MAHATMA GANDHI UNIVERSITY

SCHEME AND SYLLABI

FOR

M. Tech. DEGREE PROGRAMME

IN

ELECTRICAL AND ELECTRONICS ENGINEERING

WITH SPECIALIZATION IN

POWER SYSTEMS

(2011 ADMISSION ONWARDS)
SCHEME AND SYLLABI FOR M. Tech. DEGREE PROGRAMME IN ELECTRICAL AND ELECTRONICS ENGINEERING WITH SPECIALIZATION IN POWER SYSTEMS

SEMESTER - I

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course No.</th>
<th>Subject</th>
<th>Hrs / Week</th>
<th>Evaluation Scheme (Marks)</th>
<th>Credits (C)</th>
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Elective – I (MEEPS 105)

- MEEPS 105.1 Dynamics of linear systems
- MEEPS 105.2 Distributed generation
- MEEPS 105.3 Power system planning
- MEEPS 105.4 Power system monitoring and instrumentation

Elective – II (MEEPS 106)

- MEEPS 106.1 Analysis of ac machines
- MEEPS 106.2 Nonlinear control theory
- MEEPS 106.3 Optimal control theory
- MEEPS 106.4 Power distribution systems

L – Lecture, T – Tutorial, P – Practical

TA – Teacher’s Assessment (Assignments, attendance, group discussion, Quiz, tutorials, seminars, etc.)
CT – Class Test (Minimum of two tests to be conducted by the Institute)
ESE – End Semester Examination to be conducted by the University

Electives: New Electives may be added by the department according to the needs of emerging fields of technology. The name of the elective and its syllabus should be submitted to the University before the course is offered.
# SEMESTER – II

<table>
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<th>Sl. No.</th>
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**Elective – III (MEEPS 205)**

- **MEEPS 205.1**: Power system voltage stability
- **MEEPS 205.2**: Electricity deregulation
- **MEEPS 205.3**: Power system transients & insulation coordination
- **MEEPS 205.4**: Advanced relaying and protection

**Elective – IV (MEEPS 206)**

- **MEEPS 206.1**: Soft Computing techniques in power systems
- **MEEPS 206.2**: EHV ac & dc transmission
- **MEEPS 206.3**: Power system reliability
- **MEEPS 206.4**: Energy conservation and management

**L** – Lecture, **T** – Tutorial, **P** – Practical

**TA** – Teacher’s Assessment (Assignments, attendance, group discussion, Quiz, tutorials, seminars, etc.)

**CT** – Class Test (Minimum of two tests to be conducted by the Institute)

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### SEMESTER – III

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* TA based on a Technical Report submitted together with presentation at the end of the Industrial Training and Mini Project

** Evaluation of the Industrial Training and Mini Project will be conducted at the end of the third semester by a panel of examiners, with at least one external examiner, constituted by the University.

*** The marks will be awarded by a panel of examiners constituted by the concerned institute

### SEMESTER - IV

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** Grand Total of all Semesters 2750 80

* 50% of the marks to be awarded by the Project Guide and the remaining 50% to be awarded by a panel of examiners, including the Project Guide, constituted by the Department

** Thesis evaluation and Viva-voce will be conducted at the end of the fourth semester by a panel of examiners, with at least one external examiner, constituted by the University.
Module 1: Transforms
Fourier Transforms, cosine and sine transforms. Z transforms of $a^n$, $n^p$, $\cos nT$, $\sin nT$, $a^n \cos nT$, $a^n \sin nT$, properties, convolution. Inverse transforms by partial fractions and residues, application to solution of difference equations.

Module 2: Calculus of Variation & Integral Equations
Euler-Lagrange condition for extremum of integrals, isoperimetric problems, problems with constraints.

Module 3: Estimation Theory and Time series Analysis

Module 4: Vector Algebra
Vector spaces and subspaces, definitions and simple problems on linear dependence, basis, dimension, linear transformations, representation of linear transformation by matrices, definitions and simple problems of inner product spaces and Hilbert spaces.

References:


Module 1: Optimization problems
Statements - Classification - One Dimensional Minimization methods - Fibonacci and Golden section methods - Quadratic interpolation method - Unconstrained optimization – Uni variant method - Powell’s method - Decent methods - Steepest decent method - Conjugate gradient method - Fletcher-reves method.

Module 2: Constrained optimization problem
Computation techniques: Genetic Algorithms- representation of design variables- Objective function and constraints- Genetic operators

Module 3: Power Generation Units
Generation with limited energy supply - Take or pay fuel supply contract - Composite generation production cost function - Solution by gradient search techniques - Hard limits and slack variables - Development of loss formula and B coefficients - Application of genetic algorithm to Economic dispatch

Module 4: Hydrothermal co-ordination
Long range and short range hydro scheduling - Hydroelectric Plant models - Scheduling problems: types of Scheduling problems - Scheduling energy – Short term Hydrothermal Scheduling problem – Short term hydro scheduling: A Gradient approach - Pumped storage hydro plants - Pumped storage hydro scheduling using $\lambda-\gamma$ iteration.
Unit Commitment: Constraints in unit Commitment - Spinning reserve, thermal unit constraints, hydro constraints, must run and fuel constraints.
References: –

Module 1: Elementary linear graph theory
Incidence and Network matrices- Development of network matrices from Graph theoretic approach- Building algorithm for Bus impedance matrix- Modification of $Z_{Bus}$ matrix due to changes in primitive network.

Module 2: Load Flow Studies

Module 3: Power system components and their representation
Representation of Synchronous machine, transmission system, three phase power network. Incorporation of FACTS devices in Load Flow: Static Tap Changing, Phase Shifting (PS), Static Var Compensator (SVC), Thyristor Controlled Series Compensator(TCSC) and Unified power Flow Controller.

Module 4: Short circuit studies
Types of faults-Short circuit study of a large power system-Algorithm for calculating system conditions after fault-Three phase short circuit, three phase to ground, double line to ground, line to line and single line to ground fault-Short circuit calculations using Z bus –Short circuit calculations for balanced and unbalanced three phase network using Z-bus.

References:

Module 1: Thyristor Convertors

Module 2: Thyristor Convertors and Choppers
Three phase fully controlled bridge convertor- Effect of source inductance – Output voltage waveform- Input current- Harmonic analysis of input current- Displacement factor- Power factor- Dual Convertors- Circulating current and Non circulating current mode- Output voltage waveform and voltage across the reactor using 3 pulse convertors- Chopper- Type A and Type B Chopper- Analysis of Type A Chopper- Limit of Continuous conduction.

Module 3: AC voltage controllers and Cyclo-converters
Single Phase and Three Phase AC Voltage Controllers- Principle of operation- analysis with R and RL loads- Thyristor Controlled Inductors, Circulating and Non circulating type cyclo converters- Analysis with R and RL loads.

Module 4: Inverters
Single phase half bridge and full bridge inverters- Three phase Bridge inverters feeding star connected resistance load- Output voltage waveform of phase and line voltages- Harmonic Analysis of output voltage- Methods of voltage control sinusoidal pulse width modulation- Harmonic elimination- Current source inverters- Single phase and three phase.

References:
Module 1: State space Descriptions and basic concepts
State space representations of Transfer Function Systems - Canonical realizations- Parallel and cascade realization- Properties of state transition matrix-Transformation of system models-Solution of time invariant state equations- Vector matrix analysis- Controllability and observability.

Module 2: Lyapunov Stability Analysis

Module 3: Linear state variable feedback systems
Analysis of stabilization by output feedback- Modal controllability- Formulae for feedback gain-Significance of controllable canonic form-Ackerman’s formula- Mayne-Murdoch formula- State feedback and zeros of the transfer function-non controllable realizations and stabilizability-Controllable and uncontrollable modes-regulator problems-non zero set points and tracking .

Module 4: Asymptotic observers and compensators
Asymptotic observers for state measurement- Open loop observer-closed loop observer- Formulae for observer gain-calculation of transfer function- Implementation of the observer-Full order and reduced order observers- Separation principle- Combined observer-controller-criteria for choosing observer poles

References:
Module 1: Energy conversion

Module 2: Direct energy conversion (DEC)
DEC devices - Photo voltaic system - Solar cells - Cell efficiency - Limitations - PV modules - Battery backup - System design - Lighting and water pumping applications;

Module 3: Fuel cells and Wind Energy
Fuel cells: Types - Losses in fuel cell - Applications; MHD generators - Application of MHD generation.
Wind energy: Characteristics - Power extraction - Types of wind machines - Dynamics matching - Performance of wind generators - Wind mills - Applications - Economics of wind power

Module 4: Biofuels
Classification - Biomass conversion process - Applications; Ocean thermal energy conversion systems; Tidal and Wave power - Applications; Micro and Mini hydel power. Hybrid Energy Systems - Implementation - Case study

References:

Module 1: Introduction to load forecasting

Module 2: Generation system reliability analysis
Generation system reliability analysis-Probabilistic generating unit models-Probabilistic load models-Reliability - Analysis of isolated systems-Interconnected systems-Generation systems cost analysis –Corporate models-Production analysis-Production costing-Energy transactions-Off peak loading –Environmental cost.

Module 3: Transmission system reliability analysis
Transmission system reliability analysis-Deterministic contingency analysis-Probabilistic transmission system reliability analysis-Capacity state classification –Reliability calculation for single areas-Multi area reliability analysis.

Module 4: Automated transmission system expansion planning
Automated transmission system expansion planning-Automated transmission system planning concepts-Automated network design-DC method-Automated transmission planning using iteration graphics

References:
Module 1: Introduction to SCADA
SCADA: Signal processing and conditioning- Transducers- Metering technology – An introduction to supervisory control and data acquisition (SCADA) systems.
Introduction to SCADA: Data acquisition systems- Evolution of SCADA- Communication technologies- Monitoring and supervisory functions- SCADA applications in Utility Automation- Industries.

Module 2: SCADA System Components

Module 3: SCADA Architecture
Various SCADA architectures-Advantages and disadvantages of each system - single unified standard architecture -IEC 61850
SCADA Communication: Various industrial communication technologies -Wired and wireless methods and fiber optics- Open standard communication protocols

Module 4: Reliable operations basic functional requirements
Reliable operations basic functional requirements: Networking applied to power systems – Online load flow and security analysis – State estimation techniques- Automatic load frequency control- Modern trends in power system monitoring and control.

References:
3. Dr. Khedkar M K, Dr. Dhole G M , “A Textbook of Electric power Distribution Automation”.
Module 1: Introduction

Module 2: Transformation theory
Stationary, moving and pseudo stationary coils—Primitive machines of iron—Conventional machines as transformed versions of the primitive machines—Transformation theory as applied to rotating electrical machines with a symmetrical winding on either stator or rotor—Active and passive transformation—Power invariancy.

Module 3: Modelling cylindrical rotor and salient pole synchronous machines
Dynamic circuit formulation of different equations of performance—dqo transformation—Steady state and transient performance equations—Application to various kinds of faults, steady state, transient and sub-transient reactance and associated time constant—Stability of synchronous machines—Region of operation chart for non—salient pole and salient pole machines

Module 4: Modelling the m-n phase cylindrical rotor induction machine
Transformation to axes fixed to stator—Fixed to rotor or moving at synchronous speed—Symmetrical components transformation and applications to unbalanced operation of 3 phase and 2 phase induction machine.

References:
Module 1: Introduction and classical techniques

Module 2: Stability of Nonlinear Systems

Module 3: Harmonic Linearisation and Describing Function Method
Harmonic linearization - filter hypothesis - Sine Input describing function of standard nonlinearities (Saturation, Dead Zone, ON/OFF Non linearity, Back lash, Hysteresis) - study of limit cycles.
Feedback Control and Feedback Stabilisation- Analysis of feedback systems- Circle Criterion - Popov Criterion– Concepts of Inverse control-Feedback linearization

Module 4: Model predictive control

References:
Module 1: Optimality problems in control Theory
Mathematical models-Selection of performance measures-Constraints-Classification of problem
constraints-Problem Formulation-Examples.

Module 2: Dynamic Programming
Optimal control Law-Principle of Optimality-Application to decision making-Routing Problem –
Hamilton Jacobi Bellman equations-Discrete and Continuous Linear Regulator Problems.

Module 3: Calculus of Variations
Basic concepts –Variation of a Functional-Extremals-Fundamental theorem in calculus of
Variation-Euler equation-Piecewise smooth extremals –constrained extrema-Hamiltonian-
necessary condition for optimal control.

Module 4: Pontryagin’s Minimum Principle
Intervals

References:
Module1: Basic Consideration and Distribution system Layout
Utility load classification – Distribution system layout-Classification
Overhead and Under Ground lines: Choice of system – Optimum design considerations – Design
and construction of overhead lines – Underground System – Determination of cable rating –
Causes of failure – Systems fault location
System Over voltages: Causes – lightning – Protective Devices – Travelling waves – Protection
schemes.

Module 2: Distribution system planning and Automation
Distribution system planning: Factors affecting power system planning – planning process and
block diagram. Load forecasting – Classification – Trends or regression analysis.
Distribution Automation: Control functions – Communication system – Consumer Information
Energy Management: Supply Side Management – Demand Side Management – Technologies –
Implementation. Dispersed Generation.

Module 3: Power System reliability
System reliability: Basic reliability concept – Cost verses system Reliability – Reliability
planning procedure – Mathematical concept – series and parallel combination – Sustained
interruption indices
Power capacitors: Reactive power – Effects of series and shunt capacitors – Power factor
correction. Distribution transformers – Connections of three phase transformers – Causes of
failure – inspection and maintenance

Module 4: Deregulation of the Electricity Supply Industry
Metering of energy: Types of meters – Periodical testing of meters – Instantaneous load
measurements using watt-hour meters – Rate Structure – Automatic meter reading – Theft of
electricity – Tariffs: classification of tariff.
Grounding: Grounding system – earth and safety – nature of an earth electrode system – design
of earthing electrodes – System earthing – earth testing.

References:
List of Experiments

1. Formation of Bus Admittance Matrix and Bus Impedance Matrix using MATLAB
2. Formation of Jacobian for a system not exceeding 4 buses (no PV Buses) in polar co-ordinates using MATLAB
3. Sequence Components of Power System Network with Single Line to Ground Fault using MATLAB SIMULINK
5. Short circuit studies of power system using ETAP/PSCAD
7. DC Load flow analysis using MATLAB.
8. Simulation & Analysis of magnetic circuits using SIMULINK.
9. Simulation and measurements of Three Phase circuits using SIMULINK.
10. Modelling of Automatic Generation Control for a two area network using SIMULINK.
11. To determine 1) Swing curve 2) Critical clearing time for a single machine connected to infinite bus through a pair of identical transmission lines, three phase fault on one of the lines for variation of inertia constant/line parameters/fault locations/clearing time/pre fault electrical output using MATLAB/C-program
12. Modeling and Simulation of Non Conventional Energy Systems using MATLAB

Optional Experiments

1. Analysis of Static Var Compensators.
2. Analysis of STATCOM.
3. Load forecasting using ETAP
4. Power Quality studies using PSCAD
5. Substation layout using AutoCAD Electrical
6. Transient Stability Analysis and formation of Swing Curves using MATLAB/SIMULINK
7. Modeling of Surge Arresters using PSCAD
8. Modeling of FACTS devices using SIMULINK
9. Transformer Tests using SIMULINK /ETAP
10. Fault Analysis of a synchronous Generator using PSCAD
11. Execute optimal power flow problem using ETAP/PSCAD.
12. Analysis of voltage stability of a SLIB (Single Load Infinite Bus) system while delivering maximum power using MATLAB.
13. Continuation Power Flow(CPF) analysis using MATLAB

*In addition to the above, the Department can offer a few newly developed experiments*
Each student shall present a seminar on any topic of interest related to the core/elective courses offered in the first semester of the M. Tech. Programme. He/she shall select the topic based on the references from international journals of repute, preferably IEEE journals. They should get the paper approved by the Programme Co-ordinator/Faculty member in charge of the seminar and shall present it in the class. Every student shall participate in the seminar. The students should undertake a detailed study on the topic and submit a report at the end of the semester. Marks will be awarded based on the topic, presentation, participation in the seminar and the report submitted.
Module 1: Active Power and Frequency control
Active Power and Frequency control: - Fundamentals of speed governing - Control of Generating unit power output - Composite regulating characteristic of Power system - Responds rates of turbine - Governing systems - Fundamentals of Automatic Generation control (AGC) - Implementation of AGC

Module 2: Reactive Power & Voltage control

Module 3: Power system security

Module 4: Security assessment
Real time control of power system: Real time control of power system under normal, alert, emergency and restorative modes of operation - Introduction to system monitoring - Basic SCADA system architecture - Preventive, emergency and restorative control procedures including principles of Load Shedding and application of under frequency Relays.
References:

Module 1: Introduction

Module 2: Harmonics
Harmonics-individual and total harmonic distortion-RMS value of a harmonic waveform-triplex harmonics-important harmonic introducing devices-SMPS-Three phase power converters-arcing devices-saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.
Modeling of networks and components under non-sinusoidal conditions-transmission and distribution systems-shunt capacitors-transformers-electric machines-ground systems-loads that cause power quality problems-power quality problems created by drives and its impact on drives

Module 3: Power factor improvement

Module 4: Active Harmonic Filtering
Active Harmonic Filtering-Shunt Injection Filter for single phase , three-phase three-wire and three-phase four-wire systems . d-q domain control of three phase shunt active filters uninterruptible power supplies-constant voltage transformers- series active power filtering techniques for harmonic cancellation and isolation . Dynamic Voltage Restorers for sag, swell and flicker problems.
Grounding and wiring-introduction-NEC grounding requirements-reasons for grounding-typical grounding and wiring problems-solutions to grounding and wiring problems.
References:

Module 1: Power System Stability and Synchronous machine modeling


Module 2: Modeling of other components


Module 3: Small Signal Analysis


Effect of field flux variation on system stability-Effects of Excitation System - Block diagram representation with exciter and AVR- Effect of AVR on synchronizing and damping torque components

Module 4: Power System Stabilizer.

Small Signal Stability Enhancement: Using Power System Stabilisers- Supplementary control of Static VAR Compensators

References:
Module 1: Introduction to FACTS
Reactive power control in electrical power transmission lines – uncompensated line –
Shunt compensation and Series compensation: Voltage Stability – Improvement of Transient
stability, Power Oscillation damping
Introduction to FACTS - Basic Types of FACTS controller- Brief description and definitions of
FACTS controllers – Benefits from FACTS technology.

Module 2: Static Var generators
Variable impedance type Static Var generators – Switching Converter type Var generators. Static
Var Compensator (SVC) and Static Compensator (STATCOM): Principle of operation,
configuration and control – The Regulation Slope- Transient Stability enhancement and Power
Oscillation damping. Comparison between STATCOM and SVC

Module 3: Series Compensation
Variable Impedance Type series compensators: Thyristor Switched Series Capacitor (TSSC),
Thyristor Controlled Series Capacitor (TCSC) - Sub synchronous characteristics- Basic NGH
SSR Damper
Static Synchronous Series Compensator (SSSC): Principle of operation, configuration and
control.

Module 4: Power Flow Controllers
Unified Power Flow Controller (UPFC): Principle of operation, Conventional Transmission
control capabilities, Comparison of UPFC to Controlled Series Compensators- Control structure.
Interline Power Flow Controller (IPFC) – Basic operating Principles and Characteristics
Generalized and multifunctional FACTS controllers.

References:

Module 1: Voltage stability
Voltage stability: Definition-Power system stability classification-Physical phenomenon of Voltage collapse-Description-Time scales-Reactive power-system changes and Voltage collapse-maintaining variable voltage levels.

Module 2: Transmission System Aspects
Transmission System Aspects: Single load infinite bus system-Maximum deliverable power-Lossless transmission-Maximum power-Power voltage relationships-Generator reactive power requirement-Instability mechanism.
Effect of compensation:-Line series compensation-Shunt compensation-Static VAR compensator-VQ curves-Effect of adjustable transformer ratio.

Module 3: Generation aspects
Generation aspects: Synchronous machine theory-Physical description-Mathematical description-dq0 transformation-Motion dynamics.

Module 4: Load aspects
Load aspects: Voltage dependence of loads- Load characteristics-Exponential load-Polynomial load. Saddle node bifurcation- Simple power system example (Static and Dynamic).
Static voltage stability methods-Continuation power flow methods-P-V analysis-Modal analysis-Simple power system example.

References:
Journals:


Module 1: Introduction to Deregulation

Deregulation: Introduction – Different entities in deregulated electric markets- Background to deregulation and the current situation around the world – Benefits from a competitive electricity market – After effects of deregulation – Review of economic load dispatch problem (ELD) – Recent development in ELD.

Module 2: Optimal power flow and Unit commitment

Optimal power flow (OPF) – Basic OPF model - examples – Characteristic features of OPF. Unit commitment (UC) - basic model, Additional issues - Formation of power pools- The energy brokerage system.

Module 3: Independent system operator


Module 4: Power wheeling

Power wheeling: Transmission open access - Cost components in transmission –Pricing of power transactions -Embedded cost based transmission pricing- Incremental cost based transmission pricing-


References:

Module 1: Introduction of system transients

Introduction: Classification of system transients-The circuit closing transients-The recovery transient initiated by the removal of a short circuit-Double frequency transients, Damping-Resistance switching-Load switching.

Module 2: Transients in three phase circuits

Abnormal switching transients-Current suppression- Capacitance switching-Other restriking Phenomena- Transients in three phase circuits-Symmetrical component method for solving three phase switching transients-Transients in DC circuits-HVDC Circuit breaker.

Module 3: Traveling waves


Module 4: Insulation Coordination

Insulation Coordination: Objective and history –Insulation level for power apparatus overvoltage limiting devices- Dielectric properties- Breakdown of gaseous insulation-Tracking and erosion of insulation- High current arcs.

References:

2. Vanikov,“Power System Transients”.


Module 1: Protective Relaying

Module 2: Basic relay units
Basic relay units: Sequence networks - Fault sensing - Data processing units- FFT and Wavelet based algorithms
Comparators: Amplitude and Phase Comparators - Duality – Vector product and Coincidence type phase comparators - Zero Crossing/Level Defectors - Relay Schematics and Analysis - Over Current Relay – microprocessor implementation - Instantaneous/Inverse Time – Current setting and Time setting - IDMT Characteristics - Directional Relays - Differential Relays- Restraining Characteristics - Distance Relays - Types and Characteristics

Module 3: Protection of Power System Equipments

Module4: Advanced Relaying and Protection Schemes
Numerical Relays: Characteristics - Functional Diagrams - Architecture and algorithms - Microprocessor & DSP based relays - Sampling – Aliasing and filter principles Integrated and multifunction protection Schemes : SCADA based protection systems-

References:

Module 1: Theory of Fuzzy sets

Module 2: Fuzzy logic and Fuzzy Inference system

Module 3: Artificial Neural Networks
Biological Neural Networks-Architecture of neural network- Activation Functions-McCulloch-Pitts neuron model
Learning Process- Error correction learning-Memory based learning- Hebbian learning-Competitive learning- Boltzman- Supervised and Unsupervised learning

Module 4: Genetic Algorithm
References:

Module 1: Analysis of long line theory
Long line theory- long distance transmission problems-corona power loss- Charge Voltage Diagram with corona- Attenuation of travelling waves due to corona- Audible noise: Generation and characteristics-Limits for audible noise- AN measurement and Meters-Relation between single phase and three phase AN levels- day Night Equivalent Noise level. Radio Interference RIV and excitation functions: Generation and properties of corona pulses-Limits for radio interference fields- The CIGRE Formula- Rules for addition of RI levels of three phases-S/CS Line-Rules for addition of RI Levels for a D/C Line

Module 2: Over voltages

Module 3: Introduction to HVDC system
Comparison of EHV AC & DC transmission -HVDC system configuration and components - conversion and inversion- Analysis of three phase bridge converter and Performance equations - abnormal operations of converter.

Module 4: Control of HVDC system
Control of HVDC system- Principle of DC link control- current and Extinction angle control power and reactive power control- alternative inverter control modes. Harmonics and AC/DC filters- Influence of AC system strength on AC/DC system interaction. Responses to DC and AC system faults
References:

Module 1: Concept of reliability
Non-repairable components- Hazard models- Components with preventive maintenance-Ideal repair and preventive maintenance- Repairable components- Normal repair and preventive maintenance.

Module 2: System reliability
System reliability: Monotonic structures-Reliability of series-parallel structures, the ‘r’ out of ‘n’ configuration- the decomposition methods- Minimal tie and cut method- State space method of system representation- System of two independent components-Two components with dependent failures- Combining states- Non-exponential repair times failure effects analysis- State enumeration method- Application to non-repairable systems.

Module 3: Other methods of system reliability
Generating capacity reserve evaluation- Generation model, Probability of capacity deficiency, Frequency and duration method, Comparison of the reliability indices, Generation expansion planning, Uncertainties in generating unit failure rates and in load forecasts. Operating reserve evaluation-State space representation of generating units, Rapid start and hot-reserve units, Security function approach.

Module 4: Bulk power system reliability
Interconnected systems: Two connected systems with independent loads-Two connected system with correlated loads-More than two systems interconnected.
Bulk power system reliability: Load flow analysis-DC load flow- Effect of variable system load-Weather effects on transmission lines- Two-weather Markov model-Common model failures-Evaluation of large system-Monte Carlo simulation.
References:

Module 1: Energy conservation management
Energy conservation management: The relevance of energy management profession-General principles of energy management and energy management planning-Application of Pareto’s model for energy management-Obtaining management support-Establishing energy data base Conducting energy audit-identifying, evaluating and implementing feasible energy conservation opportunities-Energy audit report; monitoring, evaluating and following up energy saving measures/projects.

Module 2: Energy management

Module 3: Energy efficiency
Energy efficiency of turbines: Compressors and pumps (brief treatment only)-Specific energy consumption-Parameters affecting specific energy consumption-Flexi targeting technique.

Module 4: Energy economics
References:

List of Experiments

1. Measurement of output voltage of cascade transformer using,
   i. Voltage divider method
   ii. Sphere gap method
2. Generation of impulse voltage waveform
4. Power frequency testing of lightning arresters, insulators, fuses, AB Switches etc.
6. Determine the characteristic, pick-up time etc of electromagnetic relay & static relay.
7. Measurement of transient & sub transient reactance of synchronous machines
8. Determine the following for a long transmission line.
   a) Voltage regulation of the transmission line
   b) Ferranti effect demonstration
   c) Voltage and Current profile of EHVAC Transmission line under no load condition
   d) ABCD parameter evaluation
9. Plot the IDMT/IMT characteristics of Over current relay, Earth fault relay, Over voltage relay and Under voltage relay
10. Plot the functional performance characteristics of the relay
11. Plot the performance characteristics for distance relay for the feeder protection.

In addition to the above, the Department can offer a few newly developed experiments
Each student shall present a seminar on any topic of interest related to the core / elective courses offered in the second semester of the M. Tech. Programme. He / she shall select the topic based on the references from international journals of repute, preferably IEEE journals. They should get the paper approved by the Programme Co-ordinator / Faculty member in charge of the seminar and shall present it in the class. Every student shall participate in the seminar. The students should undertake a detailed study on the topic and submit a report at the end of the semester. Marks will be awarded based on the topic, presentation, participation in the seminar and the report submitted.
The student shall undergo (1) Industrial training of 3 month duration OR (2) Industrial training of one month duration and a Mini Project of two month duration. Industrial training should be carried out in an industry / company approved by the institution and under the guidance of a staff member in the concerned field. At the end of the training he / she has to submit a report on the work being carried out. He/she should also submit mini project report.

The thesis (Phase - I) shall consist of research work done by the candidate or a comprehensive and critical review of any recent development in the subject or a detailed report of project work consisting of experimentation / numerical work, design and or development work that the candidate has executed.

In Phase - I of the thesis, it is expected that the student should decide a topic of thesis, which is useful in the field or practical life. It is expected that students should refer national & international journals and proceedings of national & international seminars. Emphasis should be given to the introduction to the topic, literature survey, and scope of the proposed work along with some preliminary work / experimentation carried out on the thesis topic. Student should submit two copies of the Phase - I thesis report covering the content discussed above and highlighting the features of work to be carried out in Phase – II of the thesis. Student should follow standard practice of thesis writing. The candidate will deliver a talk on the topic and the assessment will be made on the basis of the work and talks there on by a panel of internal examiners one of which will be the internal guide. These examiners should give suggestions in writing to the student to be incorporated in the Phase – II of the thesis.
In the fourth semester, the student has to continue the thesis work and after successfully finishing the work, he/she have to submit a detailed thesis report. The work carried out should lead to a publication in a National / International Conference. They should have submitted the paper before M. Tech. evaluation and specific weightage should be given to accepted papers in reputed conferences.

MEEPS 402        MASTER’S COMPREHENSIVE VIVA

A comprehensive viva-voce examination will be conducted at the end of the fourth semester by an internal examiner and external examiners appointed by the university to assess the candidate’s overall knowledge in the respective field of specialization.