**Total**	
MELE3-101/ MELE1-205	Power System Operation and Control	**4**	**0**	**0**	**40**	**60**	**100**	**4**
MELE3-102/ MELE1-207	Power Electronic Devices & Controllers	**4**	**0**	**0**	**40**	**60**	**100**	**4**
MELE3-103/ MELE1-101	Advance Power System Analysis & Design	**4**	**0**	**0**	**40**	**60**	**100**	**4**
MELE3-104	Power System Software Lab	**0**	**0**	**2**	**60**	**40**	**100**	**1**
Departmental Elective-I (Choose any one)		**4**	**0**	**0**	**40**	**60**	**100**	**4**
MELE3-156	EHVAC Transmission System							
MELE3-157	Fast Transients in Power System							
MELE3-158	Non-Conventional Energy Resources							
MELE3-159	Applied Instrumentation & Measurements							
Departmental Elective-II (Choose any one)		**4**	**0**	**0**	**40**	**60**	**100**	**4**
MELE3-160	HVDC Transmission System							
MELE3-161	Power System Communication							
MELE3-162	Smart Grid Technologies							
MELE3-163	Discrete Time Control Systems							
Total 5 Theory & 1 Lab. Courses		**20**	**0**	**2**	**260**	**340**	**600**	**21**

(2nd SEMESTER)
TOTAL CONTACT HRS. = 22, TOTAL MARKS = 600, TOTAL CREDITS = 21

Course		Contact Hrs.			Marks			Credits
Code	**Name**	**L**	**T**	**P**	**Int**	**Ext**	**Total**	
MELE3-205	Power System Planning	4	0	0	40	60	100	4
MELE3-206	Advanced Power System Protection	4	0	0	40	60	100	4
MELE3-207	Power System Dynamics & Stability	4	0	0	40	60	100	4
Departmental Elective-III (Choose any one)		4	0	0	40	60	100	4
MELE3-264/ MELE1-374	Power System Reliability							
MELE3-265/ MELE1-265	Customized Power Devices							
MELE3-266/ MELE1-206	Advanced Electrical Machine							
MELE3-267/ MELE1-267	Artificial Intelligent Techniques							
Open Elective (Choose any one)		4	0	0	40	60	100	4
MELE3-208	Simulation Lab	0	0	2	60	40	100	1
Total 4 Theory & 1 Lab. Courses		**20**	**0**	**2**	**260**	**340**	**600**	**21**

Overall

Semester	Marks	Credits
1st	600	21
2nd	600	21
Total	**1200**	**42**

LIST OF OPEN ELECTIVES OFFERED BY ELECTRICAL ENGINEERING DEPARTMENT TO OTHER DEPARTMENTS

Sr. No.	Course Code	Title
1	MELE0-F91	Advance Electrical Machines
2	MELE0-F91	Load Forecasting and Load Management
3	MELE0-F93	Neural Networks & Fuzzy Logic
4	MELE0-F94	Engineering Optimization

POWER SYSTEM OPERATION AND CONTROL

Subject Code: MELE3-101 **L T P C** **Duration: 40 Hrs.**
4 0 0 4

UNIT-1

1. INTRODUCTION (10 Hrs.)
Characteristics of power generation units (thermal, nuclear, hydro, pumped hydro), variation in thermal unit characteristics with multiple valves, Economic dispatch with and without line losses, lambda iteration method, gradient method, Economic dispatch without line losses, economic dispatch with line losses, lambda iteration method, gradient method, Newton's method, base point and participation factors.

UNIT-1I

2. TRANSMISSION LOSSES (5 Hrs.)
Coordination equations, incremental losses, penalty factors, B matrix loss formula (without derivation), methods of calculating penalty factors.

3. UNIT COMMITMENT (5 Hrs.)
Constraints in unit commitment, priority list method, Dynamic programming method and Lagrange relaxation methods.

UNIT-1II

4. HYDRO THERMAL CO-ORDINATION (5 Hrs.)
Introduction to long range and short range hydro scheduling, Types of short range scheduling problem, Scheduling energy. The short term hydro-thermal scheduling problems and its solution by Lambda-Gamma iteration method and gradient method

5. GENERATION WITH LIMITED ENERGY SUPPLY (5 Hrs.)
Take or pay fuel supply contract, composite generation production cost function, gradient search techniques.

UNIT-1V

6. OPTIMAL POWER FLOW FORMULATION (5 Hrs.)
Gradient and Newton method, linear programming methods.

7. AUTOMATIC GENERATION CONTROL (5 Hrs.)
Load frequency control, single area system, multi-area system, tie line control, automatic voltage control.

RECOMMENDED BOOKS:

1. D.P. Kothari and J.S. Dhillon, 'Power System Optimization', Prentice-Hall of India Pvt. Ltd. New Delhi.
2. G.L.K. Kirchmayer, 'Economic Operation of Power Systems', John Willey & Sons, N.Y.
3. A.J. Wood, B.F. Wollenberg, 'Power Generation Operation and Control'.
4. D.P. Kothari and I.J. Nagrath, 'Modern Power System Analysis', Tata Mc Graw-Hill Publishing Company Ltd., New Delhi.

POWER ELECTRONIC DEVICES AND CONTROLLERS

Subject Code: MELE3-101 **L T P C** **Duration: 40 Hrs.**
4 0 0 4

UNIT-1

1. REVIEW OF SEMICONDUCTOR DEVICES (5 Hrs.)
Conduction Process in semiconductors, p-n Junction, Charge control description, Avalanche breakdown, Power diodes, Thyristors, Gate Turn Off thyristor (GTO), VI characteristics, Dynamic characteristics, ratings, protection.

2. POWER MOSFET AND IGBT (5 Hrs.)
Basic structure, I-V Characteristic, Physics of device operation, switching characteristics, operating limitation and safe operating area.

UNIT-1I

3. EMERGING DEVICES AND CIRCUITS (10 Hrs.)
Power junction Field effect transistor (FET), Integrated Gate-Commutated Thyristor (IGCT), Field Control Thyristor, Metal oxide semiconductor (MOS) Control Thyristor etc. Power ICs, New semiconductor materials.

UNIT-III

4. SNUBBER CIRCUITS (10 Hrs.)
Types of Snubber circuits, needs of Snubber circuit with diode, thyristor and transistors, Turn-off Snubber, over voltage snubber, turn on snubber, Snubber for bridge circuit configurations, GTO Snubber circuit.

UNIT-1V

5. GATE AND BASIC DRIVE CIRCUITS (10 Hrs.)
Design Consideration, De-coupled drive circuits, electrically isolated drive circuits, cascade connected drive circuits, Power device protection in drive circuits, circuit layout considerations.

RECOMMENDED BOOKS:

1. Mohan, Undeland and Robbins, ‘Power electronics: Converters, Applications and Design’, John Wiley and Sons.
2. M.H. Rashid, ‘Power Electronics Handbook’, Elsevier Press (Academic Press Series).
3. D. Finney, ‘The Power Thyristor and its Applications’, McGraw Hill, New York.
4. C.W. Lander, ‘Power Electronics’, McGraw Hill Book Co., U.K.
5. M.H. Rashid, ‘Power Electronics - Circuits, Devices and Applications’, PHI, India.

ADVANCED POWER SYSTEM ANALYSIS AND DESIGN

Subject Code: MELE3-101 **L T P C** **Duration: 40 Hrs.**
4 0 0 4

UNIT-1

1. Load Flow (10 Hrs.)
Network modeling – Conditioning of Y Matrix – Load Flow-Newton Raphson method- Decoupled – Fast decoupled Load flow -three-phase load flow.

UNIT-1I

2. DC power flow (10 Hrs.)
Single phase and three phase -AC-DC load flow - DC system model – Sequential Solution Techniques – Extension to Multiple and Multi terminal DC systems – DC convergence tolerance – Test System and results.

UNIT-I1I

3. Fault Studies (5 Hrs.)

Analysis of balanced and unbalanced three phase faults – fault calculations – Short circuit faults – open circuit faults.

4. System optimization (5 Hrs.)

Strategy for two generator systems – generalized strategies – effect of transmission losses - Sensitivity of the objective function- Formulation of optimal power flow-solution by Gradient Method-Newton's method.

UNIT-IV

5. State Estimation (10 Hrs.)

Method of least squares – statistics – errors – estimates – test for bad data – structure and formation of Hessian matrix – power system state estimation.

RECOMMENDED BOOKS:

1. J.J. Grainger and W.D. Stevenson, 'Power System Analysis', Tata McGraw hill, New Delhi, **2003**.
2. J. Arrillaga and C.P. Arnold, 'Computer Analysis of Power Systems', John Wiley and Sons, New York, **1997**.
3. M.A. Pai, 'Computer Techniques in Power System Analysis', Tata McGraw hill, New Delhi, **2006**.

POWER SYSTEM SOFTWARE LAB

Subject Code: MELE3-104	L T P C 0 0 2 1	Duration: 40 Hrs.

Development of algorithms & flowcharts and digital simulation of the following using ETAP/MATLAB Software package:

1. Z-bus and Y-bus formulation
2. Load flow studies
3. Fault analysis
4. Transient stability studies
5. Economic load dispatch

EHVAC TRANSMISSION SYSTEM

Subject Code: MELE3-156	L T P C 4 0 0 4	Duration: 40 Hrs.

UNIT-1

1. INTRODUCTION (10 Hrs.)

Introduction to EHV AC Transmission, Tower Configurations, types of self-supporting Lattice towers, Flexible and Semi Flexible towers, Thermal Rating of Lines, Temperature rise of conductors and current carrying capacity of lines and cables, properties of bundled conductor, Average value of line parameters, power handling capacity and line loss, selection of cable for EHV AC transmission, Electrical characteristics and cable insulating materials. Types of circuit breakers for EHV AC system.

UNIT-2

2. VOLTAGE GRADIENT OF CONDUCTORS (10 Hrs.)

Field of line charges and their properties, surface voltage gradient on conductors, maximum surface voltage gradient. Corona e effects, Corona formulas based on voltages and voltage gradients, Corona currents, Power loss, Audible Noise and Radio interference, Limits of audible noise, AN measurement, day night equivalent noise level.

UNIT-3

3. ELECTROSTATIC FIELD OF EHV LINES (10 Hrs.)

Capacitance of long objects under transmission lines, electrostatic field of 3 phase single circuit and double circuit AC lines, Biological effects of electrostatic fields.

UNIT-4

4. LIGHTNING AND LIGHTNING PROTECTION (10 Hrs.)

Over voltage factors, type of surge arresters, rating and classification of surge arresters based on applications, insulation withstand characteristics of long air gaps. Design of EHV Lines based on Stability limits.

BOOKS RECOMMENDED:

1. R.D. Begamudre, ‘EHV AC Transmission’, 2nd Edn., Wiley Eastern Ltd.
2. ‘Transmission Line Reference Book: 345 KV and above EPRI’, Palo Alto USA.
3. ‘Electrical Transmission and Distribution Reference Book’, Oxford book Company, Calcutta.
4. S. Rao, ‘EHV –AC and HV DC Transmission Engineering Practice’, Khanna Publishers.
5. Related IEEE/IEE Publications.

FAST TRANSIENTS IN POWER SYSTEM

Subject Code: MELE3-157 **L T P C** **Duration: 42 Hrs.**
4 0 0 4

UNIT-1

1. ORIGIN AND NATURE OF TRANSIENTS AND SURGES (10 hrs.)

Surge parameters of plant. Equivalent circuit representations. Lumped and distributed circuit transients.

UNIT-2

2. LINE ENERGIZATION AND DE-ENERGIZATION TRANSIENTS (10 Hrs.)

Earth and earth wire effects. Current chopping in circuit breakers. Short line fault condition and its relation to circuit breaker duty. Trapped charge effects. Effect of source and source representation in short line fault studies. Control of transients.

UNIT-3

3. LIGHTNING PHENOMENON (10 Hrs.)

Influence of tower footing resistance and earth resistance. Traveling waves in distributed parameter multi-conductor lines, parameters as a function of frequency. Simulation of surge diverters in transient analysis. Influence of pole opening and pole re-closing.

UNIT-4

4. INSULATION CO-ORDINATION (6 Hrs.)

Over voltage limiting devices, dielectric properties, breakdown of gaseous insulation, tracking and erosion of insulation, high current arcs, and metallic contacts.

5. COMMUNICATION LINKS (6 Hrs.)

PLCC, Microwave, Telephone line, Satellite, Fibre optic. Requirements of' various communication equipment used in power systems. Computer networking in power systems.

RECOMMENDED BOOKS:

1. V.A. Vanikov, 'Transients in Power System', Mir Publications, Moscow.
2. L.V. Bewley, 'Traveling Waves on Transmission Lines', Dover Publications Inc., New York.
3. Ravindera Arora and Mosch Wolfgang, 'High Voltage Insulation Engineering', New Age International Publishers Limited.
4. A. Greenwood, 'Electrical Transients in Power Systems', John Wiley & Sons.
5. Stallings William, 'Data and Computer Communication', PHI, **1994**.
6. Gowar John, 'Optical Communications Systems', PHI, **1993**.
7. R.E. Collin, 'Foundations of Microwave Engineering'.
8. Theodore S. Rappaport, 'Wireless Communication, Principles and Practice', IEEE Press; PTR, **1996.**

NON-CONVENTIONAL ENERGY RESOURCES

Subject Code: MELE3-158 | **L T P C 4 0 0 4** | **Duration: 45 Hrs.**

UNIT-1

1. Introduction to Energy Sources (10 Hrs.)

World Energy Futures, Conventional Energy Sources, Non-Conventional Energy Sources, Prospects of Renewable Energy Sources.

UNIT-2

2. Solar Energy (10 Hrs.)

Introduction to Solar Radiation and its measurement, Introduction to Solar Energy Collectors and Storage. Applications of Solar Energy: Solar, Thermal Electric Conversion Systems, Solar Electric Power Generation, Solar Photo-Voltaic, Solar Cell Principle, Semiconductor Junctions, Conversion efficiency and power output, Basic Photovoltaic System for Power Generation.

UNIT-3

3. Wind Energy (10 Hrs.)

Introduction to wind energy Conversion, the nature of the wind, Power in the wind. Wind data and energy estimation, Site Selection Considerations, Basic Components of a Wind Energy Conversion System, Classification of WEC Systems, Schemes for Electric Generation using Synchronous Generator and Induction Generator, Wind energy Storage.

UNIT-4

4. Direct Energy Conversion Processes (10 Hrs.)

Magneto Hydro Dynamic Power Generation: Principles of MHD power generation, Open Cycle Systems, Closed Cycle Systems, Voltage and power output, Materials for MHD generators. Basic principles of thermo-electric power-generation, Seebeck, Peltier, Thomson effects, Thermo-Electric power generator, Analysis, materials. Thermionic emission and work function, Basic thermionic generation. Classification of Fuel Cells, Types, Advantages, Electrodes, Polarization. The basic Nuclear Function and Reactions Plasma Confinement, Thermo Nuclear Function Reactions.

5. Energy from Biomass (5 Hrs.)

Biomass conversion technologies, photosynthesis, Bio-gas generation, types of bio-gas plants. Biomass as a Source of Energy: Method for obtaining energy from Bio-mass, Biological Conversion of Solar Energy.

RECOMMENDED BOOKS:

1. G.D. Rai, 'Non-Conventional Sources of Energy', Khanna Publishers.
2. David Boyles, 'Bio Energy', Elis Horwood Ltd.

3. N.K. Bansal and M. Kleemann, M. Heliss, 'Renewable Energy Sources and Conversion Technology', Tata McGraw Hill, **1990**.
4. R.A. Coombie, 'Direct Energy Conversion', Pitman.
5. O.P. Vimal and P.D. Tyagi, 'Bio Energy Spectrum', Bio Energy and Wasteland Development Organization.
6. Related IEEE/IEE Publications.

APPLIED INSTRUMENTATION & MEASUREMENTS

Subject Code: MELE3-159 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

UNIT-1

1. Transducers (10 Hrs.)
Classification of Transducers including analog and digital transducers, Selection of Transducers, Static and Dynamic response of transducer System. Measurement of length & thickness, linear Displacement, Angular Displacement, force, weight, torque, Moisture, Level, Flow, pH & Thermal Conductivity, Measurement of Frequency, Proportional, Geiger Muller & Scintillation Counters.

UNIT-2

2. Telemetry (10 Hrs.)
Basic Principles, Proximity & remote Action Telemetry systems, Multiplexing; Time Division and frequency division.

UNIT-3

3. Display Device (10 Marks)
Digital Voltmeters, Dual Slope DVMS, Digital encoders, Analog and Digital encoders, Analog and Digital Data Acquisition System, A/D Converter. Fibre Optic Technology for data transmission, Supervisory Control and Data Acquisition Systems (SCADA), Q-meter. Electrical noise in control signals, its remedial measures.

UNIT-4

4. Virtual Instrumentation (10 Marks)
Introduction to Virtual Instrumentation, conventional vs. Virtual instrumentation, advantages and basic representations. Introduction to Lab view. Applications of virtual instrumentation in various fields like Industrial applications, defense, Medical.

BOOKS RECOMMENDED:

1. W.D. Cooper & A.D. Helfrick,'Electronic Instrumentation and Measurement Techniques', PHI.
2. B.C. Nakra and K.K. Chaudhary, 'Instrumentation Measurement Analysis', Tata McGraw-Hill.
3. Hermann, K.P. Neubert, 'Instrument Transducers'.
4. Mansfleld, 'Electrical Transducers for Industrial Measurement'.
5. Mani Sharma, Rangan, 'Instrumentation Systems'.
6. Borden & Thgnel, 'Principles & Methods of Telemetry'.
7. Foster, 'Telemetry Method'.
8. Sanjay Gupta &Joseph John, 'Virtual Instrumentation Using Lab VIEW', TMG; Tata Mc-Graw Hills, **2005**.
9. Robert H. Bishop, 'Learning with Lab VIEW 7 Express', Pearson Education, **2005**.
10. Related IEEE/IEE Publications.

HVDC TRANSMISSION SYSTEM

Subject Code: MELE3-159 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

UNIT-1

1. Introduction (10 Hrs.)
Merits & Demerits of H.V.D.C. transmission over E.H.V. A.C. transmission, types of HVDC links.

UNIT-2

2. Converter Configurations (10 Hrs.)
Connection, rectifier & inverter waveforms, complete analysis of 3-phase (6 pulses) bridge converter, equations of voltage & current on AC& DC side. Equivalent Circuit of HVDC link, Basic means of control of HVDC link, CIA, CEA & CC, control characteristics, combined characteristics of a converter.

UNIT-3

3. Reactive Power compensation: (10 Hrs.)
Fundamentals of Harmonics and Harmonic filters, Stability aspect of synchronous & asynchronous link.

UNIT-4

4.. Hybrid HVDC System (10 hrs.)
Introduction to multi-terminal HVDC systems, Protective system in HVDC substations.

BOOKS RECOMMENDED:

1. K.R, Padiyar, ‘HDVC Power Transmission System’, Wiley Eastern Ltd., **1990.**
2. E.W. Kimbark, ‘Direct Current Transmission’, Vol 1, Wiley Interscience, **1971**.
3. J. Arrillage, ‘H.V.D.C. Transmission’, Peter Peregrines, **1983**.
4. J. Arrillage, ‘HVDC et.al Computer Modelling of Electrical Power System’, John Wiley, **1993**.
5. S. Rao, ‘EHV-AC and Transmission Engineering Practice’, Khanna Publishers, **1990**.
6. Related IEEE/IEE Publications.

POWER SYSTEM COMMUNICATION

Subject Code: MELE3-161 **L T P C** **Duration: 40 Hrs.**
4 0 0 4

UNIT I

1. Introduction (10 Hrs.)
Communication links required in telemetry, tele-control and tele protection.

UNIT 2

2. Analog and digital communication (10 Hrs.)
SPEd and banding requirements, Noise in power systems.

UNIT 3

3. Communication Links (10 Hrs.)
PLCC, Microwave, Telephone line, Satellite, Fiber optic, Requirements of' various communication equipment used in power systems

UNIT 4

4. Computer Networking (10 Hrs.)
Computer networking in power systems

BOOKS RECOMMENDED:

1. William Stallings, ‘Data and Computer Communication’, PHI, **1994**.

2. John Gowar, 'Optical Communications Systems', PHI, **1993**.
3. R.E. Collin, 'Foundations of Microwave Engineering'.
4. Theodore S. Rappaport, 'Wireless Communication, Principles and Practice', IEEE Press, PTR, **1996.**
5. K. Feher, 'Wireless Digital Communications', PHI, **1995**.
6. Related IEEE /IEE Publications.
7. Tanenbaum, 'Computer Network'.

SMART GRID TECHNOLOGIES

Subject Code: MELE3-162   **L T P C**   **Duration: 40 Hrs.**
4 0 0 4

UNIT I

1. Introduction to Smart Grid (10 Hrs.)

Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self-Healing Grid, Present development & International policies in Smart Grid. Case study of Smart Grid. CDM opportunities in Smart Grid

UNIT 2

2. Smart Grid Technologies (10 Hrs.)

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

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

UNIT 3

3. Micro grids and Distributed Energy Resources (10 Hrs.)

Concept of micro grid, need & applications of micro grid, formation of micro grid, Issues of interconnection, protection & control of micro grid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel cells, micro turbines, Captive power plants, Integration of renewable energy sources

UNIT 4

4. Power Quality Management in Smart Grid (10 Hrs.)

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

5. Information and Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN). Bluetooth, Zig-Bee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of CLOUD Computing & Cyber Security for Smart Grid. Broadband over Power line (BPL). IP based protocols.

Recommended Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai, 'Integration of Green and Renewable Energy in Electric Power Systems', Wiley.
2. Clark W. Gellings, 'The Smart Grid: Enabling Energy Efficiency and Demand Response', CRC Press JanakaEkanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu.

3. Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley.
3. Jean Claude Sabonnadière, Nouredine Hadjsaïd, 'Smart Grids', Wiley Blackwell.

DISCRETE TIME CONTROL SYSTEMS

Subject Code: MELE3-163 **L T P C** **Duration: 40 Hrs.**
4 0 0 4

UNIT I

1. Introduction (10 Hrs.)
Configuration of the basic Digital Control Systems, types of sampling operations, Sample and Hold operations, Sampling theorem, Basic discrete time signals'-Transforms, Properties of Z-Transform, Inverse Z-Transforms, Pulse Transfer Function, Difference equations, Z-Transform method for solving the difference equations, Block diagram and signal flow graph analysis, Time response of digital control systems.

UNIT II

2. Stability Methods (10 Hrs.)
Mapping between s-plane and z-plane, stability methods: Modified Routh Criterion, Jury's method, and modified Schur-Cohn criterion. State variable representation, conversion of state variable models to transfer function and vice-versa, Eigen values and Eigen vectors, Solution of state equations, Concepts of controllability and observability.

UNIT III

3. Models of Digital Control Systems (10 Hrs.)
Digital temperature control System, Digital position control system, stepping motors and their control. Design of Digital compensator using frequency response plots.

UNIT IV

4. State Variable Analysis (10 Hrs.)
Digital Control Systems, State variable description of digital control systems, conversion of state variable models to pulse transfer function and vice versa, solution of state difference equations, controllability and observability.

Recommended Books:
1. M. Gopal, 'Digital Control and State Variable Methods', Tata Mc-Graw-Hill.
2. K. Ogata, 'Discrete Time Control Systems, Pearson Education, Singapore, Thomson Press, India.
3. B.C. Kuo, 'Digital Control Systems', Prentice Hall.
4. I.J. Nagrath & M. Gopal, 'Control System Engg.', John Wiley & Sons.
5. K.K. Aggarwal, 'Control System Analysis and Design', Khanna Publishers.

POWER SYSTEM PLANNING

Subject Code: MELE3-205 **L T P C**
4 0 0 4

Objectives:
- To acquire skills in planning and building reliable power system.

Learning Outcomes:
- The scope of employability in power utilities will increase.
- The management skills required in the field of power system engineering is enhanced.

Contents

Unit-1

Introduction: power system planning, objective, stages in planning and design, the electric utility industry, growth characteristics generation, transmission and distribution systems.

Demand/energy forecasting: electricity consumption pattern, peak demand and energy forecasting by trend and economic projection methods. Review of load forecasting.

Unit-2

Power System Planning: Investment planning: traditional generation expansion planning models, integrated resource planning models, production cost simulation models.

Generating System Capability Planning: probabilistic models of generating units, growth rate, rate of generation capacity, outage performance and system evaluation of loss of load and loss of energy indices, power supply availability assessment. Expansion planning, unit maintenance schedule, unit effective load carrying capability.

Transmission System Planning: automatic transmission system expansion planning, automatic transmission planning using interactive graphics.

Unit-3

Distribution System Planning and Automation: load characteristics, design of sub transmission lines and distribution, substations, design considerations of' primary and secondary distribution systems, voltage drop and power loss calculations.

Interconnected Systems: multi-area reliability analysis, power pool operation and power exchange energy contracts, quantification of economic and reliability benefits of pool operation.

Unit-4

Power system Expansion planning: formulation of least cost optimization problem involving capital, operation and maintenance costs of candidate units of different types.

RECOMMENDED BOOKS

1. Y. Wallach, 'Power System Planning', McGraw Hill International.
2. P. Sullivan, 'Power System Planning', McGraw Hill International.
3. S. Dasari, 'Electric Power System Planning', IBT Publishers, New Delhi.
4. R. Billinton, 'Power System Reliability Calculation', MIT Press, USA.
5. Endreyni, 'Reliability Modeling in Electric Power System', John Wiley, New York.
6. J.R. McDonald, 'Modern Power System Planning', McGraw Hill International.
7. A.S. Pabla, 'Electrical Power System Planning', Macmillan, **1998**.

ADVANCED POWER SYSTEM PROTECTION

Subject Code: MELE3-206 **L T P C**
4 0 0 4

Objectives:

- To facilitate the students, understand the basic concepts and recent trends in power system protection.
- To enable the students design and work with the concepts of digital and numerical relaying.

Learning Outcomes:

On completion of the course the students would be skilled enough to work with various type of schemes used for different apparatus protection.

Contents

Unit-1

Fundamentals: Types of relays, their classifications and theory Phase and amplitude comparators. Static Comparators Computer Applications to protective relaying.

Circuit Breakers: Physical stress in circuit breakers, Vacuum circuit breakers, SF6 Circuit Breakers Direct current C.B.'s, Short circuit testing of circuit breakers. Comparison of different types of circuit breakers.

Unit-2

Transmission Line Protection: Carrier Current Protection. Applications of microwave Channels for protective relaying, Selection of suitable static relaying scheme for transmission line protection. Performance specifications of distance relays, effect of fault resistance and effects of power swings on operation of relays and Distance relay settings.

Unit-3

Generators and Transformers Protection: CT's and PTs burden and accuracy and their connections. Protection of rotor winding. Miscellaneous protection schemes for generators and transformers, Over fluxing protection of transformers.

Unit-4

Differential Relays: Operating Characteristics, Restraining Characteristics, Analysis of Electromagnetic and differential Static relays schemes.

Bus Zone Protection: Types of bus bar faults, Protection requirements, protection schemes and modern trend in bus-bar protection.

RECOMMENDED BOOKS:

1. T.S. Madhava Rao, 'Power System Protection (Static Relays)', Tata McGraw-Hill, **1989**.
2. A.R. Van C. Warrington, 'Protective Relays', Chapman and Hall London, **1968**.
3. S.K. Basu and S. Chaudhary, 'Power System Protection', Raju Primlan Oxford and IBH Press, **1983**.
4. Ravindra Nalh M. Chander, 'Power System Protection and Switch Gear', John Wiley Eastern, **1989**.
5. Sunil S. Rao, 'Power System Protection and Switch Gear', Khanna Publishers, **1989**.
6. Related IEEE/IEE Publications.

POWER SYSTEM DYNAMICS & STABILITY

Subject: MELE3-207 **L T P C**
4 0 0 4

Course Objectives:

- To know the elementary mathematical model and system response to small disturbances.
- To impart the concepts of transient stability.
- To impart knowledge on voltage stability.

Learning Outcomes:

After Completion of this course students will be able to

- Solve mathematical calculations and swing equation and obtain classical model of an infinite bus system.
- Analyse the effect of small speed changes in multi machine synchronous machines and voltage regulator governor system.
- Understand the transient stability analysis under common disturbances including the short circuits and find clearing time to solution for swing equation by step by step method.

Contents

Unit-1

OVERVIEW: Angular Stability, Transient stability, steady state stability, dynamic stability, Small Signal, Voltage Stability.

TRANSIENT STABILITY ANALYSIS: Single Machine - Infinite Bus System, Equal Area Criterion, Multi-machine Stability, Network Reduction and Numerical Integration Methods, Methods of Improvement.

Unit-2

SMALL SIGNAL STABILITY ANALYSIS: Eigen Value and Participation Factor Analysis; Single machine -Infinite Bus and Multi-Machine Simulation; Effect of Excitation System and AVR, improvement of Damping, Power System Stabilizer and Static VAR System (SVS) supplementary controls.

Unit-3

SUB SYNCHRONOUS OSCILLATIONS: Sub Synchronous Resonance (SSR) Phenomenon, Counter measures to SSR problems.

Unit-4

VOLTAGE STABILITY: PV and QV curves, Impact of Load and Tap changer Dynamics; Static Analysis, Sensitivity and Continuation Methods; Dynamic Simulation, Introduction to Bifurcation Analysis; Proximity Indices, Methods to enhance Stability Margin.

RECOMMENDED BOOKS:

1. P. Kundur, 'Power System Stability and Control', McGraw Hill.
2. C.W. Taylor, 'Power System Voltage Stability', McGraw Hill.
3. P.M. Anderson and A.A. Foud, 'Power System Control and Stability', IEEE Press.
4. E. Kimbark, 'Power System Stability', Vol. I, II & III, IEEE Press.

SIMULATION LAB

Subject Code: MELE3-208 **L T P C**
0 0 2 1

LIST OF EXPERIMENTS

1. Introduction to MATLAB and its basic commands.
2. MATLAB program to simulate Ferranti effect.
3. MATLAB program to model transmission lines.
4. MATLAB program to solve load flow equations by Gauss-Seidel method.
5. MATLAB program to find optimum loading of generators neglecting transmission losses.
6. MATLAB program to find optimum loading of generators with penalty factors.
7. MATLAB program to solve swing equation using point-by-point method.
8. Simulink model of single area load frequency control with and without PI controller and without PI controller in Simulink.
9. Simulink model for two area load frequency control.
10. Simulink model for evaluating transient stability of single machine connected to infinite bus.
11. Gauss Seidel load flow analysis using MATLAB Software.
12. Newton Raphson method of load flow analysis using MATLAB Software.
13. Fast decoupled load flow analysis using MATLAB Software.
14. Fault analysis using MATLAB Software.
15. Economic dispatch using MATLAB Software.

POWER SYSTEM RELIABILITY

Subject Code: MELE3-264/MELE1-374 L T P C
4 0 0 4

Course Objectives:
To develop an understanding of power system reliability evaluation by using deterministic and probabilistic techniques.

Learning Outcomes
Upon successful completion of this course, a student will be able to:

- Understand the application of basic probability theory and distribution to power system
- Identify the main subsystems of a power system and their constituent components
- To produce mathematical models for generator, transmission line and load
- Apply techniques for reliability evaluation of individual systems
- Apply techniques for reliability evaluation of composite systems

CONTENTS:

Unit-1

BASIC RELIABILITY CONCEPTS: The General reliability function, Hazard rate, MTTF, Markov processes.

STATIC GENERATING CAPACITY RELIABILITY EVALUATION: Capacity outage probability tables, loss of load probability method, Frequency and duration approach.

Unit-2

SPINNING GENERATION CAPACITY RELIABILITY EVALUATION: Spinning reserve, spinning reserve capacity evaluation, Load forecasting methods, Load forecast uncertainty, maximum capacity levels, Derated capacity levels.

Unit-3

TRANSMISSION SYSTEM RELIABILITY EVALUATION: Average interruption rate method, Frequency and duration method, Stormy and normal weather effects, The Markov process approach.

Unit-4

COMPOSITE SYSTEM RELIABILITY EVALUATION: Conditional probability approach, two–plant single load system, multi plant multi load system

RECOMMENDED BOOKS:

1. R. Billinton, ‘Power System Reliability Calculation’, MIT Press, USA.
2. Endreyni, ‘Reliability Modelling in Electric Power System’, John Wiley, New York.

CUSTOMIZED POWER DEVICES

Subject Code: MELE3-265/MELE1-265 L T P C
4 0 0 4

Course Objectives:

- To study advances in rapid development of Power systems.

Learning Outcomes

- Upon successful completion of this course, students will be able to select suitable advanced power system for the enhancement of power transfer capability and to control the power flow in an efficient manner.

Contents

UNIT-I

Static Power Frequency Changers

Fundamental Ideas: Historical Background, Basic Operational features and Operating Principles. Mathematical Representation (output voltage and Input Current) of Static Frequency Changers. Synthesis of the Output Voltage Waveform, Control of the Output Voltage (PWM, Amplitude Dependent Frequency Modulation, Phase Shift). Unwanted Components of Output Voltage, Analysis of the Input Current. Extra-basal Components of the Input Current. Control Circuit Principles: Implementation of Modulating Functions. End Stop Control, Control of Unity Displacement Factor Frequency Charger (UDFFC), NCC and CDFFC. Forced Commutation of Frequency Changers: Fundamental Principles of Hard and Soft Commutation, Points of Connection of Commutating Circuits. Some Basic Commutating Circuits. Application of Static Frequency Changers: Speed Control of AC Machines, Constant Frequency Power Supplies and Static VAR Generators.

UNIT-II

Compensators and Power Flow Controllers:

Static shunt compensators, Static series compensators, Static Voltage and phase angle regulators, **Principle of Operation of Controllers**: Control and characteristics, Model of IPFC for power flow and optimum power flow studies. FACTS Controller interactions –SVC–SVG interaction -co-ordination of multiple controllers using linear control techniques –Quantitative treatment of control coordination

UNIT-III

Power Quality Improvement:

Harmonic filters: passive, Active and hybrid filters –Custom power devices: Network reconfiguring Devices, Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC –control strategies: P-Q theory, Synchronous detection method –Custom power park –Status of application of custom power devices.
Difference in role of FACTS devices in transmission and distribution networks

UNIT-IV

RECENT TRENDS:

Application of basic active filters, multilevel and multi-pulse converters and Z-source inverter in various FACTS and FACDS devices for improving the performances of transmission system net work and distribution system network, respectively.

Recommended Books:

1. Y.H. Song and A.T. Johns, 'Flexible AC Transmission Systems', IEEE Press, **1999**.
2. N.G. Hingorani and L. Gyragyi, 'Understanding FACTS (Concepts and Technology of Flexible AC Transmission System)', Standard Publishers & Distributors, **2001**.
3. R.M. Mathur and R.K. Verma, 'Thyristor based FACTS controllers for Electrical Transmission Systems', IEEE Press, **2002**.

ARTIFICIAL INTELLIGENT TECHNIQUES

MELE3-267/MELE1-267 **L T P C**
4 0 0 4

Objectives:

- To apply artificial neural networks in various electrical and electronics engineering applications.

- To expose students to fuzzy methods of analysing problems which involve incomplete or vague criteria rather than crisp values.
- To investigates requirements analysis, logical design, and technical design of components for fuzzy systems development.

Learning Outcomes:

- The students acquire the skills required to innovate and build, smart and intelligent applications in electrical and electronics engineering.
- They will understand review of Neural Networks: models of a neuron, various activation functions, Threshold function, piecewise – linear function, stochastic model of a neuron, feedback.
- They will be able to take up fuzzy systems approach to solve applications in engineering.

Contents

UNIT I

NEURAL NETWORKS (9 hours)

Neural Networks – biological neurons – Artificial neurons – activation function – learning rules – feed forward networks – supervised & Unsupervised learning –perceptron network- linear separability – back propagation networks Algorithms-Radial basis function networks.

UNIT II

ASSOCIATIVE MODELS AND CONTROL SCHEMES IN NN (9 hours)

Auto & hetero associative memory – bi-directional associative memory – Self organizing feature Maps-Hopfield Networks-Neural Networks for non – linear system – Schemes of Neuro control – System identification – forward model and – Inverse model – Case studies.

UNIT III

FUZZY LOGIC AND GENETIC ALGORITHM: (9 hours)

Fuzzy set - Crisp set – vagueness – uncertainty and imprecision – fuzzy set – fuzzy operation-properties – crisp versus fuzzy relations – fuzzy relations –fuzzy Cartesian product and composition – composition of fuzzy Relations-Fuzzy to crisp conversion –structure of fuzzy logic controller – database – rule base – Inference engine.

GA: Working principles – terminology – Importance of mutation – comparison with traditional methods – constraints and penalty function – GA operators – Real coded GAs.

UNIT IV

APPLICATIONS: (9 hours)

Applications of Neural network, Fuzzy system & Genetic algorithms for power systems and power electronics Systems-Designing of controllers using Simulation Software, NN tool box & Fuzzy Logic Toolbox.

Recommended Books:

1. Timothy J. Ross, ‘Fuzzy Logic with Engineering Applications’, McGraw Hill International Edition, USA, **1997**.
2. Awrence Fausatt, ‘Fundamentals of Neural Networks’, Prentice Hall of India, New Delhi, **1994**.
3. Simon Haykin, ‘Neural Networks – A comprehensive Foundation’, Pearson Education Asia, **2002**.

ADVANCED ELECTRICAL MACHINES

Subject Code: MELE0-F91 **L T P C**
4 0 0 4

Objectives:

- To give a systematic approach for modelling and analysis of all rotating machines under both transient and steady state conditions.

Learning Outcomes:

- The students will be able to analyse all types of electrical machines.
- Students attain complete knowledge about electromagnetic energy conversion and time response analysis of reference frame theories for modelling of machines.

Contents

Unit-1

POLYPHASE SYNCHRONOUS MACHINES: Mathematical: Basic Synchronous machine parameters, Voltage, Flux linkage and inductance relations, Park's transformation – its physical concept, equations of performance.

BALANCED STEADY STATE ANALYSIS: Phasor equations and phasor diagrams, Power-angle characteristics, cylindrical rotor and Salient pole machines, Short circuit ratio

Unit-2

TRANSIENT ANALYSIS & MACHINE DYNAMICS: Three phase short-circuits, Armature and field transients, Transient torque, Sudden reactive loading and Unloading. Transient Analysis-a qualitative approach, Reactance and Time –Constants from equivalent circuits, Measurement of reactance, Transient Power-angle characteristics, The basic electromechanical equation, Linearized analysis, Large Angular/oscillation, Non-linear analysis.

Unit-3

TRANSFORMERS & ITS TRANSIENTS: Multi-Circuit Transformers: General theory, Equivalent circuits, Three winding transformer as a multi-circuit transformer, Determination of parameters. In-rush current phenomena, Qualitative approach, Analytical approach, In-rush current in 3-phasetransformers.

Unit-4

EXCITATION PHENOMENA IN TRANSFORMERS: study of excitation and its effect on transformer performance, Harmonics in: Single phase transformers, three-phase transformers, Disadvantages of harmonics, Suppression of harmonics.

UNBALANCED OPERATION OF THREE-PHASE TRANSFORMERS: Single-phase load on three-phase transformers, Single-Phasing in 3-phase transformers, Effect of using tertiary winding.

RECOMMENDED BOOKS

1. B. Edikins, 'Generalized Theory of Electrical Machines'.
2. Concordia, 'Synchronous Machines'.
3. E.W. Kim bark, 'Power System Stability', Vol. III., Wiley.

LOAD FORECASTING AND LOAD MANAGEMENT

Subject Code: MELE0-F92 **L T P C**
4 0 0 4

Objectives:

- To give a systematic approach for load management and forecasting.
- To analysis of all trend coming related to recent case studies conditions.

Learning Outcomes:

- The students will acquire skills of load related energy management and tariff structure.
- They will have complete knowledge about annual and monthly peak demands.

UNIT-I

Load Forecasting:
Classification and characterization of loads, Approaches to load forecasting, Forecasting methodology, Energy forecasting, Peak demand forecasting, Non-weather sensitive forecast and Weather sensitive forecast, Total forecast, Annual and monthly peak demand forecasts, Applications of state estimation to load forecasting.

UNIT-II

Load Management:
Introduction to Load management, Electric energy production and delivery system structure (EEPDS), Design alternatives for EEPD systems, Communication/control techniques for load management, Tariff structure and load management, principles of macro and microeconomics and energy pricing strategies, Assessing the impacts of load management.

UNIT-III

Energy Demand Forecasting:
Static and dynamic analysis of energy demand, Elements of energy demand forecasting, Methodologies and models for energy demand forecasting, Techno economic approach in energy demand forecasting. Energy auditing, Energy management, Power Pools and Energy Banking.

UNIT-IV

Trends and Case Studies:
Energy management strategy, Symbiotic relation between information, Energy models and decision making, Case studies like industrial energy forecasting, Transportation energy forecasting, Residential, Commercial and agricultural energy forecasting.

Recommended Books

1. J. Martino, 'Technological Forecasting for Decision Making', Elsevier Press, **1972**.
2. C.W. Gellings and P.E. Penn Well, 'Demand Forecasting in the Electric Utility Industry', Fairmount Press, **1992**.
3. S. Makridakis, 'Forecasting Methods and Applications', John Wiley and Sons, **1997**.
4. R.G. Brown, 'Smoothing, Forecasting and Prediction of Discrete Time Series', PHI Int., **1963.**

NEURAL NETWORKS & FUZZY LOGIC

Subject Code: MELE0-F93 **L T P C**
4 0 0 4

Objectives:

- To apply artificial neural networks in various electrical and electronics engineering applications.
- To expose students to fuzzy methods of analysing problems which involve incomplete or vague criteria rather than crisp values.
- To investigates requirements analysis, logical design, and technical design of components for fuzzy systems development.

Learning Outcomes:

- The students acquire the skills required to innovate and build, smart and intelligent applications in electrical and electronics engineering.

- They will understand review of Neural Networks: models of a neuron, various activation functions, Threshold function, piecewise – linear function, stochastic model of a neuron, feedback.
- They will be able to take up fuzzy systems approach to solve applications in engineering.

Contents

Network Architecture: Single layer feed forward network, multiplayer feed forward network, recurrent network, knowledge representation.

Learning Processes: Memory Based Learning Hebbian Learning, Competitive Learning, Boltzmann Learning, learning with a teacher, learning without a teacher, adaptation, single layer perceptions, multi-layer perceptions.

Introduction to Fuzzy Logic: membership function, rule generation, fuzzy concept, fuzzification, defuzzification, time dependent fuzzy logic, temporary fuzzy logic, fuzzy artificial neural network, neuro fuzzy control, fuzzy neural nets, Fuzzy Based ABS system, applications.

Recommended Books

1. Simon Haykin, ‘Neural Networks’.
2. Eleine Rich, Kevin Knight ‘Artificial Intelligence’.
3. Stamatios V. Kartalopoulos, ‘Understanding Neural Networks and Fuzzy Logic’.
4. Hungenahally Jain, ‘Neural Intelligent System’.

ENGINEERING OPTIMIZATION

Subject Code: MELE0-F94 **L T P C**
4 0 0 4

Objectives:

- To learn essential optimization techniques for applying to day to day problems.
- To study of genetic algorithms with relation to application in power system.
- To acquire knowledge of dynamic programming.

Learning Outcomes:

- After learning the techniques, they can apply to engineering and other problems.
- They can get skills to optimize the variety of programming.

Contents

UNIT I

INTRODUCTION

Definition, Classification of optimization problems, Classical Optimization Techniques, Single and Multiple Optimization with and without inequality constraints.

UNIT II

LINEAR PROGRAMMING AND NON LINEAR PROGRAMMING

Simplex method of solving LPP, revised simplex method, duality, Constrained optimization, Theorems and procedure, Linear programming, mathematical model, solution technique, duality.

Steepest descent method, conjugates gradient method, Newton’s Method, Sequential quadratic programming, Penalty function method, augmented Lagrange multiplier method.

UNIT III

DYNAMIC PROGRAMMING (DP)

Multistage decision processes, concept of sub-optimization and principle of optimality, Recursive relations, Integer Linear programming, Branch and bound algorithm.

UNIT IV

GENETIC ALGORITHM

Introduction to genetic Algorithm, working principle, coding of variables, fitness function, GA operators; Similarities and differences between Gas and traditional methods; Unconstrained and constrained optimization using genetic Algorithm, real coded gas, Advanced Gas, global optimization using GA, Applications to power system.

Recommended Books:

1. D.A. Pierre, 'Optimization Theory with Applications', Wiley Publications, **1969**.
2. H.A. Taha, 'Operations Research: An Introduction', 7th Edn., Pearson Education Edition, Asia, New Delhi, **2002**.
3. S.S. Rao, 'Optimization –Theory and Applications', Wiley-Eastern Limited, **1984**.