Text Book:

1. Stanley B. Lipman , C++ primer, Addison Wesley, 1989
2. Bertrand Meyar, Object softwere construction, Prentice Hall, 1988

Reference Book:

1. K.R. Dittrich et al , On object oriented data base system , Springer Verlag , 1991

POWER SYSTEM OPERATION AND CONTROL

PSM 201

L-T-P=4-0-0

Course Outcomes (CO):
Upon successful completion of this course, students should be able :
CO1: To understand the fundamentals of speed governing system and the concept of control areas.
CO2: To impart knowledge on the need of state estimation and its role in the daytoday operation of power system
CO3: To understand system load variations and get an overview of power system operations.
CO4:To attain knowledge about hydrothermal scheduling.
Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3					3		3		
CO2			2	3	3	2			3			
CO3									3	3		
CO4	3		2					3	1	3		

Course Contents:

Unit I
Optimal Generation Scheduling: Power flow scheduling using economic load dispatch, power flow scheduling using Lagrange multiplier method, penalty factor, scheduling with network losses, hydrothermal coordination with and without losses, cascaded and pump storage plant scheduling, unit commitment, unit commitment solution methods, introduction to optimal power flow solution using Newton Raphson method
Unit II
Automatic Generation Control: Types of alternator exciters, automatic voltage regulators for generator excitation control, static and dynamic performance of AVR loop, automatic load frequency control, primary automatic load frequency control loop, secondary automatic load frequency control loop, extension of automatic load frequency control loop to multi area systems, tie line power flow model
Unit III

Power System Security: Security analysis, security assessment, contingency analysis, algorithm to determine system security following contingency analysis procedure, security assessment using ac power flow model, security analysis using concept of performance index

Unit IV

State Estimation and load forecasting: Methods of state estimation – least square and weighted least square estimation, bad data detection and suppression of bad data, load forecasting, load forecasting techniques – methods of extrapolation and correlation, estimation of average and trend terms of deterministic part of load – limitation of the method, prediction of deterministic load, generalized load modeling, estimation of periodic components, estimation of stochastic part of load – time series approach

Text Book:

1. Power System Analysis, Operation and Control, Abhijit Chakrabarti and Sunita Halder PHI

Reference Book:

1. Power Generation Operation and Control, Allen J. Wood, Bruce F. Woolenburg

POWER SYSTEM INSTRUMENTATION

PSM 202

L-T-P=4-0-0

Course Outcomes (CO):

Upon successful completion of this course, students should be able :

CO1: TO differentiate the various types of thermodynamic cycles, Draw block diagram and describe the operation of thermal power plant with auxiliary equipments.

CO2: Clarify the operation of hydro power plants with layout, Select and governing the water turbines.

CO3: To understand system load variations and get an overview of power system operations.

CO4:To attain knowledge about hydrothermal scheduling.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		3		3		2	2		
CO2	2	2			3		3		2			3
CO3	3	3					2			1		3
CO4	3	3			3			3		1		

Course Contents:

Unit I

Introduction: Power generating Station – Thermal, Hydel, Nuclear, Wind – Their functional characteristics as processes, Components of power Grid – interdependency between different blocks, Review of Mechanical, Electrical, Electronics, Thermal, Optical, Pneumatic, fluidics

Unit II

(a) Coal handling plant – coal feed rate measurement, determination of calorific value.
(b) Water treatment
(c) Boiler – Feed water, pressure, temperature, steam flow rate, flue gas analysis, optical pyrometer
(d) Turbine – Speed, shaft eccentricity, temperature
(e) Condenser – pressure, temperature
(f) Generator – Speed, hydrogen leakage
(g) Control and protection systems of a thermal power plant. (h) Thermal power generation from nuclear reactor.
(i) Ash handling and pollution control

Unit III

Hydel Power Plant: Types - flow rate, Water pressure
Wind Power: Principles – synchronization with grids
Transformer: Transformer oil, hot spot, moisture detection,
Transmission Lines: Fibre optics meter for high voltage and high current measurement, Transmission line sag measurement using triangulation technique.

Unit IV

Tariff: Objective, Available based tariff, Digital energy meter, Remote terminal unit (RTU)
Local Dispatch Centre: Data handling – Processing, Logging, Acquisition, Accounting, Display and Storage, SCADA, Techniques of Data acquisition at Central Load Dispatch Centres for coordinated control of the grid.
Computer Control of Power Plant:
IS specification: Introduction, Application and Relevancy of IS specification in perspective of power system instrumentation

Text Book:

1. Modern Power Station Practice – Vol: C, Vol: D, Pergamon Press
2. Principles of Industrial Instrumentation - D Patranabish, TMH, New Delhi

Reference Book:

1. Industrial Instrumentation Control and Automation – S Mukhopadhyay, S.Sen, A. Deb – Jaico Publishing House, Mumbai.
2. B. G. Liptak, Instrument Engineers Handbook, Chilton Book Co. Philadelphia

ADVANCED POWER SYSTEM PROTECTION

PSM 203

L-T-P=4-0-0

Course Outcomes (CO):
Upon successful completion of this course, students should be able :
CO1:TO illustrate concepts of transformer protection.
CO2: familiarize the concepts of Generator protection and Numerical protection.
CO3: To attain knowledge about Distance and Carrier protection in transmission lines.
CO4:To attain a basic knowledge on substation automation.
Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		3			3	3	3		
CO2	2			2					3			3
CO3			2							3		3
CO4	3	3			2			3		3		

Course Contents:

Unit I
Introduction: Protective Relays; Basic requirements and type of protection, reviews of relay characteristics and operating equations, protective CTs, PTs, , phase and amplitude comparator, classification of Electromagnetic relays, Plug Setting Multiplier and Time Multiplier setting, Universal Torque Equation, Non Directional Relay, Directional relay, Distant relay, Differential relay.
Unit II
Protection of Alternators: Protection against Stator fault (Phase to Phase and Phase to Ground), Balanced earth fault protection, Stator inter turn protection, Unbalanced loading of Alternator, Prime Mover failure, Overvoltage protection, Overloading (or over current) Protection, Restricted Earth fault and standby earth fault protection, Rotor Fault Protection.
Protection of Transformer: Overcurrent and unrestricted Earth fault protection, Different CT connections, Balanced (Restricted) earth fault protection, Harmonic restraint, Frame leakage protection
Unit III
Bus bar, Feeder, Transmission line Protection: Bus bar Protection: Circulating Current Protection, Frame Leakage Protection. Feeder protection: Time Graded protection, Differential Protection. Transmission Line Protection: Introduction to distance relay, Simple Impedance relay, Reactance relay, Mho relays, comparison of distance relay – Choice between Impedance, Reactance and Mho relay, High speed Impedance relay, setting of distance relays. Pilot Relaying Schemes: Wire Pilot Protection, Carrier Current Protection
Unit IV
Static Relay Introduction: Basic construction of static relays, advantages and disadvantages of Static Relay, different types of static relays (static over current, static time over

current, static instantaneous over current, directional static over current, static differential and static distance relay) comparators and associated elements, system switching and transient effects.

Unit V

Protection of High Voltage Capacitor Bank: Including consideration of inrush current, over current and over voltage, and differential protection scheme.

Protection Of large Motors: Differential protection, Earth fault Protection, Thermal overload protection, Starting and Stalling currents and effect of negative Sequence current.

Digital Relay: Introduction, protection philosophy, basic hardware and protection schemes, protection algorithms, and microprocessor based digital relaying

Text Book:

1. A. Chakrabarti,M.L. Soni, P. V. Gupta, U. S. Bhatnagar "A text book on Power System Engineering", Dhanpat Rai and Co.
2. Paithankar.Y.G and Bhide.S.R, "Fundamentals of Power System Protection", Prentice-Hall of India.
3. Badri Ram and Vishwakarma.D.N, "Power System Protection and Switchgear", Tata McGraw- Hill Publishing Company,2002.
4. Arun K. Phadke, James. S. Thorp, "Computer relaying for Power system", John Wiley and sons, New York, 1998

Reference Book:

1. Power System Protection, PM Anderson, IEEE Press Book
2. Protective Relays Application and Guide, GEC Measurements
3. Jones D., " Analysis and protection of electrical power systems", Pitman Publishing, 1971.
4. "Power system reference manual, Ray rolls protection", Orient press, 1982.
5. Stanley H., Horowitz (ED), "Protective relaying for power system", IEEE press, 1980

POWER SYSTEM TRANSIENTS

PSM 204 (A)

L-T-P=4-0-0

Course Outcomes (CO):

Upon successful completion of this course, students should be able :

CO1: To Explain the concept of transients and Compute the solution of transient current equation for RL and RLC system.

CO2: To Apply the concept of reflection and refraction, Draw the Bewley Lattice diagram for different systems.

CO3: To Illustrate the importance of switching transients, Explain the concept of resistance switching, load switching and capacitance switching.

CO4: To analyze the concept of short line (or) Kilometric fault and justify the EMTP for transient computation.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3		3		3	3	3	
CO2	3	2	3		3	3	3		2		3	3
CO3	3	3	2				2			1	1	1
CO4	3	1			3	2	3	2		3	3	

Course Contents:

Unit I
Introduction and survey: Review of various types of power system transients – effect of transients on power systems –relevance of the study and computation of power system transients

Unit II
Lighting surges: Electrification of thunderclouds – lightning current surges – lightning current parameters and their values – stroke to tower and midspan – induced lightning surges
Switching surges: Closing and reclosing of lines – load rejection – fault initiation – fault clearing – short line faults – Ferro –resonance – isolator switching surges – temporary over voltages – surge on an integrated system – switching – harmonics.

Unit III
Computation of transient in conversion equipment: Travelling wave method – Beweley's Lattice diagram – analysis in time and frequency domain – eigen value approach – Z-transform – EMTP software

Unit IV
Insulation coordination: Over voltage protective devices – shielding wires, rods gaps and surge diverters, principles of insulation co ordination-recent advancements in insulation co ordination – design of EHV system.

Text Book:

1. Allan Greenwood, Electrical transients in Power Systems, Wiley Interscience, New York, 1971.
2. Klaus Ragaller, Surges in High Voltage Networks, Plenum Press, New York, 1980.
3. Diesendrof W., Over Voltages On High Voltage Systems, Renselaer Bookstore, Troy New York, 1971.

Reference Book:

1. Peterson H.A., transients in power systems, Dover Publications, New York, 1963.
2. Rakosh Das Begamudre, Extra High VoltageAC Transmission Engineering, Wiley Estern ltd, New Delhi, 1990

FLEXIBLE AC TRANSMISSION SYSTEM

PSM 204 (B)

L-T-P=4-0-0

Course Outcomes (CO):
Upon successful completion of this course, students should be able :
CO1: To explain the reactive power control in electrical power transmission lines and the importance of FACTS devices.
CO2: To understand the need for control of Real and Reactive power flows.
CO3: To Outline the operation, modeling and applications of TCSC
CO4: To Evaluate the performance and stability of power systems with FACTS controllers**.**
Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		3	3		3			3		
CO2	3	3			2		2				3	
CO3	3	2					2			1	3	
CO4	2	3			3		3			2		

Course Contents:

Unit I
Introduction: FACTS – a toolkit, basic concepts of static VAR compensator, Resonance Damper, thyristor controlled series capacitor, static condenser, phase angle regulator and other controllers.

Unit II
Series compensation schemes: Sub-synchronous resonance, torsional interaction, torsional torque, compensation of conventional, ASC, NGH damping schemes, modeling and control of thyristor controlled series compensators.

Unit III
Unified power flow control: Introduction, Implementation of power flow control using conventional thyristors, Unified power flow concept, Implementation of unified power flow controller. Phasor Monitoring Units; Power System Control using Synchrophasors.
Unit IV

Design of facts controllers: Approximate multi-model decomposition, variable structure FACTS controllers for power system transient stability, non-linear variable-structure control, variable structure series capacitor control and variable structure resistor control.

Unit V

Static var compensation: Basic concepts, thyristor controlled reactor(TCR), Thyristor Switched Reactor(TSR), Thyristor Switched capacitor(TSC), saturated reactor(SR), fixed capacitor(FC).

Text Book:

1. Narin G. Hingorani, Flexible AC transmission, IEEE Spectrum, April 1993, pp40-45
2. Narin G. Hingorani, High Power Electronics and flexible Ac Transmission systems, IEEE High Power Engineering Reiview, 1998.

Reference Book:

1. Gyugyi L., Unified Power Flow Control Concept For Flexible Ac Transmission, IEEE Proc-C Vol.-139, No.-4 July, 1992

ADVANCED ELECTRICAL DRIVES

PSM 204 (C)

L-T-P=4-0-0

Course Outcomes (CO):

Upon successful completion of this course, students should be able :

CO1: To explain Power devices and Motor Drive.

CO2: To understand Speed control of Induction motor (IM) drives, Vector control of IM, Direct torque control (DTC) of induction motor drives.

CO3: To apply their knowledge to prepare control schemes as per different types of motors used in industries.

CO4: To estimate & solve harmonic and power factor related problems in controlling AC and DC drives.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		3	3		3			3	3	
CO2	2						3				3	3
CO3							3					3
CO4	3	2					2	3		1		

Course Contents:

Unit I

Power devices and Motor Drive: An introduction to modern electrical drives, Power devices and their switching , Electric machines, Power converters , controllers and load

Unit II
Reference frame theory and transformation: Three phase transformation, abc-axis to dq-axis transformation, space vector and transformation

Unit III
Modeling and Control of DC Machines: Electromechanical modelling, state-space modeling Block diagram and transfer function, Control of separately excited dc motor drives for Inner current loop and speed control design

Unit IV
Speed control of Induction motor (IM) drives: V/f control, dq0 model and state space model of three phase IM, Vector control of IM, Direct torque control (DTC) of induction motor drives, Comparison of DTC and Vector control

Unit V
Brushless DC motor drives and an introduction to Microcontroller based control of electrical drives: Brushless DC motor drives, Introduction of Microcontroller and DSP based control of electrical drives and some industrial applications

Text Book:

1. B.K. Bose: Modern Power Electronics and AC Drives, 1st Edition, Pearson, 2002

Reference Book:

1. R. Krishanan: Electric Motor Drives Mode

ADVANCED CONTROL SYSTEM

PSM 205 (A)

L-T-P=4-0-0

Course Outcomes (CO):
Upon successful completion of this course, students should be able :
CO1: To Develop mathematical models of physical systems.
CO2: To represent the time-invariant systems in state space form as well as analyze, whether the system is stabilizable, controllable, observable and detectable.
CO3: To Use the techniques such as describing function, Lyapunov Stability, Popov's Stability Criterion and Circle Criterion to assess the stability of certain class of non-linear system.
CO4: To Design complex nonlinear systems with linearization.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		3			3			3	3	
CO2	3						2	3			1	3
CO3	3						1		2			3
CO4	3	3		3			3	3		3		

Course Contents:

Unit I
Overview of Control Systems: LTI Motion Control System; Temperature & Voltage Regulators; Modeling of Servo-motors, Hydraulic & pneumatic actuators. Computation of Relative stability using Bode plot and Nyquist method. Hierachical Control Of Power System; System Control; Load scheduler and Optimiser; Real Reactive power Flow Control; AVR and Turbine Speed governor set points
Unit II
Control System Performance: Improvement of System Performance through Compensation; Design of lag; Lead and Lag load Compensators; PI, PD & PID control; PID Controller Design and tuning; Disturbance rejection; System Uncertainty and performance Robustness.

Unit III
Analysis in state space: State model for SISO & MIMO Systems; State Diagram; Solution of state equation; State Transformations; Jacobian Linearization Technique; Stability; Controllability & Observability; Perspective on State-Space design; Full-State Feedback Design of continuous time control system; Full Order observer System**.**
Unit IV
Digital Control system: Configuration of Digital Control System; Supervisory Control; Direct digital control; Single-Loop Digital controllers; Sampling Process; Sampling theorem; Data reconstruction; Digital transfer function & System response; Stability Tests ; Mapping between s-plane & z-plane; Bilinear transformation; Error constants; Pole assignment design based on full state feedback; Compensator design in w-plane using Bode plot
Unit V
Common non-linearities ; Methods of Analysis; Linearization; Phase Plane method; Describing function Analysis; Limit Cycles; Relay with dead-zone and hysteresis; Stability analysis by Lyapunov's methods
Optimal Control: Characteristics of optimal control problems; Linear optimal Control with quadratic performance index; Selection of performance measure; State and Output regulators; Optimal state regulator problem with matrix Ricatti equation
Text Book:
1. Ogata, k – modern control engineering, p.h learning.
2. Kuo, b.c – automatic control systems, prentic hall.

Reference Book:
1. Gopal, m – digital control and state variable methods, tata mcgraw –hill.

MODELING AND SIMULATION OF DYNAMIC SYSTEMS

PSM 205 (B)

L-T-P=4-0-0

Course Outcomes (CO):
Upon successful completion of this course, students should be able :
CO1: To Develop mathematical models of physical systems.

CO2: To represent the time-invariant systems in state space form as well as analyze, whether the system is stabilizable, controllable, observable and detectable.

CO3: To Use the techniques such as feedback control, industrial regulation, feed forward control.

CO4: To use Sensor modeling techniques , application of Finite Element method.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		2			3					
CO2	3	1	3	2			3					
CO3	3	3	3	2			3					
CO4	3	3		3			3					

Course Contents:

Unit I

Introduction, State space representation of systems of different kind.Simulation of the state model.Describing equations and different kinds of models.Eigen values and vectors, Similarity X'formation, invariants.Stability, controllability, observability, Leverrier's algorithm. Linearization of nonlinear systems

Unit II

Theorem on feedback control, pole placement controller. Full order and reduced order observer design. Theory of industrial regulation, feed forward control. Application - motor speed control with disturbance rejection.

Unit III

Heat flow in one dimension, finite element method. Modeling and simulation through bond graphs. Qualitative reasoning: M & S with Incomplete Knowledge

Unit IV

Sensor modeling: Lumped parameter and distributed parameter models, Thick and thin film models. Numerical modeling techniques, model equations, application of Finite Element method. Different effects on modeling - temperature, radiation, mechanical, chemical, magnetic, electrical (e.g. capacitive, resistive, piezo-resistive, frequency, etc.). Examples of modeling: micro-modeling of photodiodes, magnetic, capacitive, mechanical sensors.

Text Book:

1. D M Wiberg State Space and Linear Systems Schaum's Outline Series McGraw Hill 1971
2. 2. W B J Zimmerman Process Modeling and Simulation with Finite Element Methods Univ. of Sheffield UK 2004

Reference Book:

1. Thomas Kailath Linear Systems Prentice Hall 1980
2. M Gopal Modern Control System Theory Wiley Eastern 1984

ADVANCED MICROPROCESSOR AND MICROCONTROLLER

PSM 205 (C)

L-T-P=4-0-0

Course Outcomes (CO):
Upon successful completion of this course, students should be able :
CO1: Through this course, the students will be exposed to hardware details of 8085 microprocessor with the related signals and their implications.
CO2: To Analyze the architecture of various Interfacing Devices like 8255 PPI, 8259 PIC, ADC and DAC and Programming of all the Interfacing IC's.
CO3: To Microprocessor based Voltage, Current, Power and Speed measurement.
CO4: To Microcontroller Architecture, Organization and Programming Techniques.
Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		3			3					
CO2	3	3		3			1	1	1			
CO3	3	2	2	2			2		2			
CO4	3	3	3	1			3	3				

Course Contents:

Unit I
Introduction: Review of Intel 8085 and 8086 – Architecture and Organization
Components and functions: Execution Unit, Bus Interface Unit, Registers, Minimum and Maximum Mode of Operation, Bus Arbiter, Interrupt Structure, Interrup Vector Table, I/O Ports, Experimental identification of Ports and Pins.
Unit II
Peripheral devices: PPI 8255, Mode 0, Mode 1, Mode 2 and BSR Mode. Interrupt Controller, DMA Controller, ADC, DAC
Development of waveforms: Square, Triangular, Ramp, Staircase, Sine wave.
Relays: Microprocessor based Electromagnetic Relays, IDMT, Differential Relay.

Unit III
Instrumentation & protection (smart grid): Microprocessor based Voltage, Current, Power and Speed measurement, Frequency Monitoring, Overvoltage, Undervoltage, Overcurrent and Undercurrent protection, Speed Control of Motors, Traffic Light Controller, Washing Machine Controller
Unit IV
Microcontroller: Architecture, Organization and Programming Techniques
Text Book:

1. A. K. Mukhopadhyay - Microprocessor, Microcontroller and their Applications, Narosa Publishing / Alpha Publication, Oxford University
2. Microprocessor and Microcontroller – Gaonkar

Reference Book:

1. A. K. Mukhopadhyay – Microprocessor based Laboratory experiments and Projects, I. K. International

BASICS OF PEDAGOGY AND ACADEMIC MANAGEMENT

EMM 301

L-T-P=4-0-0

Course Outcomes (CO):
Upon successful completion of this course, students should be able :
CO1: To Use the collaborative learning into a course in a way that aligns with students learning objectives and intended outcomes.
CO2: Develop knowledge, Understanding and an insight of the various underlying concepts of research.
CO3: To understand Research designs , tools and techniques of gathering data.
CO4: To understand Academic Institution Management, Quality-concept-deciphering, PERT, CPM – SWOT Analysis.