ELECTRICAL ENGINEERING
Syllabus for
M. Tech. Control & Instrumentation AND Power Electronics & Drives

CI-101  Advance Control Systems

Max. Marks: 100  Time: 3 hours  L  T  P
3  1  2

Analysis: Dynamic system modeling, State space model of dynamical system in continuous time and discrete time; Solution of continuous time state equation- similarity transformation; Cayley Hamilton approach and inverse Laplace approach; Solution of discrete time state equation.

Discrete-Time Systems:
Controllability and Observability: General concepts, controllability and observability test for continuous time and discrete time system; test for continuous and discrete time systems; Stabilizability and detectability- definition and tests; Loss of controllability and observability due to sampling; Controllable and observable canonical forms.

Controller/Observer Design: Pole placement technique; Ackerman’s approach and linear quadratic regulator for continuous time and discrete time systems; Full order and reduced order observer designs.

CI-102  Optimal Control

Max. Marks: 100  Time: 3 hours  L  T  P
3  1  0

Dynamic system optimization, calculus of variations; Euler equation, Finite & Infinite horizon problems; Optimal system performance indices; Hamiltonian, Matrix Riccati Equation; HJB, LQR, LQG, optimality principle, Potryagin’s principle, constrained and unconstrained input; Kalman filter; Dynamic programming, discrete and continuous-time.

CI-103  Advance Microprocessors and Applications

Max. Marks: 100  Time: 3 hours  L  T  P
3  1  2

Introduction to Microprocessors and Microcontrollers  Review of basics microprocessor, architecture and instruction set of a typical 8 bit microprocessor. Overview of 16 bit and 32 bit microprocessors, arithmetic and I/O coprocessors. Architecture, register details, operation, addressing modes and instruction set of 16 bit 8086 microprocessor, assembly language programming, introduction to multiprocessing, multi-user, multitasking operating system concepts, Pentium-1,2,3 and 4 processors, Motorola 68000 processor. Concepts of micro controller and micro computer, microcontroller (8051/8751) based design, applications of microcomputer in on line real time control

Input-Output Memory Interfacing
Parallel and series I/O, Interrupt driven I/O, single and multi interrupt levels, use of software polling and interrupt controlling for multiplying interrupt levels, programmable
interrupt controller, DMA controller, programmable timer/counter, programmable communication and peripheral interface, synchronous and asynchronous data transfer, standard serial interfaces like Rs.232. Types of Memory, RAM and ROM interfacing with timing considerations, DRAM interfacing

**Programmable Support Chips**

Functional schematic, operating modes, programming and interfacing of 8255, 8251, 8259 and 8253 with microprocessor.

**Analog Input & Output**

Microprocessor compatible ADC and DAC chips, interfacing of ADC and DAC with microprocessor, user of sample and hold circuit and multiplexer with ADC.

**Microprocessor Applications:**

Design methodology, examples of microprocessor applications.

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**CI-104  Advance Measurement & Instrumentation Technology**

Max. Marks: 100  Time: 3 hours  L  T  P  3  1  2

Functional elements of measurement systems, Performance characteristics (static/dynamic) of measurement system, Concept of generalized measurement system. Generalized static stiffness and input-output impedance, Error analysis, uncertainty, Histogram, normal distribution, Standards & Echelon labs. Analog measuring instruments, general features, design of sprigs, pivot/jewel, Ammeters, voltmeters, wattmeter, frequency meter, energy meters. Measurement of parameters R, L & C.

Transfer function and frequency response of zero, first and second order measurement system.

Classification of Instrumentation Transducer. Analog/digital, active/passive, Variable Resistance transducers. Measurement of non electrical parameters, displacement, velocity, acceleration, pressure, force, temperature, humidity, moisture level control/monitoring, Potentiometers, strain gauges, Special Transducers: Piezoelectric, Electromagnetic transducers, Smart Sensors.


Signal Display/Recording systems. Graphic display systems, storage oscilloscope, LED, LCD, Recorders. Microprocessor based measurement & instrumentation schemes.

**PE-101  Power Converter- I**

Max. Marks: 100  Time: 3 hours  L  T  P  3  1  2

**Power Semiconductor Devices:** Structure, Characteristics, ratings and protection of SCR, triac and Gate Turn Off Thyristor.

**Line Commutated Converters:** Single and three phase fully controlled and half controlled converters, performance characteristics, effect of source inductance,
discontinuous current operation, inverter operation, power factor improvement techniques, sequence control, 12-pulse converters, dual converter, triggering circuits.

**AC Voltage Controllers:** Single phase AC voltage controllers feeding resistive and resistive-inductive loads, sequence control, three phase AC voltage controllers.

**Cyclo-Converter:** Single phase and three phase cyclo-converters, circulating and non-circulating current operations, performance characteristics, control of harmonics, voltage and frequency control, control circuit.

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**Fundamentals of Electric Drives**

Max. Marks: 100  
Time: 3 hours  
L T P  
3 1 0

Basic drive components, classification and operating modes of electric drive, nature and types of mechanical loads, review of speed-torque Characteristics of electric motors and load, joint speed-torque characteristics, plugging, dynamic and regenerative braking of dc and ac motors, Equation of motion, equivalent system of motor-load combination, stability considerations, electro-mechanical transients during starting and braking, calculation of time and energy losses, optimum frequency of starting. Electric traction services, duty cycle of traction drives, calculations of drive rating and energy consumption, desirable characteristics of traction drive and suitability of electric motors, control of traction drives. Losses in electric drive system and their minimization energy, efficient operation of drives, load equalization. Heating and cooling of electric motors, load diagrams, classes of duty, reference to Indian Standards, estimation of rating of electric motors for continuous, short time and intermittent ratings. Servo motor drive, stepper motor drive, linear induction motor drive, permanent magnet motor drive. Selection criteria of electric drive for industrial applications, case studies related to steel mills, paper mills, textile mills and machine tool etc.

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**Modeling, Simulation, and Evolutionary Techniques**

Max. Marks: 100  
Time: 3 hours  
L T P  
3 1 2

**Modeling:** Model classification, Mathematical, physical and analog models, Estimation of model parameters.

**Simulation:** experimental nature of simulation, steps involved in simulation studies, Validation of simulation models, computer simulation of continuous & discrete systems.

**Evolutionary Techniques:** Neural networks, Fuzzy logic systems, Genetic algorithms, Hybrid systems etc. and their applications.

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**Nonlinear Systems & Adaptive Control**

Max. Marks: 100  
Time: 3 hours  
L T P  
3 1 0

**Nonlinear Control Systems:** Nonlinear models, equilibrium points, linearization of nonlinear models, separable nonlinearities; Describing function analysis, describing function of common nonlinearities; Stability analysis by describing function method;
Phase plane analysis of nonlinear systems; Bang-Bang control system; Feedback linearization.

**Stability Analysis:** Stability concepts, stability definition in the sense of Lyapunov; Stability of continuous and discrete time linear systems; Stability of nonlinear systems; Lyapunov stability and instability theorems; Lyapunov’s direct method for continuous and discrete time systems; Lyapunov function for nonlinear systems.

**Adaptive Control:** adaptive systems, MRAC, STR, dual control; System identification; model predictive control; sliding mode control; H-infinity control; Applications.

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**CI-203 Biomedical Instrumentation**

**Max. Marks:** 100  
**Time:** 3 hours  
**L T P**  
3 1 0

Introduction to Bio medical instrumentation and its development, anatomy and physiology. Biopotentials, Transducers and Electrodes: Different types of transducers and their selection for biomedical applications, Electrode theory, Different types of electrode Hydrogen Calomel, Ag-Agcl, Ph, Po2 Pco2 electrodes, selection criteria of electrodes.

Cardiovascular system and measurement: The heart and other cardiovascular systems, Measurement of Blood pressure, Blood flow, Cardiac output and cardiac rate, Electrocardiography, Phonocardiography, Plethysmography, Cardiac pace-maker, defibrillator.


Computer application in bio medical engineering, Medical Imaging: Ultra sound Imaging, Radiography, MRI, Electrical tomography & applications.


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**PE-201 Power Converter - II**

**Max. Marks:** 100  
**Time:** 3 hours  
**L T P**  
3 1 0

**Power Semiconductor Devices:** Structure, characteristics and ratings of Power Transistor, MOSFET, Insulated Gate Bipolar Transistor (IGB) and MOS – Controlled Thyristor (MCT), drive and snuber circuits.

**DC-DC Converters:** Review of chopper fundamentals, Step down chopper with resistive and resistive-inductive loads with continuous and discontinuous current operations, step up chopper, commutation techniques, impulse commutated and resonant pulse choppers, multiquadrant and multiphase choppers.

**DC-AC Inverters:** Single phase and three phase voltage source and current source inverters, commutation methods, voltage and frequency control, harmonics reductions.
Resonant Inverters: Classification, series and parallel resonant inverters, load resonant inverters, zero voltage switching and zero current switching resonant inverters, resonant dc link inverters.

PE-202 Power Semiconductor Controlled Drives

Max. Marks: 100
Time: 3 hours
L T P
3 1 2

Solid state controlled electric drive-Concept, elements and salient features, power converter motor system, closed loop control of electric drives, sensing of speed and current, performance parameters. Control of D.C. separately and series excited motor drives using controlled converters (single phase and three phase) and choppers, static Ward-Leonard control scheme, solid state electric braking schemes, closed loop control of solid state DC drives. Operation of induction and synchronous motor drives from voltage source and current source inverters slip power recovery, pump drives using AC line controllers, self controlled synchronous motor derives, brushless DC motor drive, switched reluctance motor drive. Function of microprocessor in electric drive control, salt features of microprocessor control microprocessor based control scheme for D.C. induction and synchronous motor drives, applications.

Elective - I

PE-203 Modeling and Simulation of Power Electronic Circuits

Max. Marks: 100
Time: 3 hours
L T P
3 1 2

1. Simulation Tools: General overview and understanding of SPICE/PSPICE and MATALB SIMULINK softwares.
3. Simulation of Power Electronic Circuits: Simulation and design of converters, choppers, ac voltage controllers, inverters and cycloconverters.

PE-204 Power System Planning & Optimization

Max. Marks: 100
Time: 3 hours
L T P
3 1 0

Introduction to restructuring of power industry, Ancillary services management, Electricity pricing mechanism in competitive electricity market, Fundamental of Economics, concepts of FACTS devices, planning & optimization concepts in generation, transmission and distribution systems. Quantitative methods of long and short term planning, Reactive Power management, optimal power flow and cost criteria.
PE-205  FACTS Devices

Max. Marks: 100  
Time: 3 hours  
L  T  P  3 1 0

Basics of flexible AC transmission systems, Tap changers and phase shifters, Thyristor controlled VAR compensation and series compensation, Modern (synchronous link converter) VAR compensators, Unified power flow controller (UPFC), Interline power flow controller, Static Synchronous Series compensator (SSSC), Generalized Unified Power Flow Controller (GUPFC), quality conditioners.

PE-206  Special Electric Machines

Max. Marks: 100  
Time: 3 hours  
L  T  P  3 1 0

Generalized AC and DC machines, Poly-phase AC Machines, Two Phase AC Servomotors: Construction, torque-speed characteristics, Scharage motors.
Stepper Motors: Principle of operation, variable reluctance, permanent magnet and hybrid stepper motors, characteristics, drive circuits and applications. Switched Reluctance Motors: Construction; principle of operation; torque production, modes of operation, drive circuits.
Permanent Magnet Machines: Types of permanent magnets and their magnetization characteristics, demagnetizing effect, permanent magnet dc motors, sinusoidal PM motors, brushless dc motors and their important features and applications, PCB motors. Single phase synchronous motor; construction, operating principle and characteristics of reluctance and hysteresis motors; introduction to permanent magnet generators. Single Phase Commutator Motors, Universal and Repulsion motors.

CI-204  Digital Control Systems

Max. Marks: 100  
Time: 3 hours  
L  T  P  3 1 0


CI-205  System Reliability

Max. Marks: 100  
Time: 3 hours  
L  T  P  3 1 0

Reliability: Definition and basic concepts, Failure data, failure modes and reliability in terms of hazard rates and failure density function. Hazard models and bath tub curves. Applicability of Weibull distribution.

Maintenance: Objectives, Types of maintenance, preventive, condition based and reliability centered maintenance. Terotechnology and total productive maintenance (TPM).

Maintainability: Definition, basic concepts, Relationship between reliability, maintainability and availability; corrective maintenance time distributions and maintainability demonstration. Design considerations for maintainability. Introduction to life-testing-estimation of parameters for exponential and Weibull distributions, component reliability and MIL standards.

**CI-206 Operation Research**

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**Linear Programming:** Graphical LP solution, simplex method, Big M method, two phase method, degeneracy, alternate optima, unbounded optimal solutions, infeasible solutions, duality and sensitivity analysis- dual simplex method, primal dual computations

**Transportation Problems:** Determination of starting solution iterative computations of lanation.

**Integer Programming:** Branch and bound method, zero-one implicit enumeration algorithm, cutting plane algorithm.

**Probabilistic Decision Making:** Decision making under risk, probabilistic dynamic programming.

**Inventory Models:** Static EOQ models, EOQ with price breaks, multi-item EOQ with storage limitation, dynamic EOQ models.

**Game Theory:** Optimal solution of two person zero sum game, solution of mixed strategy games.

**Queueing Theory:** Role of exponential distribution, pure birth and death models, generalized Poission queuing model, specialized Poission queues.

**Project Scheduling by CPM/PERT:** Network representations, critical path computations, construction of time schedule.

**CI-207 Neural Networks and Fuzzy Systems**

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**A. Neural Networks:**

1. **Basics:** Simple neuron, nerve structure and synapse, concept of neural network multilayer nets, auto-associative and hetero-associative networks; neural network tools (NNTs), artificial neural network (ANN) and traditional computers.

2. **Neural Dynamics:** Neurons as functions, neuronal dynamic systems, signal functions, activation models.

3. **Synaptic Dynamics:** Learning in neural nets, Unsupervised and supervised learning, signal hebbian learning, competitive learning, differential, hebbian learning, differential competitive learning, single layer perception models, the back propagation algorithm.
4. **Applications**: Applications in load flow study, load forecasting, detection of faults in distribution system and steady state stability, neural network simulator, applications in electric drive control.

**B. Fuzzy System:**

5. **Basics**: Fuzzy sets and systems, basic concepts, fuzzy sets and crisp sets, fuzzy set theory and operations, fuzzy entropy theorem, fuzzy and crisp relations, fuzzy to crisp conversions.


7. **Applications**: Fuzzy control system design and its elements, fuzzy logic controller, applications of fuzzy control in electric drive, power system, measurement and instrumentation.

**Elective - II**

**PE-301 Non Conventional Energy Resources**

Max. Marks: 100  
Time: 3 hours  
L T P 3 1 0

Various no-conventional energy resources; Introduction, availability, classification, relative merits and demerits. Theory of solar cells, solar cell materials, solar cell power plant, limitations. Solar radiation, flat plate collectors and their materials, applications and performance, focusing of collectors & their materials, applications and performance, solar thermal power plants, thermal energy storage for solar heating and cooling, limitations.

**Geothermal Energy**: Resources of geothermal energy, thermodynamics of geothermal energy conversion-electrical conversion, non-electrical conversion, environmental considerations.


**Thermo-electrical and thermionic conversions**: Principle of working, performance and limitations.

**Wind Energy**: Wind power and its sources, site selection criterion, momentum theory, classification of rotors, wind characteristics, performance and limitations of energy conversion systems.

**Bio-mass**: Availability of bio-mass and its conversion theory.

**Ocean Thermal Energy Conversion (OTEC)**: Availability, theory and working principle, performance and limitations.

**Wave and Tidal Wave**: Principle of working, performance and limitations, waste recycling plants.
**PE-302  HVDC Systems**

Max. Marks: 100  
Time: 3 hours  
L  T  P  
3  1  0

General aspects of DC transmission, multiterminal DC transmission, introduction to AC-DC system interaction, converter circuits and their analysis, DC link controls, Mechanism of active and reactive power flow control; Basic FACTS controllers: SVC, STATCOM, TCSC, TCPAR, System performance improvement with HVDC link controllers, Harmonics in DC link systems.

**PE-303  Power System Instrumentation**

Max. Marks: 100  
Time: 3 hours  
L  T  P  
3  1  0

Measurement of large currents and voltages, current and voltage transformers, design equations and operational characteristics, error compensation schemes, Protective CTs and PTs, overload and transient performance, standard specification of instrument transformers. DC current transformers, measurement of power and energy, torque equation of induction type energy meter, parasitic torques and their minimization, IS specifications, analog and digital KVAR meters. Tele-metering, remote terminal units, data acquisition systems, tri-vector meters, event and disturbance recorders.

**CI-301  Bio Medical Signal Processing**

Max. Marks: 100  
Time: 3 hours  
L  T  P  
3  1  0

Basic neurology, Cardiac system, Lead systems and electrodes, ECG normal & abnormal, ECG lead positioning, inverse cardiograph, ECG signal conditioning & processing, EEG recording & electrode, EMG signal conditioning & processing, Generation of cochlear potentials and Evoked response, noise & interference in bio electric signals, filtering techniques, active & passive filters, ECG Data compression, Telemetry, Bioinformatics Telemedicine. Speech & audio signal processing.

**CI-302  Digital Signal Processing**

Max. Marks: 100  
Time: 3 hours  
L  T  P  
3  1  0

Review of discrete time signals and systems. Sampling of CT signals: aliasing, prefiltering, decimation and interpolation, A/D and D/A conversion, quantization noise; Z-transforms; Filter design techniques, Structure and design procedure for digital filters, IIR & FIR filters; DFT Computation, Fourier analysis of signals using DFT, Finite register length effects. DSP hardware implementation & applications; FFT analysis, Wavelet transform, windowing: Hamming, Hanning, Kahair etc.
Elective - III

PE-304 Power Quality

Max. Marks: 100

Time: 3 hours

L T P

3 1 0

Power Quality Problems and Monitoring: Introduction, Surges, voltage sag and swell, over voltage, under voltage outage, voltage and phase angle imbalances, electrical noise, harmonics, frequency deviation monitoring.

Solution to Power Quality Problems: Design, measures to minimize the frequency and duration of the outage in the distribution system. Voltage regulators, harmonic filters, power conditioners, uninterruptible power suppliers, emergency and standby power systems, applications of power conditioners.

Minimization of disturbances at Customer site: Power quality related standards, standard test waveforms, power distribution system design, measures to minimize voltage disturbances.

PE-305 Energy Management

Max. Marks: 100

Time: 3 hours

L T P

3 1 0


CI-303 Power System Dynamics & Control

Max. Marks: 100

Time: 3 hours

L T P

3 1 0

Dynamic stability: basic concepts of small oscillations in single and multi machine systems, analysis with V-R and governor control loops and system stablisation, Transient stability, swing curve for single and multiple machine system, V-R and governor effects, Liapunov’s direct method for quick evaluations, Stability problems of HVDC link.

CI-304 Robotics and Automation

Max. Marks: 100

Time: 3 hours

L T P

3 1 0

Robotics: Introduction, direct & inverse kinematics of robot arm dynamics: LE formulation, equation of motion; Robot controller design approaches: computed torque, variable structure, and adaptive control; computer vision, image and video signal processing in robots; applications of robotics etc.

Automation: Introduction to automation, industrial automation and applications, Mechatronics systems.
CI-305 Digital Image Processing

Max. Marks: 100 Time: 3 hours

L    T    P
3    1    0