M.Tech. Electrical Syllabus

M.Tech. in Power System (Electrical Engineering)

S.No.	Code No.	Subject:	Teaching Scheme Hrs./Week		Exam. Hours	Examination Scheme		
						Examination Marks		
			L	T/P		Theory	Course work	Total
First Semester								
1	EEP - 101	Power System Analysis	3	1	3	100	50	150
2	EEP - 102	Power Electronics	3	1	3	100	50	150
3	EEP - 103	Power System Stability	3	1	3	100	50	150
4		ElectiveI	3	1	3	100	50	150
5		ElectiveII	3	1	3	100	50	150
6		Computer Laboratory		2			50	50
Total			16	7	15	500	300	800
Second Semester								
1	EEP-201	Operating & control of Power System	3	1	3	100	50	150
2	EEP-202	Advanced Power System Protection	3	1	3	100	50	150
3	EEP-203	EHV Av/DC Transmission	3	1	3	100	50	150
4		ElectiveII	3	1	3	100	50	150
5		ElectiveIV	3	1	3	100	50	150
6		Seminar		2			50	50

Total			15	7	15		500	300	800
Third Semester									
1	EEP-301	Disserlation							
Total			0	0	0		0	0	0
IV Semester									
1	EEP-401	Dissertation							
Total			0	0	0		0	0	0
Grand Total			30	14	30		1000	1000	2000

ELECTIVES

S.no.	Code No.	Electives I	S.nl.	Code No.	Elective II
1	EEP-109	Numerical Methods & Computer Programming	1	EEP104	Advanced Circuit Analysis & Design
2	EEP-110	Applied Mathematics	2	EEP105	Integrated Energy Systems
3	EEP-111	High Speed Computation Techniques	3	EEP106	AI Application to Power Systems
		Elective III	4	EEP107	Power Generation Sources
1	EEP-204	Power System Planning & Reliability	5	EEP108	Modern Control Theory
2	EEP-205	Power System Instrumentation		Elective IV	
3	EEP-206	Electric Drives & Their control	1	EEP208	Economics & Planning of Energy System
			2	EEP209	Power System Transients & high Voltage Engineering
4	EEP-207	High Voltage Direct Current Transmission	3	EEP210	Excilation of Synchronour Machines & Their Control
			4	EEP211	Coputer Mehtods in Power System

			5	EEP212	Microprecissors, Microcontroller & Their Applicatio to Power Systems

DETAILED SYLLABUS First Semester
EEP 101: POWER SYSTEM ANALYSIS

Fault Analysis : Positive. Negative and Zero Sequence equivalent circuits of lines, two and three winding transformers, induction machines and synchronous machines. Analysis of shunt and series faults, effect of neutral grounding. Unbalanced Operation of 3phase 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. Synchronous Machines : Short circuit currents and reactances of synchronous machine. Modelling of synchronous machine at no load and symmetrical load under steady state conditions, Sequence impedance of synchronous machines. Linear Graph Theory : Study of linear graph theory, Network topology, incidence, Cutset and Tie set matrices and their interpretation. Calculation of Zbus, Ybus, Zbranch and Y loop matrices by singular and nonsingular transformations. Algorithm for the calculation of Ybus and Zbus. Fault calculations using Zbus. Load Flow Studies : Formulation of load flow problem. Various types of buses. GauseSiedel, Newton-Raphson and Fast Decoupled Algorithms. Calculation of reactive power at voltage controlled buses in the GausesSeidel iterative method using Ybus, Representation of transformers Fixed tap setting transformer, Tap changing under load transformers, Phase shifting transformers, Tie line control, Comparison of methods for load flow.

EEP 102 : POWER ELECTRONICS

Solid State Power Semiconducting 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. Phase Controlled Converters: Single and threephase controlled converters, power factor improvement techniques. Dual Converter mode of operation, Firing Circuits. Choppers: Review of choppers, commutation circuits, firing circuits. Introduction to multiquardant and multi phase choppers. Inverters and Cycloconverters (Frequency Conversion): Line commutated, voltage source, and current source inverters; Commutation techniques, Voltage control and harmonic reduction techniques. PWM rectifiers and inverters. Single phase and three phases cycloconverters. Power Electronics Controller for Wind Energy Electric Conversion Systems, Photo Voltaic Arrays, energy Saving in AC and DC Drives. Power Factor Improvements, Extinction Angle, Symmetrical Angle. PWM Control and Sinusoidal PWM Control power techniques.
EEP 103: POWER SYSTEM STABILITY

Modelling of cylindrical rotor salient pole synchronous machines, flux linkage equations, voltage equations, Park's transformation, various inducatances and time constraints of synchronous machines, vector diagrams for steady state and transient conditions, 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. Two machine systems. Coherent and noncoherent machines. Equal area criterion of determining transient stability, fault clearing time and critical clearing angle.

Solution of Swing equation by step by step method. Euler's Method and RungaKutta Method, Application of Computers in the study of transient stability using these methods. Introduction to steady state and transient Stability using these methods. Introduction to steady state and transient stabilities of multimachine system without controller. Factors affecting steady state and transient stabilities, methods of improving steady state and transient stabilities, high speed circuit breakers, autoreclosing circuit breaker, single pole operation, excitation control, and bypass valving.

Elective – I EEP 109 : NUMERICAL METHOD & COMPUTER PROGRAMMING

1. Matrix Computation: Algebra of matrices inverse of a matrix task of a matrix. Matrix Inversion by cause elimination method computer programs for matrix computation.
2. Solution of linear equation: Gramer's rule consistency of linear sumultarcous equations, gauss elimination method gauss jordon elimination mehod gausssoidol iterative method. Computer programs for the solution of linear equations.
3. Eigen values and Eigen Vectors: Characteristic equation of a matrix determination of Eigen values and Eigen vectors. Cayley Hamilton theorem. Largest and smallest Eigen values.
4. Solution of Nonlinear Equations: Interval bisection method seemit method regular falsi method NewtcnRaphson method computer program to solve nonlinear equations.
5. Finite Difference and interposition: Finite differences forward backword and central difference operators shift operator and averaging operator divided differences interpolation using Newton's Lorwars forward and backward gauss forward and backward string's bosselst and pograms for interposition
6. Numerical Difference : Numerical differentiation using Newton's forward backward and string's interpolation formulas.
7. Numerical Integration : General quadrature formula : saimsung rule saimpsons three rule romberg, integration computer program for numerical integration
8. Solution of differential Equations : eulers method, improved eulers method runga kutta method of second order runga kutta mehod of fourth order

EEP 110 APPLIED MATHEMATICS

Numerical Analysis : Numerical integration simpson rule Newton cotes formula gaussian

1. quardrature solution of partial differential equation by following methods : Schmidt Method leasonen method crank method nicolson method duefort frenkel method
2. Statistics : Theory of Probiltiy, bayes mathematical acceptation descrete & continues probility distributions : binomial poisson gaussian bivariate distribution linear co relation and ression
3. Optimizaiton Technique : Linear programming bounded and unbounded, simplex method degenpracy duality sensitivity analysis langrage multiplier quabratic programming wolsons method beales method constrained non linear algorithm direct approach method gradient method constraint non linear programming. Panelty method

EEP 111 HIGH SPEED COMPUTATION TECHNIQUES

Characterizes features and design constraint of high performance machine, arithmetic and addressing modes, RISC&CISC optimization for speed and performance super scaller structure,

paraller and vector processing cache coherence and algorithm cache analysis and design virtual memory or improved program locality and replacement algorthm pipeline architecture maximum performance pipelines multiprocessor interconnection data structure for vector and spares matrix technique, granularity and its role in parallelism, symbolization issues, serial algorithm into paraller algorithm continence regulation and concept of paraller search serial search and sort algorithm

EEP 110 : APPLIED MATHMATICS

Numerical Analysis: Numerical integrationsimpaon's rules Newton – cotes formulae gaussian quardrature solution of partial differential equations by following methods Schmidt method crank Nicolson method dufortfrankel method.

Statistics : Theory of probability Bayes theorem mathematical expectation discrete and continous probability distributions – Binomial position and normal bivariate distribution linear correlation and regression.

Optimization techniques: Linear programming Bounded and unbounded graphical method simplex method

Elective – II

EEP 104 : ADVANCED CIRCUIT ANALYSIS & DESIGN

Network Topology: Network geometry, incidence matrix, tieset matrix and loop currents, cutset matrix, and node pair potentials. Properties of cutset and tieset matrices, f–cutset Analysis, f-circuit Analysis, Nodepair Analysis. Duality, planner and nonplanner networks. Branch parameters matrices. Kirchhoff's equilibrium equations on loop basic. Equilibrium equations on the node basis.

Network Functions : Network functions , evaluation of network function from (1) a given magnitude

(2) a given angle and (3) a given real part; integral relationship between real and imaginary parts.

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 Syunthesis. RC and RL Networks: Properties of RC network functions, foster form of RC networks, faster form of RL networks. The caur form of RC and RL networks, RLC one TerminalPairs: Minimum positive real functions. Brune's method of RLC synthesis.

Attenuators and Equalizers : Symmetrical BridgeTand lattice attenuators, asymmetrical T and π attenuators. Equalizer configuration, four terminal equalizers, full series, shunt and bridgeT and lattice equalizers.

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

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

EEP 105 : INTEGRATED ENERGY SYSTEMS

Pattern of fuel consumption: Agricultural, domestic, industrial and community needs. Projection of Energy Demands, substitution of conventional sources by alternative sources and more efficient modern technologies. Potential of Solar, Wind, Biogas, Natural Gas, Forest produce,

Tidal, Geothermal, Minihydro and other modern applications. Hybrid and Integrated Energy Systems. Total Energy concept and Waste heat utilization.

EEP 106: AI APPLICATIONS TO POWER SYSTEMS

Introduction to AI: Definition, Applications, Components of an AI program; production system. Problem Characteristics. Overview of searching techniques. Knowledge representation : Knowledge representation issues; and overview. Representing knowledge using rules; procedural versus declarative knowledge. Logic programming, forward versus backward reasoning, matching. Control knowledge.

Statistical Reasoning: Probability and Daye's theorem. Certainty factor and rule based systems. Baysian Networks, Dampster Shafer theorem. Semantic nets and frames, Scripts. Examples of knowledge based systems.

Pattern Recognition: Introduction, automatic pattern recognition scheme. Design Concepts, Methodologies, Concepts of Classifier, concept of feature selection. Feature selection based on means and covariances. Statistical classifier design algorithms; incrementcorrection and LMSE algorithms. Applications.

Artificial Neural Networks: Biological Neuron, Neural Net, use of neural 'nets, applications, Perception, idea of single layer and multilayer neural nets, backpropagation, Hopfield nets, supervised and unsupervised learning.

Expert Systems : Introduction. Study of some popular expert systems, Expert System building tools and Shells, Design of Expert Systems.

EEP 107: POWER GENERATION SOURCES

Generation of Electricity and Sources of Energy : Major sources of energySalient features, selection of site, basic schemes and constituents of Steam, Hydro, Nuclear, Diesel and Gas Turbine Power Stations. Cogeneration, Hydrothermal Energy coordination.

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. Economiser and air preheated, condenser, supply of cooling water to condenser, cooling towers.

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

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 breader reactor, Cost of Nuclear Energy. Nuclear Power Stations of India.

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.

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. Geothermal power generation.

EEP 108 : MODERN CONTROL THEORY

Discrete Time Systems and the ZTransform Method: Sampled Data Control Systems, Digital Controller, Sample & Hold Operation, Frequency consideration in Sampling and Reconstruction. Ztransformation, Solution of Differential & State Equations by 'Z' Transform Method, The Inverse ZTransform, Pulse Transfer Function and Stability in Zplane.

Transform Design of Digital Controls & State Space Concepts: Design Specifications, Design on the 'W'plane, 'W plane & 'Z' plane. The CAYLEY HAMILTON Theorem, Concepts of Controllability & Observability. Stochastic Optimal State Estimation & Stochastic Processes. Stability: Generalized Stability Creterion (dpartition technique), Pole Assignment method, LIAPUNOV's method, LURE's transformation, POPOV's criterion.

Microprocessor Based Control Systems: Digital Quantization, Positional Control System, Temperature Control System, Stepper Motor Drive circuits and Control of a Manipulator Arm.

Optimization: Time Optimal System (without proof of control law), Calculation of Switching Trajectories for second order systems. Optimal Control System based on Quadratic performance Indices (proof through Liapunov's function), Basic concepts of Model Reference Control System and Adaptive System.

Pontryagin's maximum principle, constrained and unconstrained input, Dynamic Programming-optimality principle, Discrete and Continuous Dynamic Programming.

Second Semester

EEP 201: OPERATION & CONTROL OF POWER SYSTEMS

Optimal Power System Operation: Optimal Operation of generators on a bus bar, Optimal Unit Commitment, Constraints in unit commitment, Spinning reserve, Thermal Unit Constraints, Other constraints, Hydro constraints, Must Run, Fuel constraints, Unit commitment Solution methods : PriorityList methods, Dynamic Programming solution. Backward DP Approach, Forward DP Approach, Restricted Search Ranges, Strategies.

Reliability Considerations, Patton's Security Function, Security constrained Optimal Unit Commitment, Startup considerations, Optimal Generation Scheduling, Representation of Transmission Loss by Bcoefficients, Derivation of Transmission Loss formula. Representation of Transmission Loss by Power Flow equations, Optimal Load Flow solution. Inequality constraints, Optimal Scheduling of Hydrothermal System.

Introduction to Power System Security. System State Classification, Security Analysis, Modelling for contingency Analysis.

Automatic generation and Voltage Control: Introduction Load Frequency Control, Turbine Speed Governing System, Model of Speed governing system. Turbine Model, Generator Load Model, Block diagram representation of Load Frequency Control and an Isolated System, Steady State Analysis, Dynamic Response, Control Area, Load frequency control and Economic Dispatch Control, Twoarea load frequency control, Optimal Load Frequency Control (twoarea), Automatic Voltage Control, Introduction to Digital LF Controllers, Decentralized Control.

EEP 202: ADVANCED POWER SYSTEM PROTECTION

Relaying: Review of Relay characteristics, Classification of Relays, characteristics and operating equation.

Protective Current & Potential Transformers: Types, Rating, Accuracy, burden, Polarity, connections and Transient Response.

Static Relays: Introduction, advantages of static relays over electromagnetic relays. Limitation of static relays, Reliability and Security of static realys, Recent Developments of static relays.

Comparators and Level Detectors: Static Relay Functional circuits, Amplitude and Phase comparators, level detectors.
Static Over current Relays: Introduction to static overcurrent relays, single actuating and Double actuating quantity relays, Basic principle of static overcurrent relays, time characteristics, timing circuit, Directional overcurrent relay, static time lag overcurrent relays. Static Directional relays. Static Differential Protection to Power Transformers, Static Busbar protection based on Directional comparison. Static Distance Relays and Distance Protection of EHV Lines. Influence of power swings on Distance protection. Directional wave Relays for fault protection and protection of overhead lines.
Relay setting coordination, transient over voltages in static relay, protection of static relay circuit.
Digital Relays, Microprocessor based protective relays.
Switchgear: Types of circuit breakers and their constructional features, operating mechanism Application of Circuit breakers, speed of circuit breakers, Autreclosing, selection of circuit breakers, Rating of circuit breakers, Testing of circuit breakers, SF6 Insulated Metal clad Switchgear (CIS), Advantages, Demerits, Design aspects, Busbar modules, SF6 Insulated EHV Transmission Cables (GIC). EEP 203 : EHV AC/DC TRANSMISSION
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.
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, maximum surface electric fields for bundled and single conductor lines.
Electrostatic fields of EHV lines. Effect of E.S. field on Humans, Animals and Plants.
Series and Shunt compensation : Effect of series capacitors, location of series capacitors. Sub-synchronous resonance in seriescapacitor compensated lines and counter measures. Shunt compensation Variation of no load receiving end voltage, Static VAR Systems : TCRFC, TCR, TSCTCR and MSCTCR Schemes.
HVDC Transmission
Rectification: The 3phase Bridge rectifier or Graetz circuit, Inversion, Kinds of D.C links, Paralleled and Series connection of thyristors, Power flow in HVDC transmission system.
Converter Station: Major components of a converter stationconverter unit, filters, reactive power source. Ground return and ground electrode.
Basic principles of DC link control: Converter control characteristics, firing angle control and extinction angle control. Parallel operation of D.C. link with A.C. transmission line.
Introduction to Multiterminal HVDC Systems and HVDC Circuit Breakers, Comparison between AC and DC transmissions, break even distance for overhead transmission lines and underground cables. Application of HVDC transmission.
Elective III EEP 204: POWER SYSTEM PLANNING & RELIABILITY
Load forecasting: Classification and characteristics of loads. Approaches to load forecasting. Forecasting methodology. Energy forecasting. Basic Reliability Concepts: General reliability function, Markov Chains and processes and their applications, simple series and parallel system models. Static Generating Capacity Reliability Evaluation: Outage definitions, loss of load probability methods, loss of energy probability method. Frequency and duration methods, load

forecasting uncertainty. Spinning Generating Capacity Reliability Evaluation: Spinning capacity evaluation, load forecast
uncertainty. Transmission System Reliability Evaluation: Average interruption rate method. The frequency and duration method . Stormy and normal weather effects. Interconnected Systems Generating Capacity Reliability Evaluation: Introduction, The loss of toad approach. Reliability evaluation in two and more than two interconnected systems. Interconnection benefits.

EEP 205: POWER SYSTEM INSTRUMENTATION

Transducer Instrumentation: Primary sensors, voltage and current generating analogue Transducers, variable parameter analogue Transducers, Frequency generating and Digital Transducers, transducer selection factors.

Digital Instrumentation: Introduction, Basic measurement system. Digital voltage measurement, Frequency measurement, Time measurement, Digital phasemeter, digital multimeter. Digital displays. Telemetry System: Introduction to Information Transmission. Basic ideas.

Point to Point Telemetering: Basic principles, pneumatic and electrical system, voltage and current telemetry, impulse codal telemetry.

Radio Telemetering: Basic principles of AMFM systems.

Instrumentation Associated with Power Plant: Centralized Control and Measurement in Thermal, Hydro and Nuclear Power Plants.

Power Line Carrier Principles.

EEP 206: ELECTRIC DRIVES AND THEIR CONTROL

Characteristics of Electric Motors : Characteristics of DC motors, 3phase Induction motors and Synchronous motors. Starting and Breaking of Electric motors. Status of DC and AC Drives.

Dynamics of Electric Drives : Parts of electric drives electric motors, power modulators, sources, control unit, and mechanical system. Fundamental torque equations. Multiquadrant operation. Equivalent values of drive parametersloads with rotational motion and translational motion, components of load torque, nature and classification of load torques. Dynamic conditions of a drive system. Energy loss in transient operations, load equalization.

Motor Power Rating : Power losses of motors, heating and cooling of electric motors. Thermal model of motor for heating and cooling, classes of motor duty, Determination of motor rating : continuos duty, short time duty and intermittent periodic duty. Equivalent current, torque and power for fluctuating and intermittent loads.

Control of electric Drives : Modes of operation. Closedloop control of drives. Currentlimit control. Closedloop torque, and speed control . Closedloop control of multi motor drives. Speed and current sensing. Phaselockedloop control.

DC Motor Drives : Starting, Braking, and speed control Transient Analysis of separately excited motor with armature and field control, energy losses during transient operation. Phase controlled converter DC drives, dualconverter control of DC drive, power factor, supply harmonics and ripple in motor current. Chopper control DC drives. Source Current harmonics.

3Phase Induction Motor Drives: Starting, Breaking and Transient Analysis. Calculation of energy losses. Speed Control, Staler Voltage control. Variable Frequency control from voltage and current sources, Slip power recoveryStatic Scherbius and Cramer Drives.

Synchronous Motor Drives : Starting, Pull in and Braking of Synchronous motor. Speed control-variable frequency control, cycloconverter control.

Brushless DC Motor, Linear Induction Motor, Stepper Motor and Switched Reluctance Motor Drives: Important Features and applications.

Energy Conservation in Electrical Drives : Losses in electrical drive system. Measures for energy conservation in electric drives. Use of efficient motor. Energy efficient operation of drives. Improvement of power factor and quality of supply. EEP 207 HIGH VOLTAGE DIRECT CURRUNT TRANSMISSION

Thyristor valve : thyristor divises, steady state switching charactistc, light activated power theristior, LED. Fiber optics, valve firing, praraller & series conection of thyrestior

Converter Circuit :Rectification: The 3phase Bridge rectifier or Graetz circuit, Inversion, Kinds of

D.C links, Paralleled and Series connection of thyristors, Power flow in HVDC transmission system.Converter Station: Major components of a converter stationconverter unit, filters, reactive power source. Ground return and ground electrode.

Basic principles of DC link control: Converter control characteristics, firing angle control and extinction angle control. Parallel operation of D.C. link with A.C. transmission line.

Coverters Fault and Protection : coveter fault and protection against over current, over voltage in converter prtection of DC Line and DC circuit breaker

Re active power control : re active power requirement in steady state, sources of re active power and re active power control

Harmonics and Filters : Generation of harmonics, Charactoristcs and non Charactorsics harmonic, types of ac filter : single tuned and double tuned fileter, high pass filter, DC smoothing reactor and filters

Multiterminal Types of MTDC system, caomprasion of series and paraller MTDC system, control and protection of MTDC system and applicatin of MTDC systems

Elective IV

EEP 208: ECONOMICS & PLANNING OF ENERGY SYSTEMS

System Economics: Basic concepts, National accounting framework. Criteria for economic growth. Model types and philosophy. Production functions. Inputoutput economics, macro-economic growth models. "Econometric" models, policy options and budgetary Implication, some illustrations of economic research for identifying demand functions, supply functions, cost functions, production functions, utility functions and Engel curves. Dynamic models of the economy and "Simple" theory of business fluctuations. Multiple linear and nonlinear regression analysis, energy per unit monetary value of consumer needs and services. Energy efficiency, Costbenefit risk analysis. Environmental repercussions and the economic structure. Conflict between energy consumption and pollution. Systems Design and quantitative economic policy with particular references to energy. Econometric in the context of multiple objectives, conflicting goals and decisions under uncertainty.

EEP 209: POWER SYSTEM TRANSIENTS AND HIGH VOLTAGE ENGINEERING

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 footingresistance. Traveling waves, multivelocity waves, methods of measuring tower footing resistance, voltages across insulator strings. Dynamic over voltages during surges and system faults, system recovery voltage characteristics. Methods of neutral grounding and their effect on system behaviour. Insulation coordination, requirement in surge protection of lines and equipment.

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

EEP 210: EXCITATION OF SYNCHRONOUS MACHINES AND THEIR CONTROL

Excitation Systems: Principal Controls of a generating unit. Arrangement of excitation components, voltage responseratio. Excitation specifications. Ceiling voltage, time constant and response of excitation systems. Requirements of excitation systems: Classification of excitation systems.

D.C. Excitation Systems: configuration of DC excitation system with main and pilot exciters. Amplidyne and magnetic amplifier. Automatic voltage regulator with magnetic amplifier and Amplidyne. Limitation and problems of DC excitation systems. Improvement in DC excitation system. AC Shunt Excitation Systems (Static Rectifier Excitation Systems): Static thyristor rectifier schemes. Transient Response during fault condition. Use of booster transformer. Application for
shunt excitation systems. AC Separately Excitation Systems. (AlternatorRectifier Excitation System): Scheme of alternator rectifier excitation system with (i) diode rectifier and (ii) thyristor rectifier. Comparison and Application of these schemes. Harmful effects of static excitation systems or system machine components, means of prevention. Brushless Excitation Systems: Brushslip ring problem. Scheme of Brushless excitation system with rotating diode. Control, protection and monitoring of Brushless excitation system. Introduction to brushless excitation system with rotating thyristors. Introduction to Superconducting Exciter. Automatic Voltage Regulator (AVR): Solid state automatic voltage regulator scheme. Auto and manual followup. Thyristor converter and AVR protection. Introduction to Digital AVR. Excitation Control: Introduction to power stabilizing signalspeed, frequency and power signals. Rotor current limiter, MVAR limiter. Effect of excitation on generator power limits, Dynamic and Transient stabilities.

EEP 211: COMPUTER METHODS IN POWER SYSTEMS

ThreePhase Networks: Introduction, Threephase network elements, Threephase balanced network elements. Transformation Matrices, Threephase unbalanced network elements, incidence and network matrices for threephase networks. Algorithm for formation of threephase busimpedance matrix. Modification of the threephase bus impedance matrix for changes in the network.

Short Circuit Studies: Short circuit calculations using Bus Impedance matrix, Short circuit calculations for balanced threephase network using Bus Impedance matrix, Short circuit calculations using Loop Impedance matrix.

Sensitivity Analysis and Optimal Load Flow: Classification of System variables, Sensitivity AnalysisSensitivity Matrix, Development of Gx and Gu, Optimal Load Flow, Optimisation Technique, Gradient method. Formulation of Optimal Loadflow Problem and its Solutions, Consideration of Inequality Constraints. Comparison with Classic Economic Dispatch Method.

Security Concept and Contingency Evaluation: Operating States of a Power System, Concept of security Monitoring. Techniques for Contingency Evaluation DC Load Flow, Fast Decoupled Loadflow, Preventive and corrective Measures.

Load Forecasting & State Estimation: Estimation of average, periodic, stochastic components of load, basic idea of state estimation of power system.

EEP 212 MICROPROCESSOR, MICROCONTROLLER AND THEIR APPLICATION TO POWER SYSTEM

1. Microprocessor: Intorduction architecture and programming of 16bit microprocessor 8086, 8088 Motorola 68010, 68020 and Zilo E Z8000.
2. Microcontrollers : Introduction and Architecture of Microcontrollers – Intel 8044, 8051, 8096 and 8748
3. I/O Processor and coProcessor: introduction architecture of I/O Processors UPI 452, UPI 41, 42, coprocessor 8087 and 80287
4. Application of EHV Systems: Design & Development of various systems for monitoring and control of frequency power factor of high voltage EHV systems H/W and software develoment, maserment of resistance, reactance, KVA, kalman demand etc. microprocessor and microcontroler based energymeter and photo reclising schemes for EHV system