SYLLABUS OF MASTER OF POWER ENGINEERING

First Semester

Category - Departmental / Specialization Basket

Paper - I

PG / PE / T / 111A Applied Thermodynamics

1st 2nd laws of thermodynamics, thermodynamic analysis of flow and non-flow process, Entropy, Equation of State, Thermodynamic property relations, Chemical thermodynamics, 3rd Law, Thermodynamics of compressible fluid, thermodynamics of irreversible process. Exergy Analysis.

PG / PE / T / 111B Analysis of Electrical Machines

Synchronous Machines: Definition of ideal 3-phase synchronous machines, circuit model and parameters, Parks transformation and derivation of Parks' equation for synchronous machines.
Analysis of sudden 3-phase short circuit phenomenon. Steady state analysis and frequency response of analysis of synchronous machines. Starting phenomenon, negative sequence resistances. Small oscillation of synchronous machine and associated constants.
Induction Motor:
Theory of instantaneous symmetrical components, Kirchoff's voltage equation of stator and rotor of multiphase cylindrical rotor machine, derivation of equation for instantaneous torque.
Space vector method of transient analysis of induction machines, equivalent circuit of induction machine valid during transient processes, transient reluctances and and time constants, derivation of instantaneous torque and current during (a) DOL starting operation and (b) 3-phase short circuit.
Application of electromagnetic field theory in electrical machines, eddy current loss in tubular conductor, power flow in cylindrical rotor machines. Poyinting vector and derivation of torque equation in cylindrical rotor machine.

Paper - II

PG / PE / T/ 112A Applied Fluid Mechanics

Review of Basic Laws of fluid flow in integral and differential form. Kinematics, Ideal Fluid Flow, Velocity potential and Stream function, Flow net, Combination of flows, Newtonian fluid flow and application, Creeping flow, Boundary Layer Theory, Transition and Turbulence, Turbulent Boundary Layer, thin aerofoil theory, Review of fundamentals of compressible flow with and without friction and heat transfer. Latest techniques of fluid flow measurements.

PG / PE / T/ 112B Advanced Power System Principles

Load flow studies: Load flow problem, formation of bus and admittance matrix, solution of load flow problem by Gauss-Seidel and Newton-Raphson methods.
Power System Control: Economic operation, load frequency and voltage control, CIA, CC and CEA control of HVDC link.
Short Circuit Studies: Short circuit problem, formation of bus impedance matrix, solution of symmetrical and unsymmetrical short circuit faults using Network Analyser and Digital computer.
Transient Stability Studies: Concept of equal area ctriteria, Swing Equation foe multimachine and their solution by numerical methods.
Static and numerical relays: Phase and amplitude comparators, derivation of voltage and current values by sampling method.

Paper - III

PG / PE / T/ 113A Heat and Mass Transfer

Steady State Conduction, Analysis of fins, Critical thickness of insulation, Systems with internal heat generation.

Transient conduction analysis: Application of numerical methods to conduction problems. Theory of heat convection.

Conservation equation of energy, mass & momentum and their analogies. Significance of various dimensionless numbers, laminar & turbulent boundary layer concept, thermal boundary layer, forced convection inside tubes and ducts, Forced convection over external bodies, Natural convection. Boiling and Condensation

Radiation properties and laws, Radiation exchange among black and gray bodies, Electrical analogy, Radiation through participating gases.

Mass transfer by convection and molecular diffusion, Fick's laws, Calculation of mass transfer coefficient, Interface mass transfer.

PG / PE / T/ 113B Digital Systems

Recapitulation: Registers, Counters, Programmable Counters, Paged Memory blocks, Timers.
Signals and Signal Processing Concepts: Classification of Signals, Discrete Signals, Transforms, Sampling, Convolution, Digital Filters.
Digital Systems in Automation: Basic functional blocks, overview of Programmable Logic Controllers (PLCs) and Supervisory Control and Data Acquisition Systems (SCADA).
*Digital Connectivity for Automation***:** Coding techniques and mechanisms, connectivity standards: RS232C,RS422,GPIB,USB and the CAN.

Category – Inter - Disciplinary Basket

Paper –IV

PG / PE / T/ 114A Power Generation Methodologies

Energy Resources, Primary, secondary, conventional, non-conventional and renewable energy sources.
Major energy resources in use for power generation: Fossil fuel, nuclear fuel, hydel, solar, wind and geothermal resources.
Advanced features of various types of power plants, e.g., thermal, hydro, nuclear, solar, wind, tidal, bio-gas, geothermal, fuel cell, thermo photovoltaic, etc.

Alternately, from the inter-disciplinary basket of ME, EE, IEE and Energy Science.

Paper-V

PG / PE / T/ 115A Power Plant Cycles and Systems

Power Plant Cycles: Thermodynamic cycles for heat engines, Choice of working fluid. *Vapor Power Cycles:* Analyses of ideal & actual cycles – Rankine cycle, Reheat cycle, regenerative cycles – work ratio, heat rate, steam rate, thermal efficiency, heat balance, exergy analysis. Choice of feed-water heaters & their arrangements. Different practical losses in power plant cycles.

Gas Turbine Cycles: Performance analyses of ideal & actual cycles – Reheating, intercooling and regeneration. Introduction to Combined cycles, classification, binary vapor cycles, steam and gas turbine combined cycles.

Power Plant Systems: Basic components of steam turbine power plants. Main and reheat steam system, HP-LP bypass system, condensate and feed water system, CW system, air and flue gas system, Turbine seal steam system, Auxiliary PRDS.

Alternately, from the inter-disciplinary basket of ME, EE, IEE and Energy Science.

Paper- VI

PG / PE / T / 116A Energy Planning Management and Modeling

Thermodynamic laws and energy balance of thermal systems. Energy auditing and accounting concepts. Energy management principles, organizations and implementation techniques. Energy conservation through better management techniques, improved product design and modification of improved techniques.
Energy modeling principles and classification. Linear programming and its use for energy system models, policy analysis and planning. Geometric programming and design of energy systems. Conventional versus non-conventional sources – environmental considerations.

Alternately, from the inter-disciplinary basket of ME, EE, IEE and Energy Science.

Category – Sessional Courses

Sessional 1

PG /PE/ S / 111 Power Plant Simulator Lab

Each Student is required to get familiarized with the various systems and interlock, protection and control systems implemented in a modern power plant through simulator training.

Sessional 2

PG /PE/S / 112 Seminar

Each Student is required to present along with a report on any advanced topic related to Power Engineering.

Second Semester

Category - Departmental / Specialization Basket

Paper – VII

PG / PE / T/ 127A Combustion Technologies

Chemistry of Combustion: Molecularity and order of reaction, Rates of reaction, Arrhenius equation. Conservation equations of mass, momentum, energy and species for a multicomponent system.
Combustion of gaseous fuel jets: Premixed and diffusion flames, Laminar and turbulent flames. Concepts of kinetically controlled and diffusion controlled reactions, Flammability limits, Ignition, Burning velocity, Flame structure and Stability for laminar flames.
Liquid Fuel combustion: Atomization of liquid, Various atomizers and their performances Evaporation of droplets in high temperature gas streams, Simple model of droplet burning, Physical and mathematical models of spray flames.
Combustion of Solids: Description of carbon sphere combustion, Diffusional theory of carbon combustion of pulverized coal.
Pollutant formation in various combustion processes and their controlling measures.

PG / PE / T/ 127B Advanced Electrical Drives

AC-DC Converters; Power semiconductor devices; Multi-pulse converters; Half-controlled and fully controlled operation with R-L and back e.m.f. loads; p.f. improvement; performance evaluation; effect of source impedance; harmonics; gating circuits. DC-DC converters; chopper regulators – PWM and variable frequency strategies. SCR-choppers – voltage impulse, current impulse and load commutation; filter elements; multi-phase choppers; gating circuits.

AC Regulators; phase angle control of single phase and three phase loads; integral cycle control. Inverters; Voltage source inverters – bridge inverters, control strategy and output wave form; PWM inverters; series inverters; gating circuits; Current source inverters – single and three phase-commutation aspects – output wave forms. Cycloconverters; principle, output voltage, wave form, harmonics and power factor. Application of power electronic devices to electrical drives control.

PG / PE / T/ 127C Fan Blower Compressors

Classification of air and gas handling machines – mechanical details, theory and design of axial flow fans and radial flow blowers, performance characteristics. Thin aerofoil theory, Selection of blade profile and number of blades.

Axial flow Compressors – simple and multistage, polytropic and overall efficiency, stalling and surging, stable range of operation, performance characteristics.

Centrifugal Compressors – inlet, impeller, casing and diffuser analysis. Design features, pre-whirl and choking phenomena, Flow through vaneless and vaned radial diffuser, Flow through curved and annular diffuser.

PG / PE / T/ 127D Nuclear Power Engineering

Basics of reactor physics, reactor kinetics, reactor saving. Reactivity- it's measurement and control. Neutron detection. Concepts of radiation measurement and dosimetry. Nuclear power production – fission and fusion – nuclear fuels – prospecting – processing of nuclear fuels. Reactor technology – types of reactors – BWR, PHWR, GCR, fast breeder – comparison. Fuel handling and reprocessing. Constructional features of nuclear power plants. Waste disposal and environmental management.

PG / PE / T/ 127E Non conventional Power Engineering

Reserves and resources of energy – transformation – origin of renewable sources. Solar radiation, Power duration curves, Solar collectors – applications. PV Cells. Wind Power – variability, speed data, conversion process. Power in ocean waves and their utilization. Geothermal power and its prospects. Tidal power and its economy. Mini-hydel and micro-hydel plants. MHD generation – State of the art technology.

Paper – VIII

PG / PE / T/ 128A Steam and Gas Turbines

Steam Turbine: Classification, Flow through nozzles – supersaturated expansion, nozzle through blade passages, Blade design, Multistage Turbine, Reheat factor, Curtis, Rateau Parsons Turbine, Different losses in steam turbines, Leakage of steam and its minimization, Blade erosion, Construction of Rotor and Stator, Differential expansion, Vibration in turbine. Steam turbine performance and operation, Governing of steam turbine, Lubrication of bearing, Choice of materials for different parts.

Gas Turbine: Introduction – analysis of GT cycles – Basic gas dynamics. Axial flow & centrifugal compressors – Characteristics and dynamics. Combustion process and the system – Combustion chambers. Axial flow gas turbines – Vortex theory, Blade profile, pitch and chord, stage performance, Overall turbine performance and effects of variable parameters on performance, Blade cooling, Turbine construction. Jet propulsion and aeroderivative gas turbines. Choice of materials for different gas turbines plant components.

PG / PE / T/ 128B Computational Heat Transfer and Fluid Flow

Mathematical description of conservation equations, classification of physical behaviour, nature of discretisation methods, outline of discretisation techniques e.g. formulation by finite elements, finite volume, finite difference etc. Modelling of heat conduction, convection-diffusion and flow-fluid using control volume formulation, solution of discretised equations, outline of advanced modeling techniques e.g. modeling of turbulence, combustion, melting-solidifications etc. Computer simulation – Introduction to a Computational Fluid Dynamics (CFD) package.

PG / PE / T/ 128C Power Apparatus

Transformers: 3-winding and grounding transformers. HVDC Transmission system
Reactive power compensation: Static VAR compensation and synchronous condensers, series and shunt compensators and optimum location.
Static apparatus: Digital phase angle indicator, controlled switching units, CVT, CT and CT saturation, digital and logic circuit for PS control. FACTS Technology.
Switchgears: Theory and construction of SF6 and vacuum switchgears and testing.
Overvoltage phenomena: Different types of lightning arrestors, their theory and construction.

PG / PE / T/ 128D Power Transducer Technology

Classification of Instrumentation Transducer: Analog/ digital, active/ passive, force balance.
Variable resistance transducers: Potentiometers, strain gauges, resistance thermometers, thermistors, hot wire anemometers, ac and dc bridges and half bridges.

Variable inductance and variable capacitance transducers: Application, ac bridge and other interfacing methods.
Special transducers: piezoelectric, magnetoresistive, electromagnetic transducers, thermoelectric sensors, semiconductor temperature sensors.
Mechanical characteristics of sensors: Electrodynamic transducers, eddy current, damping resonance effect, design considerations.
Force balance transducers: Static performance—sensitivity, linearity, threshold. Dynamic performance—harmonic response and bandwidth, transient response, phase compensation, velocity feedback. Applications
Power system transducers: Voltage, current, power factor, frequency, power, VAR.
Analog signal conditioning techniques: Bridge amplifier, carrier amplifiers, charge amplifiers and impedance converters, modulation-demodulation, dynamic compensation, linearization, multiplexing, and demultiplexing.
Digital interfacing techniques: Interfaces, processors, code converters, linearizers.
Single transmission: Cable transmission of analog and digital signal, fiber optic signal transmission, radio, telemetry, pneumatic transmission.
Signal display/ recording systems: Graphic display systems, storage oscilloscope, recorders-ink, thermal, UV. Smart Sensors.

PG / PE / T/ 128E Impeller Pumps

Fundamentals notations and classifications of impeller pumps. Flow through impeller, Euler's equation, pressure and velocity distribution in impeller passages. Influence of finite number of blades, impulse and reaction types of impellers. Dynamic Centrifugal Pumps, single and multistage.

Mixed flow pumps, helical and diagonal pumps, propeller pumps, circular cascades. Inlet and outlet systems. Cavitation and net-positive suction head considerations.

PG / PE / T/ 128F Computer Networking and Network Programming

Computer Network Components (Hardware & Software) – Theoretical basics of data communication – types of physical media (UTP, TX, Baseband & Broadband Coaxial cables) – protocol hierarchies – design issues for the layers – interfaces & services – service primitives – the relation of services to protocols.

The OSI Rference Model. TCP/IP. The IEEE 802.2 and LLC – brief overview. The IEEEE 802.3 – Ethernet, Overview of IEEEE 802.4 and 802.5 (token bus & token ring). Switched Ehernet Lan. Modern Switched Lans e.g. Myrinet. Sockets (Berkley & Winsock).

Paper – IX

PG / PE / T/ 129A Advanced Power Cycles and Economics

Exergy-based analyses of power cycles.

Combined Cycles: Steam and Gas Turbine Combined Cycle, supplementary firing, dual pressure cycle, STIG. Integrated coal gasification combined cycle, Combined heat and power cycles, waste heat recovery system, Fuel cell combined cycles, MHD combined cycle. Kalina cycle.

Power Economics: The general economic problem, Load curves, Selection of base load & peak load plant etc. Economic operation of generating units in an integrated system, Economic generation and load dispatch – practical limitations. Cost of Power Generation, Tariff structure. Techno-economic evaluation criteria of plants and equipment. Thermoeconomic analysis and optimization based on energy.

PG / PE / T/ 129B Hydro Turbines

Introduction, Review of fluid dynamics and thermodynamics of flow through turbomachines. Application of similarity concept for the preliminary design of turbomachines.

Importance and place of water power – relationship with thermal and nuclear power, economy.

Hydrology – descriptive hydrology, hydrograph, mass curve, storage, dams.

Selection of hydro-turbines – impulse, reaction and propeller turbines, hydroturbines accessories, torque, power efficiency, water turbine design, installation, operation and maintenance, governing mechanism of water turbines, characteristics curves.

Tidal Power – power from sea waves and its machinery. Pumped storage plant, multipurpose projects and effects on environment.

PG / PE / T/ 129C Advanced Power System Operation

Introduction: frequency dependence of load, governors of generating units, MW-frequency control problem, PF control of single control area and its modeling, supplementary control, PF control of multi-control area system and its modeling, optimum systems control, development of dynamic state variables model of two area system. Load frequency control with generation rate constraints (GRCs), speed governor dead band and its effect on automatic generation control (AGC), digital LF controllers decentralized control.
Data acquisition systems(DAS): microprocessor-based DAS for power system applications, data transmission and telemetry, DAS and man-machine interface, power plnt control, integrated BTG control systems.
MegaVAR voltage control: Fundamental characteristics of typical excitation system, automatic voltage regulator (AVR) for generator excitation control.

Load scheduling: Scheduling problem in the thermal system and their solution, derivation of B-coefficients and incremental transmission loss (ITL), ITL from the Jacobian of N-R load load flow, base point, participation factor and real time implementation of economic dispatch, reactive power dispatch and its coordination with active power dispatch, short range hydro thermal scheduling problem and solutions.
Unit commitment: various constraints in thermal unit commitment. Problem by dynamic programming.
State estimation: Introduction to the problem of state estimation, maximum likelihood estimation and weighted least-estimation, redundancy in measurement, bad data identification, concept of power system monitoring, the line of power flow estimator, state estimation n presence of noise, variance and normalization of measurement, improving state estimation by adding measurements.

PG / PE / T/ 129D Power Plant Control and Instrumentation

Review of the fundamentals –state variable approach for continuous and discrete data systems. The Z-transformation. Canonical forms – Observability and controllability – state feedback. Non-linear functions – Linearisation techniques. Phase plane & D-partition methods. Compensators – Computer aidede design of control systems. Process dynamics – modeling – identification & estimation of parameters. Different types of controllers – effect of load and disturbance variables on the system performance. Multivariable process control – strategy, difficulties due to lags. Security measures & reliability concepts – concept of optimization – adaptive control.

Modern instrumentation schemes of power plants – supervisory controls like SCADA. Microprocessor-based control schemes – data-logging, digital control schemes. Electrical instruments and meters. Telemetry. Data transmission channels – Interference effect. Automatic meter reading and billing. Disturbance recorders. Application of digital computers for data processing and on-line system control.

PG / PE / T/ 129E Steam Generator

Introduction to Power Station Steam Generators. Fuels of Steam Generators, Coal Firing methods, Design of Pulverized Coal-fired Furnaces, Different types of Coal Burners and their arrangement, Principles of Low NO_x Burners, Fluidized Bed Coal firing, Design aspects of different fluidized bed furnaces.

Fuel oil and Gas-fired Boilers, Different types of Oil and Gas Burners and their performance, Furnace dynamics, Furnace safeguard supervisory systems.

Heat exchange in heating surfaces of boilers, thermal characteristics of water walls, Flame emissivity, Radiant and Convective heat transfer in steam generators, Hydrodynamics of steam generators tubes, Boiling phenomena and introduction to two-phase flow, Heat crisis in evaporative tubes. Effects of water impurities on the performance of boilers, Methods of water conditioning. Fireside slagging and corrosion in steam generators, Separation of ash from the boiler.

PG / PE / T/ 129F Power system planning and Operation

Basic principles of planning for power system expansion: load forecasting, short, medium and long term planning. Reliability and security considerations.

Power system operation: Preparation of daily load curve, unit commitment, economic generation scheduling – hydro-thermal coordination, Security aspects of system operation. System reserve consideration.

Transmission system operation: Reactive power generation and control. Control of voltage profile. System loss minimization. Load frequency control. Role of microprocessors & microcomputers in system operation and control.

Category – Inter - Disciplinary Basket

Paper - X

PG / PE / T/ 1210A Real Time Embedded System

Introduction: (Defining real time systems, Embedded real time systems, special characteristic of real time systems, a brief evolutionary history). Hardware Architecture of real time systems. Software Architecture (concepts of interrupt driven activation, need for real time monitor, pseudo parallelism). System Development life cycle (Phases, separate HW and software design tracks, Hybrid, co design, difficulty of debugging without target hardware etc., Available development methodologies. Specifying a real time system (complexities and difficulties, mention of formal specification languages – no details).
Software Design.
Introduction: Characteristics of Real Time Software Design Methodologies and life cycle. Overview of ward & Mellor methodology: Ward & Mellor Life Cycle, The Essential Model Step, The Implementation model, Real time Extensions to DFD. Environment Model: Context Diagram, The Event list. Behavioral Model: Expanding the contest diagram, Disambiguation of Transformation schema, describing the data schema, describing the data transform and control transforms, state transition diagrams. Implementation model steps: Processor Environment Model, Software environment model, code organization model, Translating STD's to structure charts, Translating data Transform based schema's to structure charts. Developing testing and evaluation of real time systems.
System Development and Implementation. Real time programming language-issues and Ada. Real time O/S (facilities, UNIX/VENIX/POSIX, IRMX (historical reasons), concepts of processes and threads, communication among processes, kernel services). Development systems (Options, ICE, emulators, Section 15 of existing syllabus). External World Interfacing Issues: (Standard buses, connectors, isolation of signals from EMI/EMC).

PG / PE / T/ 1210B Environmental Engineering

Air pollution and combustion processes. Primary and secondary pollutants – effects on health, vegetation, materials and atmosphere. Analysis of the dispersion pattern in local and global scales – measurement techniques. Ambient air quality and emission standards. Control principle – removal of gaseous pollutants and SPM by various methods.

Water pollutants – analysis and treatment of waste water. Solid waste management. Environmental aspects.

Environmental impact assessment – socioeconomic considerations – ecological balance. Environmental management and auditing.

Pollution caused by different types of power plants – monitoring and abatement.

PG / PE / T/ 1210C Experimental Techniques and Simulation

Experimental Techniques: Basic principles of experimental analysis-error analysis – principles of basic instrumentation schemes used in engineering. Flow visualization technique, measurement of flow, velocity, temperature discharge in a fluid flow. Hot wire, hot flow and laser-Doppler anemometer. Experiments on fluid flow measurement. Measurements on heat and mass transfer.

Modelling and Simulations: Modelling of physical systems – off-line and on-line estimation of parameters – f-response techniques. Estimation of parameters of power system elements. Signal flow graphs of dynamic systems, decomposition, state variable represenatation. State transition matrix – analog, digital and hybrid simulation. Simulation languages: TUTISM, CSMP etc. Data modeling and identification – large scale dynamic systems – reduced order modeling. Application to power plants and systems.

Alternately, from the inter-disciplinary basket of ME, EE, IEE and Energy Science.

Category – Sessional Courses

Sessional – I

PG / PE / S / 121 Term Paper Leading to Thesis

Each student will be given a Thesis / Project problem at the beginning of the third Semester. He/She will work on the literature survey, set scope of work, find stages of completion, experimental setup required study site (if experiments can be carried out at industry) and constraints which should be satisfied and submit a report / dissertation. Thesis /Project work will, however, be done in the Third Semester.

Sessional – II

PG / PE / S / 122 Laboratory-II

Third and Fourth Semester

Sessional 1

PG / PE / TH / 21 Thesis Work

Each Student will devote full time in the 2nd Year on Thesis / Project on an assigned research problem or Design /Development work under the supervision of a Faculty Member. He/ She will present a Thesis / Project Report at the end of the Third semester which will be evaluated by a Board Of Examiners consisting of the Supervisor and External Examiner. The Evaluation of the Thesis / Project will be followed by a viva-voce in front of faculty members and other post- Graduate students.

Sessional 2

PG / PE / VV/ 22 Viva – Voce