Total Contact Hours = 22 **Total Marks = 600** **Total Credits = 21**

1ST SEMESTER		Contact Hrs			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MELE1-101	Advanced Power System Analysis & Design	4	0	0	40	60	100	4
MELE1-102	Modern Control Theory	4	0	0	40	60	100	4
MELE1-103	Applied Instrumentation & Measurements	4	0	0	40	60	100	4
MELE1-104	Power System Software Lab	0	0	2	60	40	100	1
Departmental Elective-I (Select any one)		4	0	0	40	60	100	4
MELE1-156	Energy Management and Energy Auditing							
MELE1-157	Microprocessors & Embedded Control							
MELE1-158	Non-Conventional Energy Resources							
MELE1-159	Wind Energy and Small Hydro Energy Station							
Departmental Elective-II (Select any one)		4	0	0	40	60	100	4
MELE1-160	EHVAC & HVDC Transmission Systems							
MELE1-161	Digital Signal Processing & its Applications							
MELE1-162	Adaptive Control							
MELE1-163	Discrete Time Control Systems							
Total		**20**	**0**	**2**	**260**	**340**	**600**	**21**

MRSPTU

Total Contact Hours = 22 **Total Marks = 600** **Total Credits = 21**

2nd SEMESTER		Contact Hrs.			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MELE1-205	Power System Operation and Control	4	0	0	40	60	100	4
MELE1-206	Advanced Electrical Machines	4	0	0	40	60	100	4
MELE1-207	Power Electronic Devices & Controllers	4	0	0	40	60	100	4
MELE1-208	Simulation Lab.	0	0	2	40	60	100	1
Departmental Elective-III (Select any one)		4	0	0	40	60	100	4
MELE1-264	Power System Modelling & Dynamics							
MELE1-265	Customized Power Devices							
MELE1-266	Advanced Electrical Machine Design							
MELE1-267	Artificial Intelligent Techniques							
Open Elective-I		4	0	0	40	60	100	4
Total		**20**	**0**	**2**	**240**	**360**	**600**	**21**

Total Contact Hours = 24 **Total Marks = 500** **Total Credits = 24**

3RD SEMESTER		Contact Hrs			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
Departmental Elective-IV (Select any one)		4	0	0	40	60	100	4
MELE1-368	Power System Dynamics & Stability							
MELE1-369	Advanced Power System Protection							
MELE1-370	Smart Grid Technologies							
MELE1-371	Engineering Optimization							
Departmental Elective-V (Select any one)		4	0	0	40	60	100	4
MELE1-372	Power System Planning							
MELE1-373	Electric Traction System							
MELE1-374	Power System Reliability							
MELE1-375	Distribution System Operation & Analysis							
MELE1-309	Project	0	0	8	60	40	100	12
MELE1-310	Seminar	0	0	4	100	0	100	2
MELE1-311	Research Lab.	0	0	4	60	40	100	2
Total		**8**	**0**	**16**	**300**	**200**	**500**	**24**

Total Credits = 24

4TH SEMESTER		Contact Hrs.			Evaluation Criteria	Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Satisfactory/ Unsatisfactory**	
MECE5-411	Thesis	0	0	24		24

MRSPTU

Overall

Semester	Marks	Credits
1st	600	21
2nd	600	21
3rd	500	24
4th	--	24
Total	**1700**	**90**

ADVANCED POWER SYSTEM ANALYSIS AND DESIGN

Subject Code: MELE1-101/MELE3-103 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

UNIT-1

1. Load Flow (8 Hrs.)
Network modeling – Conditioning of Y Matrix – Load Flow-Newton Rapson method- Decoupled – Fast decoupled Load flow -three-phase load flow.

UNIT-2

2. DC Power Flow (9 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-3

3. Fault Studies (9 Hrs.)
Analysis of balanced and unbalanced three phase faults – fault calculations – Short circuit faults – open circuit faults.

4. System Optimization (12 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-4

5. State Estimation (7 Hrs.)
Method of least squares – statistics – errors – estimates – test for bad data – structure and formation of Hessian matrix – power system state estimation.

MRSPTU

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**.

MODERN CONTROL THEORY

Subject Code: MELE1-102/ **L T P C** **Duration: 44 Hrs.**
4 0 0 4

UNIT-1

1. Mathematical Preliminaries (12 Hrs.)
Fields, Vectors and Vector Spaces – Linear combinations and Bases – Linear Transformations and Matrices – Scalar Product and Norms – Eigen-values, Eigen Vectors and a Canonical form representation of Linear operators – The concept of state – State Equations for Dynamic systems – Time invariance and Linearity – Non-uniqueness of state model – State diagrams for Continuous-Time State models.

UNIT-2

2. State Variable Analysis (10 Hrs.)
Linear Continuous time models for Physical systems– Existence and Uniqueness of Solutions to Continuous-Time State Equations – Solutions of Linear Time Invariant Continuous-Time State Equations – State transition matrix and its properties. General concept of controllability – General concept of Observability – Controllability tests for Continuous-Time Invariant Systems –

Observability tests for Continuous-Time Invariant Systems – Controllability and Observability of State Model in Jordan Canonical form – Controllability and Observability Canonical forms of State model.

UNIT-3

3. Non Linear Systems (8 Hrs.)

Introduction – Non Linear Systems - Types of Non-Linearties – 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-4

4. Stability Analysis (7 Hrs.)

Stability in the sense of Lyapunov, Lyapunov's stability and Lypanov's instability theorems - Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method. State feedback controller design through Pole Assignment – State observers: Full order and Reduced order.

5. Optimal Control (7 Hrs.)

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

RECOMMENDED BOOKS:

1. M. Gopal 'Modern Control System Theory', New Age International, **1984.**
2. K. Ogata 'Modern Control Engineering', Prentice Hall, **1997.**
3. I.J. Nagarath and M. Gopal, 'Control Systems Engineering', New Age International (P) Ltd.
4. M. Gopal, 'Digital Control and State Variable Methods', Tata Mc Graw-Hill Companies, **1997**.
5. H. Zak, 'Systems and Control by Stains Law', Oxford Press, **2003**.
6. Kuo, 'Digital Control Systems', 2nd Edn., Oxford University Press, **2003**.

MRSPTU

APPLIED INSTRUMENTATION & MEASUREMENT

Subject Code: MELE1-103	L T P C 4 0 0 4	Duration: 40 Hrs.

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 (8 Hrs.)

Basic Principles, Proximity & remote Action Telemetry systems, Multiplexing; Time Division and frequency division.

UNIT-3

3. Display Devices (10 Hrs.)

Various types of Display Device, Digital Voltmeters, Dual Slope DVMS, Digital encoders, Analog and Digital encoders, Analog and Digital Data Acquisition System, A/D Converter. Fiber 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 (12 Hrs.)

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.

RECOMMENDED BOOKS:

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. pH 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 McGraw Hills, **2005**.
9. Robert H. Bishop, 'Course with Lab VIEW 7 Express', Pearson Education, **2005**.
10. Related IEEE/IEE Publications.

POWER SYSTEM SOFTWARE LAB.

Subject Code: MELE1-104 **L T P C**
0 0 2 1

MRSPTU

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

ENERGY MANAGEMENT & ENERGY AUDITING

Subject Code: MELE1-156 **L T P C** **Duration: 40 Hrs.**
4 0 0 4

UNIT-1

1. Energy Scenario (9 Hrs.)

Energy needs of growing economy, Long term energy scenario, Energy pricing, Energy sector reforms, Energy and environment: Air pollution, Climate change, Energy security, Energy conservation and its importance, Energy strategy for the future, Energy conservation Act- 2001 and its features.

UNIT-2

2. Energy Management and Audit (9 Hrs.)

Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments.

3. Data Gathering (6 Hrs.)

Level of responsibilities, energy sources, control of energy and uses of energy get Facts, figures and impression about energy /fuel and system operations, Past and Present operating data, Special tests, Questionnaire for data gathering.

UNIT-3

4. Analytical Techniques (5 Hrs.)

Incremental cost concept, mass and energy balancing techniques, Inventory of Energy inputs and rejections, Heat transfer calculations, Evaluation of Electric load characteristics, process and energy system simulation.

UNIT-4

5. Evaluation of Saving Opportunities (5 Hrs.)

Determining the savings in rupees' Noneconomic factors, Conservation opportunities, estimating cost of implementation.

6. Energy Audit and Instruments (6 Hrs.)

The plant energy study report- Importance, contents, effective organization, report writing and presentation, Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy.

RECOMMENDED BOOKS:

1. W.R. Murphy, G. Mckay, 'Energy Management', Butterworths.
2. C.B. Smith, 'Energy Management Principles', Pergamon Press.
3. I.G.C. Dryden, 'Efficient Use of Energy', Butterworth Scientific.
4. A.V. Desai, 'Energy Economics', Wiley Eastern.
5. D.A. Reay, 'Industrial Energy Conservation', Pergamon Press.
6. W.C. Turner, 'Energy Management Handbook', John Wiley and Sons, A Wiley Interscience.
7. Publication.
8. 'CIBSI Guide – User's Manual', U.K.
9. 'CRC Handbook of Energy Efficiency', CRC Press.

MRSPTU

MICROPROCESSORS AND EMBEDDED CONTROL

Subject Code: MELE1-157 | **L T P C 4 0 0 4** | **Duration: 42 Hrs.**

UNIT-1

1. Overview (9 Hrs.)

Microprocessor 8086, Architecture, PIN Diagram, BIU and EU, memory addressing, Clock generator 8284, buffers and latches, maximum and minimum modes.

UNIT-2

2. Addressing Modes (10 Hrs.)

Addressing modes of 8086, Assembly language Programming, Assemblers and Procedures, Macros, Interrupts. Interfacing of 8086: IC 8155 (Static RAM with ports and timers), 8755 (EPROM with I/O ports), 8251A (USART), 8255 A, 8253/8254,8257 and 8259 controllers.

UNIT-3

3. Microcontroller (10 Hrs.)

Introduction to microcontrollers, Architecture, Pin Diagram, I/O ports, Internal RAM and registers, Interrupts, addressing modes, memory organization and external addressing, Instruction set. Interfacing with LCD, ADC, DAC, Stepper motor, Key Board and sensors.

UNIT-4

4. Embedded Systems (13 Hrs.)

Introduction, Classification, Processors, Hardware units, Software embedded into systems, applications and products of embedded systems, Structural Units in processor, Memory Devices, I/O Devices, Buses, Interfacing of Processor memory and I/O devices. Case Study of an embedded system for a smart card.

RECOMMENDED BOOKS

1. Mazidi, Mazidi & McKinlay, 'The 8051 Microcontroller and Embedded Systems using Assembly and C', PHI.
2. Myke Predko, 'Programming and Customizing the 8051 Micro-controller', Tata McGraw-Hill edn.
3. R.A. Gaonkar, 'Fundamentals of Microcontrollers and Applications in Embedded Systems (with the PIC18 Microcontroller Family)', Penram Publishing India.
4. K. Shibu, 'Embedded Systems', Tata McGraw Hill Publishing, New Delhi, **2009**.
5. Barry B. Brey, 'The Intel Microprocessors 8086/8088, 8086, 80286, 80386, 80486, Pentium, Pentium Pro Processor, Pentium II, Pentium III, Pentium 4, Architecture, Programming and Interfacing', Prentice Hall of India Private Limited, New Delhi, **2003**.
6. John Peatman, 'Design with Microcontroller', McGraw Hill Publishing Co. Ltd, New Delhi.

NON-CONVENTIONAL ENERGY RESOURCES

Subject Code: MELE1-158 **L T P C** **Duration: 41 Hrs.**
4 0 0 4

UNIT-1

1. Introduction to Energy Sources (5 Hrs.)

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

MRSPTU

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 (9 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 (11 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 (6 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.

WIND ENERGY AND SMALL HYDRO POWER STATION

Subject Code: MELE1-159 **L T P C** **Duration: 40 Hrs.**
4 0 0 4

UNIT-1

1. Wind Energy (12 Hrs.)
Introduction, general theory of wind machines, basic laws and concepts of aerodynamics, Micro-siting, Description and performance of the horizontal–axis wind machines. Introduction to blade design, Description and performance of the vertical–axis wind machines, generation of electricity by wind machines and case studies.

UNIT-2

2. Hydro Power Plant (10 Hrs.)
Overview of micro mini and small hydro, site selection and civil works. Penstocks and turbines, speed and voltage regulation, investment issues,

UNIT-3

3. Tariffs (8 Hrs.)
Study of load management and tariff scheme, distribution and marketing issues related to power generation.

UNIT-4

4. Hybrid Power System (10 Hrs.)
Wind and hydro based stand-alone / hybrid power systems, control of hybrid power systems, wind diesel hybrid systems

RECOMMENDED BOOKS:

1. J.F. Manwell, J.G. McGowan and A.L. Rogers, 'Wind Energy Explained – Theory, Design and Application', John Wiley & Sons, Ltd., **2002**.
2. O.L. Martin Hansen, 'Aerodynamics of Wind Turbines', Earthscan, **2008**.
3. Fernando D. Bianchi, Hernan De Battista and Ricardo J. Mantz, 'Wind Turbine Control Systems- Principles, Modelling and Gain Scheduling Design', Springer, **2007.**
4. Adam Harvey, Andy Brown and Priyantha Hettiarachi, 'Micro-Hydro Design Manual: A Guide to Small-Scale Water Power Schemes', ITDG, **1993**.
5. Maria Laguna, 'Guide on How to Develop a Small Hydropower Plant', ESHA, **2004**.
6. 'Good & Bad of Mini Hydro Power', edited by Roman Ritter, GTZ, **2009**.

EHVAC AND HVDC TRANSMISSION SYSTEM

Subject Code: MELE1-160 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

UNIT-1

1. Overview (6 Hrs.)
Comparison of EHV AC and DC transmission, description of DC transmission systems, modern trends in AC and DC transmission.

MRSPTU

2. EHV AC Systems (8 Hrs.)

Limitations of extra-long AC transmission, Voltage profile and voltage gradient of conductor, Electrostatic field of transmission line, Reactive Power planning and control, traveling and standing waves, EHV cable transmission system.

UNIT-2

3. Static Var System (6 Hrs.)

Reactive VAR requirements, Static VAR systems, SVC in power systems, design concepts and analysis for system dynamic performance, voltage support, damping and reactive support.

4. HVDC System (7 Hrs.)

Converter configurations and their characteristics, DC link control, converter control characteristics; Monopolar operation, converter with and without overlap, smoothing reactors, transients in DC line, converter faults and protection, HVDC Breakers.

UNIT-3

5. Corona and Interference (7 Hrs.)

Corona and corona loss due to EHV AC and HVDC, Radio and TV interference due to EHV AC and HVDC systems, methods to reduce noise, radio and TV interference.

6. Harmonic Filters (5 Hrs.)

Generation of harmonics, Design of AC filters, DC filters.

UNIT-4

7. Power Flow Analysis in AC/DC Systems (6 Hrs.)

Component models, solution of DC load flow, per unit system for DC quantities, solution techniques of AC-DC power flow equations, Parallel operation of HVDC/AC systems, Multi terminal systems.

RECOMMENDED BOOKS:

1. K.R. Padiyar, 'HVDC Power Transmission Systems', Wiley Eastern Ltd., New Delhi.
2. E. Kimbark, 'Direct Current Transmission', Vol-I, John-Wiley and Sons, NY.
3. J. Arrillaga, 'HVDC Transmission', IEE Press, London.
4. R.D. Begamudre, 'EHV AC Transmission Engineering', Wiley Eastern Press.

MRSPTU

DIGITAL SIGNAL PROCESSING AND APPLICATIONS

Subject Code: MELE1-161 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

UNIT-1

1. Introduction (10 Hrs.)

Limitations of analog signal processing, Advantages of digital signal processing and its applications; Some elementary discrete time sequences and systems; Basic elements of digital signal processing such as convolution, correlation and autocorrelation, Concepts of stability, causality, linearity, difference equations. DFT and its properties; Linear Periodic and Circular convolution; Linear Filtering Methods based on DFT; Fast Fourier Transform algorithm using decimation in time and decimation frequency techniques; Goertzel algorithm.

UNIT-2

2. Z Transform (6 Hrs.)

Introduction, Z-Transform, Region of convergence; Inverse Z Transform methods, properties of Z transform.

UNIT-3

3. Design of Digital Filters (12 Hrs.)

Structures of realization of discrete time system, direct form, Cascade form, parallel form and lattice structure of FIR and IIR systems. Linear Phase FIR filters; Design methods for FIR filters; IIR filter design by Impulse Invariance, Bilinear Transformation, Matched Z-Transformation, Analog and Digital Transformation in the Frequency Domain. Finite Precision Effects: Fixed point and Floating point representations, Effects of coefficient unitization, Effect of round off noise in digital filters, Limit cycles.

UNIT-4

4. DSP Processors (10 Hrs.)

Architectures of ADSP and TMS series of processor. Digital Signal Processing Principles, Algorithms and Application.

RECOMMENDED BOOKS:

1. Alan V. Oppenheim, Ronald W. Schafer, 'Discrete-Time Signal Processing', John R. Back, Prentice Hall.
2. S. Salivahan, A. Vallavaraj, Gnanpiya, 'Digital Signal Processing', Tata McGraw Hill.
3. S.K. Mitra, 'Digital Signal Processing - A Computer based Approach', Tata McGraw Hill.
4. Jervis, 'Digital Signal Processing‖', Pearson Education India.
5. 'Introduction to Digital Signal Processing', 1st Edn., Johny R. Johnson, Prentice Hall, **2006.**

ADAPTIVE CONTROL SYSTEM

Subject Code: MELE1-161 | **L T P C 4 0 0 4** | **Duration: 40 Hrs.**

UNIT-1

1. Introduction to Adaptive Control (6 Hrs.)

Development of adaptive control problem-The role of Index performance (IP) in adaptive systems-Development of IP measurement process model.

UNIT-2

2. System Response Identification (10 Hrs.)

Identification by Cross Correlation - Synthesis techniques for flat spectrum Pseudo random signals - Quasi Linearization-Impulse Response Expansion-Identification using matched filter, Adaptive control using steepest Descent.

3. Perturbation Systems (5 Hrs.)

Single and Multi-dimensional adaptive systems – Stability Analysis of Sinusoidal perturbation adaptive controllers – Formulation of signal synthesis system.

UNIT-3

4. Self-Tuning Regulators (Str) and Model Reference Adaptive Systems (10 Hrs.)

Introduction - Pole Placement Design-Indirect Self-tuning regulators - Continuous Time Self-Tuners - Direct self-tuning regulators - Linear quadratic self - Tuning regulators - Adaptive predictive control. The MIT rule – Determination of Adaptation Gain – Design of MRAS using Liapunov theory – BIBO Stability – Applications to Adaptive control- Model Free Adaptive Control.

UNIT-4

5. Gain Scheduling (9 Hrs.)

Principle-Design of Gain Scheduling Controllers - Nonlinear Transformations of second Order Systems Applications of Gain Scheduling. Case study - ABB Adaptive Controllers, Satt Control ECA40, The First Control Adaptive Controller.

RECOMMENDED BOOKS:

1. Karl J. Astrom and Bjorn Wittenmark, 'Adaptive Control', 2nd Edn., Pearson Education Inc., New Delhi, **2008**.
2. Shankar Sastry and Marc Bodson, 'Adaptive Control – Stability, Convergence and Robustness', Prentice Hall, Englewood Cliffs, New Jersey, **1989**.
3. L. Ljung, 'System Identification: Theory for the User', Prentice Hall, Englewood Cliffs, **1999**.

MRSPTU

4. V.V. Chalam, 'Adaptive Control Systems – Techniques and Applications', Marcel Dekker Inc., New Jersey, **1987**.
5. Kumpathi S. Narendra, Romeo Ortega and Peder Dorator, 'Advances in Adaptive Control', IEEE Press, New Jersey, 1991.
6. Petros A. Loannov and Jing Sun, 'Robust Adaptive Control', Prentice Hall Inc.

DISCRETE TIME CONTROL SYSTEMS

Subject Code: MELE1-163 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

UNIT-1

1. Introduction (7 Hrs.)
Configuration of the basic Digital Control Systems, types of sampling operations, Sample and Hold operations, Sampling theorem, Basic discrete time signals.

UNIT-2

2. Analysis of Digital Control Systems (9 Hrs.)
Z-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-3

3. Stability Methods (8 Hrs.)
Mapping between s-plane and z-plane, stability methods: Modified Routh Criterion, Jury's method, modified Schur-Cohn criterion.

4. Models of Digital Control Systems (5 Hrs.)
Digital temperature control System, Digital position control system, stepping motors and their control.

UNIT-4

5. Control Systems Analysis Using State Variable Methods (8 Hrs.)
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.

6. State Variable analysis of Digital Control Systems (8 Hrs.)
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 McGraw-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 & Gopal, 'Control System Engineering', John Wiley & Sons.
5. K.K. Aggarwal, 'Control System Analysis and Design', Khanna Publishers.

POWER SYSTEM OPERATION AND CONTROL

Subject Code: MELE1-205/MELE3-101 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

Course Objectives:

- To impart Course about the power system controls namely load frequency and AVR control for both single-machine infinite bus system and multi machine systems.

MRSPTU

- To learn optimal system operation through optimal generation dispatch, unit commitment, hydro-thermal scheduling and pumped storage plant scheduling and their implementation through various classical methods

Course Outcomes:

- Understanding about the power system controls namely load-frequency and AVR control for both single-machine infinite bus system and multi machine systems,
- Student will understand the optimal system operation through optimal generation dispatch, unit commitment, hydro-thermal scheduling and pumped storage plant scheduling and their implementation through various classical methods.

Unit-1

INTRODUCTION: 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, Newton Raphson method, base point and participation factors.

Unit-2

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

UNIT COMMITMENT: constraints in unit commitment, priority list method, Dynamic programming method and Lagrange relaxation methods.

Unit-3

HYDRO THERMAL CO-ORDINATION: 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

GENERATION WITH LIMITED ENERGY SUPPLY: take or pay fuel supply contract, composite generation production cost function, gradient search techniques.

Unit-4

OPTIMAL POWER FLOW FORMULATION: gradient and Newton method, linear programming methods.

AUTOMATIC GENERATION CONTROL: load frequency control, single area system, multi-area system, tie line control, automatic voltage control.

RECOMMENDED BOOKS:

1. D.P. Kothari and J.S. Dillon, ‘Power System Optimization’, Prentice-Hall of India Pvt. Ltd. New Delhi, **2011.**
2. G.L.K. Kirchmayer, ‘Economic Operation of Power Systems’, John Willey & Sons, N.Y., **2004.**
3. A.J. Wood, B.F. Wollenberg, ‘Power Generation Operation and Control’, **1998.**
4. D.P. Kothari and I.J. Nagrath, ‘Modern Power System Analysis’, Tata McGraw Hill Publishing Company Ltd., New Delhi, **1999.**

ADVANCED ELECTRICAL MACHINES

Subject Code: MELE1-206	L T P C 4 0 0 4	Duration: 45 Hrs.

Course Objectives:

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

Course Outcomes:

1. The students will be able to analyse all types of electrical machines.

MRSPTU

2. Students attain complete knowledge about electromagnetic energy conversion and time response analysis of reference frame theories for modelling of machines.

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.

MRSPTU

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.
4. P.S. Bimbhra, 'Generalized Theory of Electrical Machines', **2010.**
5. E.W. Kimbark., 'Power System Stability', Vol. III, **1998**.
6. A. Draper, 'Electrical Machines', **2011.**
7. 'Magnetic Circuits and Transformer', MIT Staff, **2004.**

POWER ELECTRONIC DEVICES AND CONTROLLERS

Subject Code: MELE1-207/MELE3-102   L T P C   Duration: 45 Hrs.
4 0 0 4

Course Objectives:

- Learn the physics of device operation, static and dynamic characteristics, ratings, protection, operating limitations and safe operating area
- Know about the design issues of drive circuits and their usage
- Understanding the different types of inverters and cyclo-converters

Course Outcomes:

- Knowledge of power semiconductor devices and their Gate and base drive circuits
- Develop skills to utilize the different PWM schemes
- Know about the different types of power converters and their applications

UNIT-1

REVIEW OF SEMICONDUCTOR DEVICES: Conduction Process in semiconductors, pn Junction, Charge control description, Avalanche breakdown, Power diodes, Thyristors, Gate Turn Off Thyristor (GTO), VI characteristics, Dynamic characteristics, ratings, protection.

UNIT-2

POWER MOSFET AND IGBT: Basic structure, I-V Characteristic, Physics of device operation, switching characteristics, operating limitation and safe operating area.

EMERGING DEVICES AND CIRCUITS: 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-3

SNUBBER CIRCUITS: 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-4

GATE AND BASIC DRIVE CIRCUITS: 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.

MRSPTU

SIMULATION LAB.

Subject Code: MELE1-208/MELE3-208 L T P C

0 0 2 1

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 MODELLING AND DYNAMICS

Subject Code: MELE1-264 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

Course Objectives:

1. This course aims to give basic knowledge about the dynamic mechanisms behind angle and voltage stability problems in electric power systems, including physical phenomena and modelling issues.

Course Outcomes:

At the end of this course,

1. Will be able to solve the reactive power problems in power system
2. Students will be able to analyse and understand the electromagnetic and electromechanical phenomena taking place around the synchronous generator.

UNIT-I

Static Model of Power System Components:

Generator, single circuit & multi-circuit transmission line, regulating & phase shifting transformer, VAr compensators and Loads for balanced and unbalanced conditions. Formulation of Admittance and Impedance Matrices for balanced and unbalanced conditions, their modifications, Sparcity and Optimal ordering,

UNIT-II

TRANSIENT STABILITY ANALYSIS

Review of numerical integration methods: Euler and Fourth Order Runge-Kutta methods, Numerical stability and implicit methods, Interfacing of Synchronous machine (variable voltage) model to the transient stability algorithm (TSA) with partitioned –explicit and implicit approaches – Interfacing SVC with TSA-methods to enhance transient stability.

UNIT III

UNIFIED ALGORITHM FOR DYNAMIC ANALYSIS OF POWER SYSTEMS

Need for unified algorithm-numerical integration algorithmic steps-truncation error-variable step size –handling the discontinuities-numerical stability-application of the algorithm for transient. Mid-term and long-term stability simulations.

UNIT IV

TRANSMISSION, GENERATION AND LOAD ASPECTS OF VOLTAGE STABILITY ANALYSIS

Review of transmission aspects –Generation Aspects: Review of synchronous machine theory – Voltage and frequency controllers –Limiting devices affecting voltage stability –Voltage-reactive power characteristics of synchronous generators –Capability curves – Effect of machine limitation on deliverable power –Load Aspects –Voltage dependence of loads –Load restoration dynamics – Induction motors –Load tap changers –Thermostatic load recovery –General aggregate load models.

RECOMMENDED BOOKS:

1. R. Ramnujam, 'Power System Dynamics Analysis and Simulation', PHI, Course Private Limited, New Delhi, **2009.**
2. P. Kundur, 'Power System Stability and Control', McGraw-Hill, **1993**.
3. J.D. Grainger, 'Power System Analysis', Tata McGraw Hill Publishing Company, **2008**.
4. L.P. Singh, 'Advanced Power System Analysis and Dynamics', 3rd Edn., Wiley Eastern, New Delhi, **2012.**

MRSPTU

CUSTOMIZED POWER DEVICES

Subject Code: MELE1-265 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

Course Objectives

1. To study of advances in Power Electronics Industry led to rapid development of Power Electronics controllers for fast real and reactive power control and to introduce these advancements.

Course Outcomes

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

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 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 multipulse 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**.

MRSPTU

ADVANCED ELECTRICAL MACHINES DESIGN

Subject Code: MELE1-266 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

Course Objectives:

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

Course Outcomes:

1. Develop the basic elements of generalized theory and derive general equations for voltages and currents applicable to all types of rotating machines, to deal comprehensively with their steady-state, dynamic and transient analysis.
2. Obtain the voltage and torque equations for a symmetrical induction machine in terms of machine variables and transform these equations by applying reference-frame theory to Analyse the dynamic performance of the machine.
3. Apply Park"s transformation to transform the time varying synchronous machine equations to a time-invariant set of equations and study the dynamic performance.
4. Linearize the nonlinear equations of induction and synchronous machines to study the dynamic behaviour of small displacements about the operating point.

UNIT-I

Introduction: Design of Machines, Factors, limitations, Modern trends. Materials: Conducting, magnetic and insulating materials. Calculations of mmf for air gap and teeth, real and apparent flux densities, iron losses, field form, leakage flux, specific permanence. Modes of heat dissipation, Temperature gradients, types of enclosures, types of ventilation, conventional and direct cooling, amount of coolants used, Ratings.

MRSPTU

UNIT-II

Transformer and DC Machine

Transformer: Magnetic circuit, core construction and design, winding types, insulation, Loss allocation and estimation, Reactance, Temperature rise.

D C Machine:

No. of poles and main dimensions, armature, windings, Magnetic circuit and Magnetisation curve, Commutator and brushes.

UNIT-III

AC Machine

Induction Machine-3 Phase: Rating specifications, standard frame sizes, Main dimensions' specific loadings, Design of stator windings, Rotor design –slots and windings, calculations of equivalent circuit parameters.

Synchronous Machine: Main dimensions, Magnetization characteristic, Field winding design.

UNIT-IV

Computer Aided Design of Electrical Machines

Analysis and synthesis approaches, design algorithms, Introduction to optimization techniques, Implementing computer program for design of three phase induction motor.

RECOMMENDED BOOKS:

1. A.K. Sawhney, 'A Course in Electrical Machine Design', Dhanpat Rai & Co.
2. A.E. Clayton & N.N. Hancock, 'The Performance and Design of Direct Current Machines', CBS Publishers and Distributors.
3. E.S. Hamdi, 'Design of Small Electrical Machine', John Wiley and Sons, **1994**.
4. M. Ramamoorty, 'Computer Aided Design of Electrical Equipment', Eastern Press Private Limited, **1989**.
5. M.G. Say, 'Design and Performance of Machines', CBS Publications, **1981**.

ARTIFICIAL INTELLIGENT TECHNIQUES

Subject Code: MELE1-267/ MELE2-267/ MELE3-267 **L T P C 4 0 0 4** **Duration: 45 Hrs.**

Course Objectives:

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

Course Outcomes:

1. The students acquire the skills required to innovate and build, smart and intelligent applications in electrical and electronics engineering.
2. 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.
3. They will be able to take up fuzzy systems approach to solve applications in engineering.

UNIT I

NEURAL NETWORKS (9 hours)

Neural Networks – biological neurons – Artificial neurons – activation
function – Course rules – feed forward networks – supervised & Unsupervised Course –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**.

MRSPTU

POWER SYSTEM DYNAMICS & STABILITY

Subject Code: MELE1-368/ MELE3-207 L T P C Duration: 45 Hrs.
4 0 0 4

Course Objectives:

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

Course Outcomes:

After Completion of this course students will be able to

1. Solve mathematical calculations and swing equation and obtain classical model of an infinite bus system.
2. Analyse the effect of small speed changes in multi machine synchronous machines and voltage regulator governor system.
3. 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.

UNIT-I

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

2. Transient Stability Analysis: Single Machine - Infinite Bus System, Equal Area Criterion, Multi-machine Stability, Network Reduction and Numerical Integration Methods, Methods of Improvement.

UNIT-II

3. 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-III

4. Sub Synchronous Oscillations: Sub Synchronous Resonance (SSR) Phenomenon, Counter measures to SSR problems.

UNIT-IV

5. 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.

ADVANCED POWER SYSTEM PROTECTION

Subject Code: MELE1-369 / MELE3-206 L T P C Duration: 45 Hrs.
4 0 0 4

Course Objectives:

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

Course Outcomes:

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

MRSPTU

UNIT-I

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

2. 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-II

3. 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-III

4. 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-IV

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

6. 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, Raju Primlan 'Power System Protection', 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.

MRSPTU

SMART GRID TECHNOLOGIES

Subject Code: MELE1-370/ MELE3-162 L T P C Duration: 45 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-II

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-III

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-IV

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.

BOOKS RECOMMENDED:

1. Ali Keyhani, N. 'Integration of Green and Renewable Energy in Electric Power Systems', Marwali, Min Dai, Wiley.
2. Clark W. Gellings, 'The Smart Grid: Enabling Energy Efficiency and Demand Response', CRC Press.
3. Akihiko Yokoyama, Janaka E kanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, 'Smart Grid: Technology and Applications', Wiley.
4. Jean Claude Sabonnadière, Nouredine Hadjsaïd, 'Smart Grids', Wiley Blackwell.

MRSPTU

ENGINEERING OPTIMIZATION

Subject Code: MELE1-371/ MELE3-371/ MELE0-F94 **L T P C 4 0 0 4** **Duration: 45 Hrs.**

UNIT I

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

UNIT II

Linear Programming (LP) and Non Linear Programming (NLP): Simplex method of solving LP, revised simplex method, duality, Constrained Optimization, Theorems and procedure, linear programming, mathematical model, solution technique, duality. Steepest descent method, Conjugate gradient method, Newton 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 (GA): Introduction to Genetic Algorithm, working principle, coding of variables, fitness function, GA operators; Similarities and differences between GA and traditional methods; Unconstrained and constrained optimization using genetic Algorithm, real coded GA, Advanced GA, global optimization using GA, Applications to power system.

RECOMMENDED BOOKS:

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

4. D.P. Kothari & J.S. Dhillon, 'Power System Optimization', PHI Publishers.
5. Donald E. Kirk, 'Optimal Control Theory', Dover Publications, New York.
6. Kalyanmoy Deb, 'Optimization for Engineering Design: Algorithms and Examples', PHI Publishers.

POWER SYSTEM PLANNING

Subject Code: MELE1-372 / MELE3-205 L T P C Duration: 45 Hrs.
4 0 0 4

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

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

UNIT-I

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

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

UNIT-II

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

4. 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.

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

MRSPTU

UNIT-III

6. 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.

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

UNIT-IV

8. 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 Modelling 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**.

ELECTRIC TRACTION SYSTEM

Subject Code: MELE1-373 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

UNIT-I

1. Traction Systems and Latest Trends: Present scenario of Indian Railways – High speed traction, Metro, Latest trends in traction-Metro, monorail, Magnetic levitation Vehicle, Steam, diesel, diesel-electric, Battery and electric traction systems, General arrangement of D.C., A.C. single phase and 3-phase, Composite systems, Choice of traction system - Electric and Diesel-Electric.

UNIT-II

2. Mechanism of Train Movement: Analysis of speed time curves for main line, suburban and urban services, Simplified speed time curves. Relationship between principal quantities in speed time curves, Requirement of tractive effort, Specific energy consumption and Factors affecting it.

UNIT-III

3. Traction Motors and their Control: Features of traction motors, Significance of D.C. series motor as traction motor, A. C. Traction motors-single phase, Three phase, Linear Induction Motor, Comparison between different traction motors, Series-parallel control, Open circuit, Shunt and bridge transition, Pulse Width Modulation control of induction motors, Types of electric braking system.

UNIT-IV

4. Electric Locomotives: Important features of electric locomotives, Different types of locomotives, Current collecting equipment, Coach wiring and lighting devices, Power conversion and transmission systems, Control and auxiliary equipment, Distribution systems pertaining to traction (distributions and feeders), Traction sub-station requirements and selection, Method of feeding the traction sub- station.

MRSPTU

RECOMMENDED BOOKS:

1. R.B. Brooks, 'Electric Traction Hand Book', Sir Isaac Pitman and sons Ltd., London.
2. A.T. Dover, Mac Millan, 'Electric Traction', Dhanpat Rai and Sons, New Delhi.
3. J. Upadhyay S.N. Mahendra, 'Electric Traction', Allied Publishers Ltd., Dhanpat Rai and Sons, Delhi.
4. H. Partab, 'Modern Electric Traction', Dhanpat Rai and Sons, New Delhi.
5. J.B. Gupta, 'Electric Power Utilization', Kataria and Sons, New Delhi.

POWER SYSTEM RELIABILITY

Subject Code: MELE1-374/ MELE3-264 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

Course Objectives

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

Course 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

UNIT-I

1. Basic Reliability Concepts: The General reliability function, Hazard rate, MTTF, Markov processes.

2. Static Generating Capacity Reliability Evaluation: Capacity outage probability tables, loss of load probability method, Frequency and duration approach.

UNIT-II

3. Spinning Generation Capacity Reliability Evaluation: Spinning reserve, spinning reserve capacity evaluation, Load forecasting methods, Load forecast uncertainty, maximum capacity levels, Derated capacity levels.

UNIT-III

4. Transmission System Reliability Evaluation: Average interruption rate method, Frequency and duration method, Stormy and normal weather effects, The Markov process approach.

UNIT-IV

5. 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.
3. Ali Chowdhury Don Koval, 'Power Distribution System Reliability: Practical Methods and Applications', Wiley-IEEE Press.

DISTRIBUTION SYSTEM OPERATION AND ANALYSIS

Subject Code: MELE1-375/ MELE3-369 L T P C
4 0 0 4

MRSPTU

UNIT-I

1. System Planning: Introduction, Distribution system planning, Factors affecting system planning, present planning techniques, planning models, Introduction to optimum line network. future trends in planning, systems approach, distribution automation. Load Characteristic: Basic definitions, relation between load and loss factors, maximum diversified demand, load forecasting, Load management.

UNIT-II

2. System Design and Operation: Criteria, system developers, dispersed generation, distribution systems, economics and finance, mapping, Design of substation and feeder, Operation criteria, voltage measurements, harmonics, load variations, system losses, Introduction to energy management.

UNIT-III

3. Voltage Regulation and Automation: Quality of Service and Voltage Standards, Voltage Control, Line Drop Compensation, Distribution capacitor automation, Voltage fluctuations, SCADA and Communication with Load Dispatch Centres.

UNIT-IV

4. Distribution System Protection: Objective of distribution system protection, high impedance faults coordination of protective devices: fuse to fuse co-ordination, re-closer to re-closer coordination, re-closer to fuse coordination, re-closer to substation transformer high side fuse coordination, fuse to circuit breaker coordination, re-closer to circuit breaker coordination, lightning protection.

RECOMMENDED BOOKS:

1. Gonen, Turan, 'Electric Power Distribution System Engineering', CRC PRESS, **2012**, 3rd Indian Reprint.
2. A.S. Pabla, 'Electric Power Distribution', 6th Edn., TMH, **2011**,

3. ‘Electric Power Distribution Handbook’, Thomas Allen Short.

PROJECT

Subject Code: MELE3-309/ MELE1-309/ MELE2-309 **L T P C**

Course Objectives:

1. To propose engineering based project in a clear and concise manner.
2. Allow students to develop problem solving, analysis, synthesis and evaluation skills.

Course Outcomes:

1. Synthesis of knowledge.
2. To demonstrate the aptitude of applying the own knowledge to solve a specific problem.
3. To mature the knowledge.
4. Able to organize, compile and record all work details in an efficient manner

Each student will be required to complete a Project and submit a Project Report on a topic on any of the areas of modern technology related to Electrical Engineering including interdisciplinary fields. The project will carry 10 credits. Its evaluation will be done as under:

Internal Marks		External Marks	
1. Formulation of Problem	10	Implementation	10
2. Design	10	Result & Analysis	10
3. Implementation	20	Report	10
4. Testing & Analysis	10	Viva-Voce	10
5. Report	10	----	---
Total Marks	60	**Total Marks**	40

MRSPTU

SEMINAR

Subject Code: MELE1-310/ MELE2-310/ MELE3-310 **L T P C**

Course Objectives:

1. To identify, understand and discuss current advanced research topic.
2. To gain experience in the critical assessment of the available scientific literature
3. To practice the use of various resources to locate and extract information using offline & online tools, journals

Course Outcomes:

1. An ability to utilize technical resources
2. An ability to write technical documents and give oral presentations related to the work completed.
3. To learn preparation and presentation of scientific papers in an exhaustive manner

Each student will be required to prepare a Seminar Report and present a Seminar on a topic in any of the areas of modern technology related to Electrical Engineering including interdisciplinary fields.

Seminar will carry 4 credits. It will be done on any topic within/outside the curriculum. Its evaluation will be done as under:

Sr. No.	Parameters for Evaluation	Internal Marks	External Marks
1	Depth & Coverage of Topic	40	-
2	PPT Presentation & Report	20	-
3	Presentation	20	-
4	Questions & Answers	20	-
Total		**100**	**-**

RESEARCH LAB.

Subject Code: MELE1-311/ MELE2-311/ MELE3-311 **L T P C**

Students will be made familiar with one or more available softwares like MATLAB, ETAP, GAMS, Power System Toolbox, Power world Simulator, Network Simulator, LABVIEW, etc. so that students can use any one or more of them for their dissertation. Students will be advised to go through maximum research papers and conclude a particular domain to work further.

DISSERTATION

Subject Code: MELE1-412/ MELE2-412/ MELE3-412 **L T P C**

Course Objectives: To learn, practice, and critique effective scientific writing and to formulate the research objectives clearly, state claims and evidence clearly, assess validity of claims, evidence, outcomes, and results.

Course Outcomes:

1. Design and execute a meaningful research project that demonstrates spatial thinking and uses the knowledge and skills.
2. Define and analyse a problem in latest research areas.
3. Formulate and write a research proposal.
4. Able to learn effectively record data and experiments so that others can understand them.
5. Communicate the findings by means of a thesis, written in the format specified by the department/institute.

Each student will be required to complete a Dissertation and submit a written Report on the topic on any of the areas of modern technology related to Electrical Engineering including interdisciplinary fields in the Final semester of M.Tech. Course.

The thesis will carry 24 credits and will be evaluated as under:

Dissertation will be evaluated as under:

Sr. No.	Parameters for Evaluation	Internal Marks	External Marks
1	Originality	12	08
2	Presentation	12	08
3	Contents & Volume of work	18	12
4	Discussion (Contribution of candidate)	18	12
Total		**60**	**40**

MRSPTU