Faculty of Engineering & Technology

M.Tech(Electrical Engg.)

(2017-19)

Scheme of Examination & Detailed Syllabi

FACULTY OF ENGINEERING & TECHNOLOGY

M.TECH in Electrical Engineering with specialization in

Power System Engineering

Choice Based Credit System (CBCS)

CORE COURSE:

- Advance Power System Analysis (MTEEPS101)
- Advanced Power Electronics (MTEEPS102)
- Power System Transient & High Voltage Engineering (MTEEPS103)
- Advance Power System Stability (MTEEPS201)
- Flexible AC Transmission System (MTEEPS202)
- Advanced Circuit Analysis and Design (MTEEPS203)
- Power System Networking and Management (MTEEPS301)
- Modeling and analysis of Electrical Machines (MTEEPS302)
- Power system operational and control (MTEEPS303)
- Seminar (MTEEPS305)
- Dissertation (MTEEPS401)

ELECTIVE COURSE

- EHV AC/DC Transmission (MTEEPS104A)
- Advanced Power Electronics Drives (MTEEPS104B)
- Reactive power Compensation and management(MTEEPS104C)
- Advanced Relaying & Protection System (MTEEPS204A)
- Power Generation Sources (MTEEPS205B)
- Demand Side Energy Management (MTEEPS206C)

- Power system planning and reliability (MTEEPS304A)
- Power Quality (MTEEPS304B)
- Power System Deregulation (MTEEPS304C)

FACULTY OF ENGINEERING & TECHNOLOGY

M.TECH in Electrical Engineering with specialization in

Power System Engineering

Choice Based Credit System (CBCS)

SEMESTER I

Theory Papers

Code	Title Of Subject	L	P	T	IA	EA	Total	Credits
MTEEPS101	Advance Power System Analysis	3	0	1	50	100	150	4
MTEEPS102	Advanced Power Electronics	3	0	1	50	100	150	4
MTEEPS103	Power System Transient & High Voltage Engineering	3	0	1	50	100	150	4
Electives (Any One)								
MTEEPS104A	EHV AC/DC Transmission	3	0	1	50	100	150	4
MTEEPS104B	Advanced Power Electronics Drives	3	0	1	50	100	150	4
MTEEPS104C	Reactive Power Compensation and Management	3	0	1	50	100	150	4
Practical/Viva Voce								
		L	**P**	**T**	**Sessional**	**Practical**	**Total**	**Credits**
MTEEPS105	Power System Simulation Lab	0	2	0	60	40	100	1

Total	**12**	**02**	**04**	**260**	**440**	**700**	**17**

SEMESTER II

Theory Papers

Code	Title Of Subject	L	P	T	IA	EA	Total	Credits
MTEEPS201	Advance Power System Stability	3	0	1	50	100	150	4
MTEEPS202	Flexible AC Transmission System	3	0	1	50	100	150	4
MTEEPS203	Advanced Circuit Analysis and Design	3	0	1	50	100	150	4
Electives (Any One)								
MTEEPS204A	Advanced Relaying & Protection System	3	0	1	50	100	150	4
MTEEPS204B	Power Generation Sources	3	0	1	50	100	150	4
MTEEPS204C	Demand Side Energy Management	3	0	1	50	100	150	4
Practical/Viva Voce								
		L	**P**	**T**	**Sessional**	**Practical**	**Total**	**Credits**
MTEEPS205	Advance Power System design Lab	0	2	0	60	40	100	1
Total		**12**	**02**	**04**	**260**	**440**	**700**	**17**

SEMESTER III

Theory Papers

Code	Title Of Subject	L	P	T	IA	EA	Total	Credits
MTEEPS301	Power System Networking and Management	3	0	1	50	100	150	4
MTEEPS302	Modeling and analysis Electrical Machines	3	0	1	50	100	150	4
MTEEPS303	Power system operational and control	3	0	1	50	100	150	4
Electives (Any One)								
MTEEPS304A	Power system planning and reliability	3	0	1	50	100	150	4
MTEEPS304B	Power Quality	3	0	1	50	100	150	4
MTEEPS304C	Power System Deregulation	3	0	1	50	100	150	4
Practical/Viva Voce								
		L	**P**	**T**	**Sessional**	**Practical**	**Total**	**Credits**

MTEEPS305	Seminar	0	-	-	60	40	100	2
Total		**12**	**00**	**04**	**260**	**440**	**700**	**18**

SEMESTER IV

Theory Papers

Code	Title Of Subject	L	T/P	IA	EA	Total	Credits
MTEEPS401	Dissertation	0	0	300	400	700	12
Total		-	**-**	**300**	**400**	**700**	**12**

Note-: The student will submit a synopsis at the beginning of the semester for approval from the departmental committee in a specified format, thereafter he/she will have to present the progress of the work through seminars and progress reports. Seminar related to the project should be delivered one after starting of semester .The progress will be monitored through seminars and progress reports.

- The Total Number of credits of the M-Tech(Power System) program=64.
- The award of the degree a student shall be required to earn the minimum of 60 credits.

SEMESTER I

Code	Title Of Subject	L	P	T	IA	EA	Total	Credits
MTEEPS101	Advance Power System Analysis	3	0	1	50	100	150	4
MTEEPS102	Advanced Power Electronics	3	0	1	50	100	150	4
MTEEPS103	Power System Transient & High Voltage Engineering	3	0	1	50	100	150	4
Electives (Any One)								
MTEEPS104A	EHV AC/DC Transmission	3	0	1	50	100	150	4
MTEEPS104B	Advanced Power Electronics Drives	3	0	1	50	100	150	4
MTEEPS104C	Reactive Power Compensation and Management	3	0	1	50	100	150	4
Practical/Viva Voce								
		L	**P**	**T**	**Sessional**	**Practical**	**Total**	**Credits**
MTEEPS105	Power System Simulation Lab	0	2	0	60	40	100	1
Total		**12**	**02**	**04**	**260**	**440**	**700**	**17**

Theory Papers

Advanced Power System Analysis (MTEEPS101)

UNIT-1

Fault Analysis: Positive, negative and zero sequence impedance, per unit system, symmetrical components, Analysis of shunt, series and simultaneous faults, symmetrical three-phase faults, unsymmetrical faults Short Circuit studies.

UNIT -2

Unbalanced Operation of 3-phase Induction Motors: Characteristics with application of unbalanced voltage to a balanced motor and with application of balanced voltage to a motor having unbalanced impedances in the rotor circuit.

UNIT-3

Linear Graph Theory: Study of linear graph theory, Network topology, incidence, Cut-set and Tie-set matrices and their interpretation. Calculation of Z-bus, Y-bus, Z-branch and Y loop matrices by singular and non-singular transformations. Algorithm for the calculation of Y-bus and Z-bus. Fault calculations using Z-bus.

UNIT-4

Load Flow Studies: Formulation of load flow problem. Various types of buses. Gause-Siedel, Newton-Raphson and Fast Decoupled Algorithms. Calculation of reactive power at voltage controlled buses in the Gauses-Seidel iterative method using Y-bus, Representation of transformers

UNIT-5

Tap Changing: Fixed tap setting transformer, Tap changing under load transformers, Phase shifting transformers, Tie line control, Comparison of methods for load flow.

References:

1. D. P. Kothari & I. J. Nagrath, “Modern power system analysis”, Tata McGraw-Hill Pub. Co. New Delhi 2003.
2. G.W. Stagg & A.H El-Abaid, “Computer methods in Power system analysis”, McGraw Hill, New York.
3. G.L Kusic., “Computer-Aided Power System Analysis”, Prentice Hall of India, New Delhi.
4. John J.Grainger and W.D.Stevenson, “Power System Analysis”, McGraw Hill, New York, 1994.
5. A.J. Wood & W.F. Wollenberg, “Power Generation, Operation, and Control”, 2nd Edn, John Wiley & Sons, New York, 1996.
6. O.I. Elgerd, “Electric Energy Systems Theory: An Introduction”, McGraw Hill, New York, 1982.
7. J. Arrillaga, C.P Arnold & Harker, “Computer Modeling of Electrical Power Systems”, John Wiley & Sons.

Advanced Power Electronics (MTEEPS102)

UNIT -1

Solid State Power Semi-conducting Devices: Review of the thyristors, TRAIC, GTO, transistor MOSFET and other modem power devices (IGBT, SIT, SITCH, MCT), characteristics ratings, commutation methods, protection and requirement of firing circuits.

UNIT-2

Phase Controlled Converters: Single and three-phase controlled converters, power factor improvement techniques. Dual Converter mode of operation, Firing Circuits.

UNIT-3

Choppers: Review of choppers, commutation circuits, firing circuits. Introduction to multi-quadrant and multi phase choppers.

UNIT-4

Inverters: Line commutated, voltage source, and current source inverters; Commutation techniques, Voltage control and harmonic reduction techniques. PWM rectifiers and inverters.

UNIT-5

Cyclo-converters (Frequency Conversion): Single phase and three phase cyclo-converters. Recent trends in power converters and controllers.

References:

1. Ned Mohan et. al : Power Electronics ,John Wiley and Sons

2. P C Sen : Power Electronics , TMH

3. G K Dubey et. al : Thyristorised Power Controllers , Wiley Eastern Ltd.

4. B K Bose : Modern Power Electronics and AC Drives, Pearson Edn(Asia)

Power System Transient & High Voltage Engineering (MTEEPS103)

UNIT-1

Wave terminology, development of wave equations, terminal problems, lattice diagrams. Origin and nature of power system surges, wave shapes, attenuation, effect of shielding by ground wires and masts, tower footing-resistance.

UNIT-2

Traveling waves, multi-velocity waves, methods of measuring tower footing resistance, voltages across insulator strings. Dynamic over-voltages during surges and system faults, system recovery voltage characteristics.

UNIT-3

Methods of neutral grounding and their effect on system behavior. Insulation coordination, requirement in surge protection of lines and equipment. Impulse generator development. Impulse testing technique.

UNIT-4

Power frequency h.v. transformers, cascade connection. H.V.D.C. generators, tests with power frequency and d.c. voltages. Large current generating and measurement techniques. Partial discharge testing.

UNIT-5

High voltage and high current testing of power equipment. Field investigations. Magnetic links their calibration and mounting, klydenographs, potential dividers and cathodes ray oscillorgraph.

References:

1. K. R. Padiyar. "High Voltage D.C. Power Transmission Systems", New Age International (P) Ltd.
2. *Allen Greenwood, „Electrical transients in power systems", Wiley Interscience, 1991.*
3. *Gallaghar, P.J. and Pearmain, A.J., 'High voltage measurement, Testing and Design', John Wiley and sons, New York, 2001.*
4. *I.J. Nagrath & Kothari "Power system Engineering"*

EHV AC/DC Transmission (MTEEPS104A)

UNIT-1

EHV AC Transmission

Bulk power transmission over long distance, need for EHV transmission problems of EHV transmission, Power Handling capacity and surge impedance loading. Current carrying capacity of conductor. Choice of economic voltage, standard transmission voltages.

UNIT-2

Bundled Conductors: Properties of bundled conductors, geometric mean radius of bundle,

inductance and capacitance, Voltage gradients of conductors, maximum surface voltage gradients of bundled conductors.

UNIT-3

EHV Lines :Electrostatic fields of EHV lines. Effect of E.S. field on Humans, Animals and Plants, corona loss, maximum surface electric fields for bundled and single conductor lines.

UNIT-4

Rectification: The 3-phase Bridge rectifier or Graetz circuit, Inversion, Kinds of D.C links, Paralleled and Series connection of thyristors, Major components of a converter station-converter unit, filters, reactive power source.

UNIT-5

HVDC:Introduction to Multi-terminal HVDC Systems and HVDC Circuit Breakers. Application of HVDC transmission, Ground return and ground electrode.

References:

1. *HVDC power transmission, K.P.Padiar.*

2. Direct current transmission. E.W.Kimbark.

3. High voltage direct current Transmission by J.Arrillage

Advanced Power Electronics Drives (MTEEPS104B)

UNIT-1

Basic power electronic drive system, components. Different types of loads, shaft-load coupling systems. Stability of power electronic drive.

UNIT-2

Conventional methods of D.C.motor speed control, single phase and three phase converter fed D.C motor drive. Power factor improvement techniques,

UNIT-3

Four quadrant operation. Chopper fed drives, input filter design. Step -up chopper for photovoltaic systems. Braking and speed reversal of DC motor drives using choppers, multiphase choppers.

UNIT-4

Conventional methods of induction motor speed control.Solid state controllers for Stator voltag control, soft starting of induction motors, Rotor side speed control of wound rotor induction motors. Voltage source and Current source inverter fed induction motor drives.

UNIT-5

Speed control of synchronous motors, field oriented control, load commutated inverter drives, switched reluctance motors and permanent magnet motor drives.

References:

1. *P.C Sen „Thyristor DC Drives", John wiely and sons, New York, 2001.*

2. R.Krishnan, „Electric Motor Drives – Modeling, Analysis and Control", Prentice-Hall of India Pvt Ltd., New Delhi, 2003.

3. Bimal K.Bose, „Modern Power Electronics and AC Drives", Pearson Education (Singapore) Pte. Ltd., New Delhi, 2003.

REACTIVE POWER COMPENSATION AND MANAGEMENT (MTEEPS104C)

UNIT I: Load Compensation

Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing –Load patterns – basic methods load shaping – power tariffs- KVAR based tariffs

UNIT II: Steady – state reactive power compensation in transmission system:

Load compensator as a voltage regulator – phase balancing and power factor correction of

unsymmetrical loads Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples

UNIT III: Transient state reactive power compensation in transmission systems:

Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation –compensation using synchronous condensers – examples

UNIT-IV: Reactive power coordination:

Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency – Harmonics, radio frequency and electromagnetic interferences

UNIT-V: Distribution side Reactive power Management:

KVAR requirements for domestic appliances – Purpose of using capacitors ,System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks

Reference Books:

1. Reactive power control in Electric power systems by T.J.E.Miller, John Wiley and sons, 1982

2. Reactive power Management by D.M.Tagare,Tata McGraw Hill,2004

Power System Simulation Lab (MTEEPS105)

List of Experiments

Simulate Swing Equation in Simulink (MATLAB)

1. Modeling of Synchronous Machine.

2. Modeling of Induction Machine.

3. Simulate simple circuits using Circuit Maker.

4. (A) Modeling of Synchronous Machine with PSS.

   (B) Simulation of Synchronous Machine with FACTS device.

5. (A) Modeling of Synchronous Machine with FACTS device.

   (B) Simulation of Synchronous Machine with FACTS devices.

6. FACTS Controller designs with FACT devices for SMIB system.

SEMESTER II

Code	Title Of Subject	L	P	T	IA	EA	Total	Credits
MTEEPS201	Advance Power System Stability	3	0	1	50	100	150	4

MTEEPS202	Flexible AC Transmission System	3	0	1	50	100	150	4
MTEEPS203	Advanced Circuit Analysis and Design	3	0	1	50	100	150	4
Electives (Any One)								
MTEEPS204A	Advanced Relaying & Protection System	3	0	1	50	100	150	4
MTEEPS204B	Power Generation Sources	3	0	1	50	100	150	4
MTEEPS204C	Demand Side Energy Management	3	0	1	50	100	150	4
Practical/Viva Voce								
		L	**P**	**T**	**Sessional**	**Practical**	**Total**	**Credits**
MTEEPS205	Advance Power System design Lab	0	2	0	60	40	100	1
Total		**12**	**02**	**04**	**260**	**440**	**700**	**17**

Theory Papers

Advance Power System Stability (MTEEPS201)

UNIT-1

Modelling of cylindrical rotor salient pole synchronous machines, flux linkage equations, voltage equations, Park's transformation, various inductances and time constraints of synchronous machines, vector diagrams for steady state and transient conditions,

UNIT-2

power angle curves. Steady state and transient stabilities, their definitions and methods of determination. Development of Swing equation. Steady state stability of single machine connected to an infinite bus by the method of small oscillations.

UNIT-3

Two machine systems. Coherent and non-coherent machines. Equal area criterion of determining

transient stability, fault clearing time and critical clearing angle. Solution of Swing equation by step by step method.

UNIT-4

Euler's Method and Runga-Kutta Method, Application of Computers in the study of transient stability using these methods. Introduction to steady state and transient Stability using these methods.

UNIT-5

Introduction to steady state and transient stabilities of multi-machine system without controller. Factors affecting steady state and transient stabilities, methods of improving steady state and transient stabilities, high speed circuit breakers, auto-reclosing circuit breaker, single pole operation, excitation control, and bypass valving.

References:

1. D. P. Kothari & I. J. Nagrath, "Modern power system analysis", Tata McGraw-Hill Pub. Co. New Delhi 2003.

2. Kundur, P., „Power System Stability and Control", McGraw-Hill International

2. O.I. Elgerd, "Electric Energy Systems Theory: An Introduction", McGraw Hill, New York, 1982.

3. J. Arrillaga, C.P Arnold & Harker, "Computer Modeling of Electrical Power Systems", John Wiley & Sons.

FLEXIBLE AC TRANSMISSION SYSTEMS (MTEEPS202)

UNIT-1

Fundamentals of ac power transmission, transmission problems and needs, emergence of FACTS-FACTS control considerations,

UNIT-2

FACTS controllers. Principles of shunt compensation – Variable Impedance type & switching converter type-Static Synchronous Compensator (STATCOM) configuration, characteristics and control.

UNIT-3

Principles of static series compensation using GCSC, TCSC and TSSC, applications, Static

Synchronous Series Compensator (SSSC).

UNIT-4

Principles of operation-Steady state model and characteristics of a static voltage regulators and phase shifters- power circuit configurations**.**

UNIT-5

UPFC -Principles of operation and characteristics, independent active and reactive power flow control, comparison of UPFC with the controlled series compensators and phase shifters.

References:

1. Song, Y.H. and Allan T. Johns, „Flexible ac transmission systems (FACTS)", Institution of Electrical Engineers Press, London, 1999.

2. *Hingorani ,L.Gyugyi, „ Concepts and Technology of flexible ac transmission system", IEEE Press New York, 2000 ISBN –078033 4588.*

3. R .Mohan Mathur and Rajiv K.Varma , „Thyristor - based FACTS controllers for Electrical transmission systems", IEEE press, Wiley Inter science , ISBN no . 0-471-20643-1,2002.

4. *K.R.Padiyar, „FACTS controllers for transmission and Distribution systems" New Age international Publishers 1st edition -2007*

Advanced Circuit Analysis and Design (MTEEPS203)

UNIT-1

Network Topology: Network geometry, incidence matrix, tie-set matrix and loop currents, cut-set

matrix, and node pair potentials. Properties of cut-set and tieset matrices, f–cutset Analysis, f-circuit Analysis, Node-pair Analysis. Duality, planner and non-planner networks. Branch parameters matrices. Kirchhoff's equilibrium equations on loop basic. Equilibrium equations on the node basis.

UNIT-2

Elements of Realizability : Driving point functions, Brune's positive real functions, properties of positive real functions. Testing driving point functions An application of the maximum modulus theorem, properties of Hurwitz polynomials, the computation of residues, even & odd functions, Sturm's theorem, An alternative test for positive real character. Driving point synthesis with LC elements: Elementary synthesis operations, LC Network Synthesis.

UNIT-3

RC and RL Networks: Properties of RC network functions, foster form of RC networks, and faster form of RL networks. The cauer form of RC and RL networks, RLC one Terminal-Pairs: Minimum positive real functions. Brune's method of RLC synthesis.

UNIT-4

Active RC filters: Realisable approximation to Ideal filter, constant time delay & ThomEEon filter, frequency transformation, Active RC filter, Multi amplifier Biquad realization. Fixed capacitor filter.

UNIT-5

Computer Application: Network solution by matrix Inversion- Gauss Elimination Method, Computer Programme for plotting transient response, Computer Programme for finding roots of polynomial equations.

References:

1. William Hart Hayt, "Engineering Circuit Analysis", Tata Mc graw-Hills Publications.
2. *P. Kundur, 'Power System Stability and Control', Mc Graw Hill.*
3. *K.R. Padiyar, 'Power System Dynamics' BS Publications.*
4. *P.M Anderson and A.A Fouad 'Power System Control and Stability'.*

Advanced Relaying & Protection System (MTEEPS204A)

UNIT-1

Review of: Characteristics & operating equations of basic electromagnetic relays, comparison of transistor operation with electromechanical relays. Introduction to static relays & their basic

construction.

UNIT-2

Comparators:- Introduction, mixing transformers, Amplitude comparators, Rectified bridge

& direct comparators, phase comparators, direct, coincidence & phase splitting type comparators. Duality between phase & amplitude comparators.

UNIT-3

Directional relays: - Integrating phase comparison type, instantaneous coincidence type, rectifier phase comparator type, amplitude comparator, directional units. Over current relays: - Introduction, instantaneous over current relay, time - over current relay, definite time over current relay. Differential

UNIT-4

Relays:- Introduction, types of differential relays, analysis of electromagnetic & static differential relays, differential relay equations for e.m. type & static type relays, voltage & current comparison, harmonic restraint, percentage differential relays for transformer protection.

UNIT-5

Distance Relays: - Characteristics, elements of 3-zone directional & MHO relay protection. Special characteristics i.e. swiveling characteristic, conic section & Quadrilateral characteristic. Microprocessor based Relay**:-** Implementation of over current, impedance, reactance, directional & Mho relays using assembly level programming. Review of arc formation, interruption of currents in circuit breakers, operation of SF6, vacuum type and H.V.D.C. circuit breakers, different ratings of circuit breakers &

testing methods of circuit breakers.

References:

1 *Power System protection - static Relays by "T.S.M.Rao" Tata Mcgraw Hill Publishing Co.*

2 *Power System protection & switchgear by "B Ravindernath &M Chander" Wiley Eastern Limited.*

3 *Protective relays theory & practice Vol-II-" A.R.Van & C. Warrington" Chapman & Hall.*

4 *Fundamental of microprocessors & microcomputers by "B.Ram" Dhanpat Rai & Sons.*

5 *Power System stability Vol.-II by E.W.Kimbark" John Wiley & Sons..*

Power Generation Sources (MTEEPS204B)

UNIT-1

Generation of Electricity and Sources of Energy : Major sources of energy- Salient features, selection of site, basic schemes and constituents of Steam, Hydro, Nuclear, Diesel and Gas Turbine Power Stations. Co-generation, Hydro-thermal Energy co- ordination.

UNIT-2

Steam Power Plants: *Thermodynamic cycles and use of high steam pressure and temperature. Super heating of steam. Reheat cycle. Regenerative cycle. Binary vapour cycle. Coal Classification, use of high ash coal, Indian Coal, supply, storage and handling of coal, Ash handling and dust collectors.*

Steam Generators: Fire tube and water tube boilers. Modern boilers. Economizer and air preheated, condenser, supply of cooling water to condenser, cooling towers.

Steam Primemovers: Impulse and reaction types. Heat balance and efficiency.

UNIT-3

Station Auxiliaries: Types of auxiliaries, power supply scheme for auxiliaries. Modern development in steam power plants.

Hydro Electric Plants: Selection of site, classification and basic schemes. Types of turbines, capacity calculation, Pump storage projects.

Nuclear Power Plant: Types of fuels. Classification of reactors, methods of cooling; moderators, methods of control, safety measures, Basic schemes of nuclear power stations: Boiling water reactor, pressurized heavy water reactor, fast breeder reactor, Cost of Nuclear Energy. Nuclear Power Stations of India.

UNIT-4

Gas Turbine Power Plants: Operation of gas turbine power plant, open cycle plant, closed cycle plant, Combined gas turbine and steam turbine cycle. Comparative study of thermal, hydro, and nuclear power stations: Economic comparison of power stations, Inter connections. Base and peak load power stations. Impact of thermal, hydro and nuclear stations on environment.

UNIT-5

New Energy Sources: Principle of MHD power generation, open cycle MHD system and closed cycle MHD system. Wind power generation. Solar power generation: Solar power plant, photo voltaic cell, photo voltaic power generation. Tidal power generation. Geo-thermal power generation.

References:

1. John F.Walker & Jenkins. N, “Wind energy Technology”, John Wiley and sons, chichester
2. Freries LL , “Wind Energy Conversion Systems‟, Prentice Hall, U.K.,

DEMAND SIDE ENERGY MANAGEMENT (MTEEPS204C)

Unit-1 :

Energy Audit : Definitions-Need-concepts-Types of energy audit; Energy index – cost index – pie harts – Sankey diagrams.

Unit-2 :

Energy Economics: Introduction-Cost benefit risk analysis-Payback period-Straight line depreciation-Sinking fund depreciation—Reducing balance depreciation-Net present value method-Internal rate of return method-Profitability index for benefit cost ratio.

Unit-3 :

Energy Conservation in Electric utilities and Industry: Electrical load management: Energy and load management devices-Conservation strategies; conservation in electric utilities and industry: Introduction-Energy conservation in utilities by improving load factor-Utility voltage regulation-Energy conservation in Industries-Power factor improvement.

Unit-4 :

Energy–efficient electric motors (EEMs) : Energy efficient motors-construction and technical features-case studies of EEMs with respect to cost effectiveness-performance characteristics; Economics of EEMs and system life cycle-direct savings and payback analysis-efficiency factor or efficiency evaluation factor

Unit-5 :

Electric Lighting: Introduction-Need for an energy management program-Building analysis-Modification of existing systems-Replacement of existing systems-priorities:

Illumination requirement : Task lighting requirements-lighting levels-system modifications-non illumination modifications-lighting for non task areas-reflectances-space geometry ;System elements**.**

References:

1. Energy management Hand book by Wayne C.Turner,John wiley and sons

publications

2.Electric Energy Utilization and Conservation by S C Tripathy,Tata McGraw

hill publiching company ltd.New Delhi

3.Energy efficient electric motors selection and application by John C.Andreas

4.Hand book on Energy Audit and Management by Amit kumar Tyagi,published

by TERI(Tata energy research Institute)

5.Energy management by Paul W.O' Callaghan McGraw hill book company

6.Energy conversion systems by Rakosh Das Begamudre New age

international publishers

7.Energy Management – by W.R.Murphy & G.Mckey Butterworths

Advance Power System design Lab (MTEEPS205)

List of Experiment:

1. To compute the fault level, post-fault voltages and currents for different types of faults.
2. To plot Swing Curve for one Machine System
3. To Formulate Y_{BUS} Matrix By Singular Transformation.
4. Gauss Siedal Load flow analysis using Matlab Software.
5. Newton Raphson load flow analysis Matlab Software.
6. Load sharing between two interconnected power systems.
7. Load sharing between two interconnected power systems including transmission losses component.
8. Load-frequency dynamics of single area power system.

SEMESTER III

Code	Title Of Subject	L	P	T	IA	EA	Total	Credits
MTEEPS301	Power System Networking and Management	3	0	1	50	100	150	4
MTEEPS302	Modeling and analysis Electrical Machines	3	0	1	50	100	150	4
MTEEPS303	Power system operational and control	3	0	1	50	100	150	4
Electives (Any One)								
MTEEPS304A	Power system planning and reliability	3	0	1	50	100	150	4
MTEEPS304B	Power Quality	3	0	1	50	100	150	4
MTEEPS304C	Power System Deregulation	3	0	1	50	100	150	4
Practical/Viva Voce								
		L	**P**	**T**	**Sessional**	**Practical**	**Total**	**Credits**
MTEEPS305	Seminar	0	-	-	60	40	100	2
Total		**12**	**00**	**04**	**260**	**440**	**700**	**18**

Theory Papers

POWER SYSTEM NETWORKING AND MANAGEMENT (MTEEPS301)

Unit-1

Role of Reactive Power on Voltage and Voltage Regulation, Relation between Incremental Reactive Power, Active Power and Voltage at a Node, Reactive Compensation in Power System

Unit-2

Types of Compensator, Sub-Synchronous Resonance, Flexible AC Transmission systems (FACTS), Control of Voltage-Control by Generators, Control by VAR generators, control by Transformers.

Unit-3

Automatic load frequency control of single area system, Speed Governing System, Block Diagram Model, Static and Dynamic Response with and without Integral Control, Control Area Concept, Two Area Load Frequency Control, Digital load frequency controller, De-centralized Control

Unit-4

Concept of Stability: Steady State, Dynamic and Transient Stability, Voltage Stability-Voltage Collapse. The Synchronous Machine-Three Phase Generation, Synchronous Reactance and equivalent circuits, Real and Reactive Power Control, Loading Capability Diagram, The Two Axis Machine Model, Voltage Equations, Salient Pole-Machines, Transient and Sub-Transient Effects, Short Circuit Currents-Problem

Unit-5

Dynamic Analysis and Modelling of Synchronous Machines, Excitation System, the Prime Mover and Governing System, Induction Machine Modelling.

References:-

1. E.W. Kimbark, 'Power System Stability, Vol. I, John Wiley & Sons, 1948
2. Power System Engineering-I J Nagrath, D P Kothari, Tata McGraw-Hill
3. Electrical Power System-C L Wadha, New Age International (Private) Limited Publication.
4. Power System Analysis-John J Granger, Willium D Stevenson, Tata McGraw-Hill
5. Electrical Energy system Theory-O. L. Elgerd Tata, McGraw-Hill

MODELING AND ANALYSIS OF ELECTRICAL MACHINES (MTEEPS302)

Unit-1

Matric analysis of Electrical machines, invariance of power, Modelling and their solutions, Generalised of first kind, quasi holonomic reference frame, impedance metrics, torque matrix, flux and current density matric modelling of DC Machines.

Unit-2

Steady state and transient analysis repulsion and universal machines, cross field generator, steady state. Transient analysis, Matrix analysis of single and three phase transformer under steady state and transient conditions

Unit-3

Rectifier transformer, Generalised theory of electrical machines in rotational frame Holonomic and non - holonomic reference frame Torque matrix. Voltage and impedance matrix

Unit-4

Transient analysis of single phase and three induction motor. Analysis using revolving field theory; sequence reference frame.

Unit-5

State space modelling of electrical machines; Equivalent circuits, synchronous generator under sudden short circuit; generalized fault analysis.

References:-

1. Charles Kingsley,Jr., A.E. Fitzgerald, Stephen D.Umans, „Electric Machinery", Tata Mcgraw Hill, Fifth Edition, 1992.
2. R. Krishnan, „Electric Motor & Drives: Modeling, Analysis and Control", Prentice Hall of India, 2001.
3. Miller, T.J.E., „Brushless permanent magnet and reluctance motor drives", Clarendon ress, Oxford, 1989.

POWER SYSTEM OPERATION AND CONTROL (MTEEPS303)

Unit-1

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

Unit-2

Hydroelectric plant models, short term hydrothermal scheduling problem, gradient approach, Hydro units in series, pumped storage hydro plants, hydro-scheduling using Dynamic programming and linear programming

Unit-3

Review of LFC and Economic Dispatch control (EDC) using the three modes of control viz. Flat frequency, tie-line control, and tie-line bias control, AGC implementation , AGC features static and dynamic response of controlled two area system.

Unit-4

MVAR control, Application of voltage regulator, synchronous condenser, and transformer taps – static var compensators.

Unit-5

Power system security, contingency analysis, linear sensitivity factors, AC power flow methods, contingency selection, concentric relaxation, bounding-security constrained, optimal power flow-Interior point algorithm-Bus incremental costs.

References:-

1. Allen J.Wood and Wollenberg B.F., „Power Generation Operation and control", John Wiley & Sons, Second Edition.
2. Kirchmayer L.K., „Economic Operation of Power System', John Wiley & Sons, 1953.
3. Kirchmayer L.K., „Economic Control of Interconnected Systems", John Wiley & Sons, 1959.

POWER SYSTEM PLANNING AND RELIABILITY (MTEEPS304A)

Unit-1

Objectives of planning, Long and short term planning, Load forecasting , characteristics of loads, methodology of forecasting, energy forecasting, peak demand forecasting, total forecasting, annual and monthly peak demand, forecasting.

Unit-2

Reliability concepts, exponential distributions, meantime to failure, series and, parallel system, MARKOV process Recursive technique.

Unit-3

Generator system reliability analysis, probability models for generators unit and loads, reliability analysis of isolated and interconnected system, generator system cost analysis, corporate model, energy transfer and off peak.

Unit-4

Transmission system reliability model analysis, average interruption rate, LOLP method, frequency and duration method, Two plant single load system-two plant two load system, Load forecasting uncertainly interconnection benefits.

Unit-5

Introduction system modes of failure, The loss of load approach, frequency & duration approach, spare value , assessment, multiple bridge equivalents.

References:-

1. Sullivan, R.L., „Power System Planning", Heber Hill, 1977
2. Roy Billington, `Power System Reliability Evaluation", Gordan & Breach Scain Publishers, 1970.
3. Dhillan, B.S., „Power System Reliability, Safety and Management", An Arbor Sam, 1981.

POWER QUALITY (MTEEPS304B)

Unit 1 : Power and Voltage Quality : General, classes of Power Quality Problems, Power quality terms, Power frequency variations, the power quality evaluation procedure. Voltage quality : Transients, long and short duration Voltage variations, Voltage imbalance, waveform distortion, Voltage Flicker.

Unit 2 : Voltage sags and Interruptions : Sources of sags and Interruptions. Estimating Voltage sag performance. Fundamental Principles of Protection. Solutions at the end-user level. .

Unit 3 : Fundamentals of Harmonics : Harmonic distortion. Voltage versus Current distortion. Harmonic indexes. Harmonic sources from commercial loads. Harmonic sources from industrial loads.

Locating Harmonic sources. System response characteristics. Effects of Harmonic Distortion.

Unit 4 : Distributed Generation and Power Quality : Resurgence of DG. DG Technologies. Interface to the Utility System. Power Quality Issues. Operating Conflicts. DG on distribution Networks . Siting DG distributed Generation, Interconnection standards.

Unit 5 : **Wiring and Grounding :** Resourses, Definitions, Reasons for Grounding, Typical wiring and grounding problems, Solution to wiring and grounding problems.

References

1. Electrical Power Systems Quality : By ROGER C.DUGAN, Electrotek Concepts Inc (second edition)
2. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Rai – PHI Publication.
3. Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 1997.

Power System Deregulation (MTEEPS304C)

Unit –I

Deregulation, Reconfiguring Power systems, unbundling of electric utilities, Background to deregulation and the current situation around the world, benefits from a competitive electricity market after effects of deregulation

Unit –II

Role of the independent system operator, Operational planning activities of ISO: ISO in Pool markets, SO in Bilateral markets, Operational planning activities of a GENCO: Genco in Pool and Bilateral markets,

market participation issues, competitive bidding

Unit –III

Power wheeling, Transmission open access, pricing of power transactions, security management in deregulated environment, and congestion management in deregulation

Unit –IV

General description of some ancillary services, ancillary services management in various countries, and reactive power management in some deregulated electricity markets

Unit –V

Reliability analysis: interruption criterion, stochastic components, component models, And Calculation methods, Network model: stochastic networks, series and parallel connections, minimum cut sets, reliability cost

Reference Books :

1. K. Bhattacharya, MHT Bollen and J.C Doolder, "Operation of Restructured Power Systems", Kluwer Academic Publishers, USA, 2001.
2. Lei Lee Lai, "Power System restructuring and deregulation", John Wiley and Sons, UK. 2001.
3. Fred I Denny and David E. Dismukes "Power System Operations and Electricity Markets", CRC Press, LLC, 2002.

Seminar (MTEEPS305)

SEMESTER IV

Code	Title Of Subject	L	T/P	IA	EA	Total	Credits
MTEEPS401	Dissertation	0	0	300	400	700	12
Total		-	-	**300**	**400**	**700**	**12**

Theory Papers

Note-: The student will submit a synopsis at the beginning of the semester for approval from the departmental committee in a specified format, thereafter he/she will have to present the progress of the work through seminars and progress reports. Seminar related to the project should be delivered one after starting of semester .The progress will be monitored through seminars and progress reports.

- The Total Number of credits of the M-Tech(Power System) program=64.
- The award of the degree a student shall be required to earn the minimum of 60 credits.

Dissertation (MTEEPS401)