B. Tech. in ELECTRICAL ENGINEERING

Syllabus of Paper – 1

SIGNALS & NETWORKS

Mathematical Description of Signals: Continuous-Time & Discrete-Time Signal, Energy and Power Signal; Mathematical Description of Systems: Linear Time Invariant Systems& its Characteristics, Convolution Sum, Convolution Integral and their Evaluation, Analysis of LTI Systems based on Convolution and Differential Equations; Fourier Series and Fourier Transform: Fourier Series of Periodic Signals, Continuous and Discrete Time Fourier Transform, Frequency Response of Systems; Sampling: Representing a Continuous-Time Signal by Samples, Shanon's Sampling Theorem, Aliasing; Solving Networks using Super-node and Super-mesh techniques; Network Theorems for Circuits with both Dependent sources; Laplace Transform: Properties, Solutions of Differential Equations with Non-zero Initial Conditions; Network Transients: Laplace Transform based Solution, Frequency Response of R-L-C Series Circuit, Series and Parallel Resonance; Graph Theory and Electrical Circuit Solution; Two-Port Network Analysis.

ELECTRICAL MACHINES-I

Magnetic circuits: Magnetic materials and their properties, Flux linkage, inductance and energy, magnetically induced emf, ac operation of magnetic circuits, electromagnetic force and torque, hysteresis and eddy current losses. Transformers: Construction and practical considerations, No load conditions, ideal transformer, practical transformer and equivalent circuit, losses, testing, the Per Unit system, efficiency, voltage regulation, excitation phenomenon, autotransformers, three phase transformer, parallel operation of transformers, three winding transformers, Scott connection, Tap changing transformers DC Machines: Armature winding and commutator, EMF and Torque, circuit model, armature reaction, compensating winding, commutation, methods of excitation. DC generator: operation characteristics, self-excitation, characteristics, parallel operation. DC motors: starting, speed control, braking, efficiency, testing and dynamics. Applications of DC machines.

ELECTRICAL MACHINES-II

Introduction to rotating machines: Elementary machines, MMF of distributed windings, Rotating MMF wave, generated voltage, Toque in round rotor machine: Synchronous machine, Induction machine, and linear machine. Magnetic Leakage in rotating machines: Leakage in main poles and leakage in armature. Losses and efficiency: Generator and motor. Rating and loss dissipation. Steady state operation of motor-load system. AC armature windings Synchronous machines: Basic model, circuit model, synchronous reactance, Potier method, Armature reaction, synchronizing to infinite bus bar, operating characteristics, efficiency, power flow equations, Two-reaction model, Synchronizing power and torque, Slip test, Parallel operation, hunting phenomenon and starting methods.Induction machines: Construction, principle of operation, Equivalent circuit, air-gap power, output power, torque, determination of circuit model parameters, starting methods, cogging and crawling, Speed control: voltage control and rotor resistance control. Single phase induction motors: Two rotating field theory, toque-speed characteristics, performance analysis, Single phase two winding motors, split phase motor, shaded pole motor, reluctance motor and hysteresis motor.Introduction to Brushless Permanent Magnet motors, Stepper motor, Switched reluctance motor,

POWER ELECTRONICS

Power Semiconductor Devices: power diodes, power transistors, SCRs, TRIAC, GTO, power MOSFETs, IGBTs-Principles of operation, characteristics, ratings, protection and gate drive circuits, dv / dt and di / dt protection, Series and parallel operation of Thyristors. Controlled rectifiers: Single phase and Three-phase, Effect of Source Inductance, Power factor improvement, Dual converter. DC-DC converters: Buck, Boost, Buck-Boost converters with circuit configuration and analysis. Introduction to Zero Voltage Switching and Zero Current Switching. DC-AC converters: Single phase and Three phase; Voltage Source (VSI) and Current Source Inverter (CSI), frequency and voltage control; Pulse Width Modulation Techniques (PWM). Introduction to Multilevel Inverter. AC-AC converter: Single and Three phase controllers, phase control, PWM AC voltage controller, Principle of O N -OFF control and Cyclo-converters.

ELECTRIC DRIVES

Factors affecting selection of drives, speed-torque characteristics of motors and loads, condition of steady-state stability, transient stability: equal area criterion, dynamics of motor load combination, DC shunt motor and series motor braking methods and speed-torque characteristics in four quadrants, Induction motor: steady-state performance analysis, braking methods, four quadrant speed-torque characteristics, dc and ac dynamic braking, Methods of starting, energy relations during starting and braking, Transients in dc and ac drives; Motor and converter performance parameters, 1-phase full- and semi- converter fed dc shunt and dc series motor, Mathematical analysis of 1-phase converter fed dc motors, 1-phase Dual converter: waveforms, operations with and without circulating current, 3-phase full converter, semi converter and dual converter fed dc drives, Power factor considerations of semi- and full converters, Power factor improvement of phase controlled converters, Sequence control of converters, Chopper controlled dc drives; Static speed control of induction motor: stator voltage control, Static control of rotor resistance, Static slip power recovery scheme, VSI and cyclo-converter fed drives, V/f control, constant torque and constant power operations, closed loop V/f control, CSI fed drives; Induction motor behaviour with non-sinusoidal supply and unbalanced supply, PWM inverters and reduction of harmonics, Synchronous motor drives: true and self-synchronous modes, hunting; Brushless dc motor drive, Reluctance motor, SRM, stepper motors; Illumination, electrical heating, furnaces, arc welding, industrial application of motors in steel mills, textile mills, cement mill and paper mills; Electric traction services, nature of traction load, main line and sub-urban train configuration, traction mechanics, traction drives, braking, power factor and harmonics, traction motor.

ANALOG ELECTRONICS

Scope and applications of analog electronic circuits, Amplifier models: Voltage amplifier, Current amplifier, transconductance amplifier and transresistance amplifier. Biasing schemes for BJT and FET amplifiers, bias stability, various configurations(such as CE/CS, CB/CG, CC/CD) and their features, small signal analysis, low frequency transistor models, estimation of voltage gain, input resistance, output resistance etc., design procedure for particular specifications, low frequency analysis of multistage amplifiers. High frequency transistor models, frequency response of single stage and multistage amplifiers, various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues. Oscillators: Review of the basic concept, Barkhausen criterion,RC oscillators (phase shift, Wien bridge etc.), LC oscillators (Hartley, Collpit, Clapp etc.) . Differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and PSRR. OP-AMP design: design of differential amplifier for a given specification, design of gain stages and output stages,

compensation. OPAMP applications: review of inverting and non-inverting amplifiers, integrator and differentiator, summing amplifier, precision rectifier, non-sinusoidal oscillators, Schmitt trigger and its applications. Active filters: Low pass, high pass, bandpass and bandstop, design guidelines. Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string etc. Analog-to-digital converters (ADC): Single slope, dual slope, successive approximation, etc.

Syllabus of Paper – 2

ELECTRICAL MEASUREMENT AND INSTRUMENTATION

Measurement of Electrical Quantities: Standards of Measurement & Errors, Voltmeter, Ammeter, Multimeter, Wattmeter and Energy meter. Measurement of Electrical Elements: Measurement of low, medium and high resistances, insulation resistance measurement AC bridges for inductance and capacitance measurement. Instrument Transformers: Current and Potential transformers, ratio and phase angle errors. Electronic Measurements: Electronic voltmeter, multi-meter, wattmeter & energy meter. Time, Frequency and phase angle measurements using CRO; Spectrum & Wave analyzer. ; Digital counter, frequency meter, voltmeter, multi-meter and storage oscilloscope. ; Instrumentation: Transducers, classification & selection of transducers, strain gauges, inductive & capacitive transducers, piezoelectric and Hall-effect transducers, thermistors, thermocouples, photo-diodes & photo-transistors, encoder type digital transducers, Signal conditioning and telemetry, basic concepts of smart sensors and applications. Data Acquisition Systems.

POWER SYSTEM OPERATION AND CONTROL

Load Flow Analysis: Network equation, Power Flow problem, Gauss-Seidel method, Newton-Raphson method, Decoupled method, Fast Decoupled method. Power System Fault Analysis: Balanced Fault, Fault analysis using Z-bus matrix, Z-bus matrix building algorithm; Symmetrical Component and Unbalanced fault, Sequence impedances of load, transmission lines, transformer and generator, Unbalanced Fault analysis using sequence impedance matrices, Single-line-to-ground fault, Line-to-line fault, Double-line-to-ground fault analysis. Power System Stability: Swing Equation of synchronous machine, Steady-state stability –small disturbances, Transient stability analysis – Equal Area criterion, Application of equal area criterion to sudden increase in power input and to three-phase fault; Numerical solution of nonlinear equation, Numerical solution of swing equation, Transient stability analysis of a multi-machine power system. Optimal Dispatch of Generation: Operating cost of a thermal plant, Economic Dispatch problem, Unconstrained and constrained optimization technique, Economic dispatch neglecting losses, Kron's loss formula, Economic dispatch including losses. Automatic Generation and Voltage Control: Load Frequency control, concept of control area, Proportional plus Integral control, Two-Area load frequency control, Automatic voltage control, Regulator, Exciter modelling, Generator modelling and static performance of AVR loop.

DIGITAL ELECTRONICS

Introduction to Boolean algebra and Switching Function, Boolean minimization. Combinational Logic Design using MSI circuits: Full Adder / Subtractor, BCD Adder, LAC Adder, Decoder, MUX/DEMUX structure, Combinational logic design using ROM array, Integrated Circuits: Difference between combinational and sequential circuits, Flip Flops, Counters, Shift Registers and PLA. ; Analysis and Synthesis of Sequential Circuits: Basic models of sequential M/C, Analysis of Asynchronous and Synchronous circuits, Synthesis of completely and incompletely specified synchronous sequential M/Cs. Finite state machine, state transition diagrams and state transition tables. Design Concepts, Introduction to Cad Tools, Introduction to VHDL. Implementation Technology**:** Transistor Switches, NMOS Logic Gates, CMOS Logic Gates, Negative Logic System, Standard Chips, Programmable Logic Devices, Custom Chips, Standard Cells and Gate Arrays Practical Aspects, Transmission Gates.

MICROPROCESSORS & EMBEDDED SYSTEMS

Overview of Embedded System and Design; The 8085 Microprocessor: Architecture & Programming; Microprocessor Peripheral Interface Controller & I/O interfaces: Memory Interface, Parallel Interfaces for Signal Acquisition, User Interface (Keyboard & Displays), Serial Communication Protocol & Interface, Programmable Interval Timer, Programmable Interrupt Controller, Direct Memory Access; The 8086 Microprocessor: Architecture & Programming; 8051 Microcontroller: Architecture & Programming; Microcontroller Peripheral Interfacing: Real-time Operating System, Parallel Interface for Signal Acquisition, User Interface (Keyboard & Displays), Design with Low Pin Count, Serial Communication Protocol & Interface, External Memory Interface; Application of Embedded Systems and Simulation.

PRINCIPLES OF CONTROL SYSTEMS ENGINEERING

Introduction to Automatic Control: Concept of control system, Definition, Open Loop/Closed-loop, Basic elements of a servo mechanism, Types of servomechanism, Development of Automatic Control; Mathematical Model: Mathematical representation of physical system, Electrical mechanical systems, liquid level system, transfer function and impulse response of linear systems, Block diagram, signal flow graphs, Application of the signal flow graphs for gain formula to block diagrams. Mathematical modelling of dynamical systems. ; General Feedback Theory: Feedback, effect of feedback, Mathematical definition of feedback, Control System Components: Potentiometer, Synchros, A.C. Servo motors D.C. and A.C. tacho generator, Example of closed loop systems using D.C. & A.C. Servomotors, Synchro's, Tacho generators; Hydraulic Systems & Pneumatic Systems; Pump controlled and valve controlled Hydraulic motor & Actuators, Hydraulic valve, Hydraulic controllers and Pneumatic controllers ; Time Response of feedback control systems: Typical test signal for the transient analysis, time domain performance characteristics of feedback control systems, transient response, transient response of 2nd order systems, transient response of a positional servomechanism, effects of derivative and integral controls on the transient performance, PI, PD, PID controllers, Tachometer feedback, Steady state response steady state error, The generalized error analysis, Stability linear control system: Routh-Hurwitz criterion. Frequency response method polar plots, Bodes plot, Magnitude versus phase shift plot frequency response of feedback control system. Frequency domain specifications, MP and WP for a second order system; The Nyquist criterion and stability : ; Introduction, The Principle of argument the Nyquist path, Nyquist criterion and the GH Plot, The application of the Nyquist criterion, The effects of additional poles and zeros of G(s) H(s) on the shape of the Nyquist locus, Relative stability, gain margin, Phase margin, conditionally stable systems. The Root Locus Technique: Introduction to Root Locus, construction of the root loci, some other properties of the root locus, root locus of conditional stable systems; Compensator Design: Lag/Lead/Lag-Lead Compensator Design using Root Locus & Bode Plot Methods ; State variable analysis: Introduction, Concept of state, state variable and state model, State equations of continuous data control system, Derivation of state Model from transfer functions and Vice versa. Diagonalisation, Solution of state equation.

DIGITAL SIGNAL PROCESSING

An introduction to signals and systems, and representation of signals in time domain, Linear, time-invariant systems, impulse response and convolution sum, Fourier transform, Sampling and Reconstruction of continuous time signals, Characterization and properties of discrete time signals and systems, Computation of the discrete time Fourier transform and its properties, Computation of the discrete Fourier transform and its properties, Fast Fourier transform algorithms, The Z-transform and its properties, The inverse z-transform, System function and system stability, Transform analysis of linear time invariant systems, Implementation of structures for discrete time systems, Digital filter design techniques, Design of FIR & IIR filters, Applications of DSP.

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