B.Tech. in ELECTRICAL AND ELECTRONICS ENGINEERING

Syllabus of Paper – 1

CIRCUIT THEORY-I

Circuit Elements and Relations: Types of Sources and Source Transformations, Dot convention, Formation of loop and node equations, Graph of a network – Incidence matrix, Cut set and Tie set matrices & Formation of equilibrium equations, Dual networks. Steady State Analysis of Circuits for Sinusoidal Excitations: Single phase Series, Parallel, Series –Parallel circuits, Solution of AC networks using mesh and nodal analysis, 3-phase balanced and unbalanced network analysis, Neutral voltage calculations, complex power. Time Domain Analysis: Solution of network equations in time domain, Classical differential equations approach, Initial conditions & evaluation, applications to simple RLC circuits only. Applications of Laplace Transforms in Circuit Theory: Laplace transforms of various signals of excitation, Laplace transformed networks, determination and representation of initial conditions, Waveform synthesis, Response for impulse function and its relation to network admittance, Convolution integral and applications. Resonance: Series and Parallel resonance, Bandwidth, Q factors.

ELECTRIC AND MAGNETIC FIELDS

Electrostatics: Coulomb‘s law, electric field intensity, electric flux density, Gauss‘ law, Electric potential, electric dipole, Poisson‘s and Laplace‘ equations, Uniqueness theorem, resistance, capacitance, dielectrics, energy in electrostatic fields, boundary conditions. Magnetostatics: Biot-Savart‘s law, magnetic flux density, magnetic field intensity, Ampere‘s Law, magnetic potential, magnetic dipole, Inductance, conductors, magnetic materials, Hall effect, energy in magneto-static fields, boundary conditions. Time Varying Fields: Equation of continuity, Faraday‘s law, Lenz‘s law, transformer emf and motional emf, Inconsistency in Ampere‘s law, displacement current, Maxwell‘s equations, Electromagnetic wave, Poynting theorem, energy in electro-magnetic fields.

ELECTRICAL MACHINES-I

DC Machines: Constructional details, Simplex and multiplex lap and wave windings; Methods of excitation, characteristics of saturated and un-saturated series, shunt, cumulatively and differentially compound excited machines operating as motors and generators; Armature reaction, demagnetizing and cross magnetizing ampere turns, compensating windings, commutation, interpoles. Speed control methods of D.C. shunt & series motors, losses and efficiency; 3 point starter, 4-point Starter for D.C. motors and design of 3-point starter. Testing of D.C. machines: No-load test, Direct load test, Hopkinson‘s and Field‘s test, Retardation test. Principle of operation and applications of Amplidyne and Metaldyne generators. Single Phase Transformers: Construction, principle of operation, EMF equation, phasor diagram; Equivalent circuit, determination of equivalent circuit parameters, Losses, calculation of efficiency and regulation by direct and indirect methods; Predetermination of performance by Sumpner‘s test, Load sharing and operation of transformers in parallel, Separation of no load losses by experimental method, principle of auto transformer, Saving of copper compared to two winding transformer and its application; Cooling methods of transformers. Three Phase Transformer: Type of connections, Relation between line and phase voltages and currents, use of tertiary winding, Scott connection of transformers for phase

conversion. Tap Changing Transformers: Concept of tap changing, on-load and off-load tap changers, single phase and three phase induction regulators and moving coil regulators.

ELECTRICAL MACHINES-II

3-Phase Induction Motor: Constructional details, types, production of magnetic field-principle of operation, Phasor diagram, equivalent circuit. Torque equation-starting and maximum torque-maximum output, slip for max. Output, Torque-slip characteristics, losses and efficiency. Testing-no load and blocked rotor tests-determination of equivalent circuit parameters ,Pre-determination of performance from equivalent circuits and circle diagram, Methods of starting-auto transformer, star delta and rotor resistance starters, Double cage induction motor –construction, theory, equivalent circuit, Characteristics and applications. Induction generator-principle of operation, equt. Circuit and application. Synchronous Generator: Construction, types, winding factors, production of emf, harmonics, armature reaction, Synchronous reactance, phasor diagram, load characteristics, open circuit and short circuit tests. Methods of pre-determination of regulation by synchronous impedance, ampere turn, Potier triangle and ASA methods. Two reaction theory –analysis and its application for the pre- determination of regulation of salient pole alternator, phasor diagram. Slip test, power angle characteristics, synchronization and synchronizing power. Parallel operation and load sharing– operation on infinite bus-bar typical applications. Synchronous Motor: Theory of operation–phasor diagrams, variation of current and power factor with excitation. Hunting and its suppression, determination and pre-determination of V and inverted V curves. Excitation circles, power circles, method of starting.

SOLID STATE DRIVES

Introduction to electric drives: Electrical Drives, Advantages of Electric drives, Parts of Electrical Drives, Electric Motors, Power Modulators, Sources, Control unit, Choice of Electric Drives and Losses. Dynamics of electrical drives: Fundamental torque equation, components of load torque, load characteristics, modified torque equation, speed-torque convention & multi-quadrant operation. Equivalent values of drive parameters, load with rotational motion, loads with translational motion, measurement of moment of inertia, components of load torques, Nature and classification of load torque. Calculation of time and energy loss in transient operation, steady state stability, loads equalization. Control of electrical drives: Modes of operation, speed control and drive classifications, closed loop control of drives. DC Motor Drives: Starting, Braking, Speed control of DC motors using single phase fully controlled and half controlled rectifiers. Three phases fully controlled and half controlled converter fed DC motor drives. Chopper controlled DC drives. Induction Motor Drives: Speed control using pole changing, stator voltage control, AC voltage controllers. Variable frequency and variable voltage control from inverter. Different types of braking, dynamic, regenerative and plugging. Energy Conservation in Electric Drives: Losses in Electric drive systems, measurement of Energy conservation in Electric drives. Use of efficient converters, energy efficient operation of drives, Improvement of p.f., improvement of quality of supply, maintenance of motors.

ANALOG ELECTRONICS

Semi Conductor Physics: Introduction, static characteristics of PN-Junction diode, zener diode, BJT, FET and MOSFETs. Power supplies: Single phase half wave, full wave and bridge rectifiers with filters (LC and π), Regulated power supply, series voltage regulator, principles of uninterrupted

power supply. Transistor Amplifiers: Bias stability and thermal runway, analysis of amplifier circuits using h-parameters, emitter follower, simplified CE hybrid model, CE short circuit current gain, single stage CE amplifier response, low frequency response of an RC coupled amplifier, gain-band width product, high frequency response of two cascaded CE stages. Feedback Amplifiers And Oscillators: Analysis of voltage series, voltage shunt, current series, current shunt, feedback amplifiers, stability of negative feedback amplifiers, analysis of RC phase-shift, Wien bridge, LC-oscillators (using BJT‘s only) and crystal oscillators. Direct Coupled Amplifiers: Analysis of differential amplifier configurations, CMRR, stability and drift problems, compensation techniques. Power Amplifiers: Classification of power amplifiers, analysis of class-A, class-B and class-AB operations, push- pull amplifiers and complementary symmetry, harmonic distortion, and cross-over distortion in power amplifiers. Wave Shaping Circuits: RC-low pass, high pass circuits, response to step, pulse ramp and square wave inputs, differentiating and integrating circuits, clipping circuits using diodes-single level and two-level clipping, clamping circuits using diodes. Multivibrators And Sweep Circuits: Introduction to voltage sweep circuits, boot strap and miller sweep circuits, Astable and Monostable. Multi-vibrators and Triggering methods.

Syllabus of Paper – 2

ELECTRICAL MEASUREMENTS AND INSTRUMENTATION

Analog Ammeters and Voltmeters: PMMC and MI Instruments, Construction, Torque Equation, Range Extension, Effect of temperature, Classification, Errors, Advantages and Disadvantages. Analog Wattmeters and Power Factor Meters: Power and Power Factor, Electrodynamometer type wattmeter, power factor meter, Construction, theory, Shape of scale, torque equation, Advantages and disadvantages, active and reactive power measurement in single phase, Measurement in three phase. Analog Energy Meter: Single phase induction type energy meters, construction, theory, Operation, lag adjustments, Max Demand meters/indicators, Measurement of VAH and VARh. DC and AC Bridges: Measurement of resistance, Wheatstone Bridge, Kelvin‘s Bridge, Kelvin‘s Double Bridge, Measurement of inductance, Capacitance, Maxwell‘s Bridge, Desauty Bridge, Anderson Bridge, Schering Bridge, Wien Bridge, Applications and Limitations. Instrument Transformers: Current Transformer and Potential Transformer - construction, theory, phasor diagram, errors, testing and applications. Transducers: Measurement of Temperature, RTD, Thermistors, LVDT, Strain Gauge, Piezoelectric Transducers, Digital Shaft Encoders, Tachometer, Hall effect sensors. Electronic Instruments: Electronic Display Device, Digital Voltmeters, CRO, measurement of voltage and frequency, Lissajous Patterns, Plotting B-H curve of a magnetic material, Wave Analyzers, Harmonic Distortion Analyzer.

POWER SYSTEMS-I

Introduction: Typical Layout of an Electrical Power System–Present Power Scenario in India. Generation of Electric Power: Conventional Sources (Qualitative): Hydro station, Steam Power Plant, Nuclear Power Plant and Gas Turbine Plant. Non Conventional Sources (Qualitative): Ocean Energy, Tidal Energy, Wave Energy, wind Energy, Fuel Cells, and Solar Energy, Cogeneration and energy conservation and storage. Economics of Generation: Introduction, definitions of connected load, maximum demand, demand factor, load factor, diversity factor, Load duration curve, number and size of generator units. Base load and peak load plants. Cost of electrical energy-fixed cost, running cost, Tariff on charge to customer. A.C. Distribution: Introduction, AC distribution, Single phase, 3-phase, 3 phase 4 wire system, bus bar arrangement, Selection of site for substation. Overhead Line Insulators: Introduction, types of insulators, Potential distribution over a string of suspension insulators, Methods of equalizing the potential, testing of insulators. Insulated Cables: Introduction, insulation, insulating materials, Extra high voltage cables, grading of cables, insulation resistance of a cable, Capacitance of a single core and three core cables, Overhead lines versus underground cables, types of cables. Inductance and Capacitance Calculations of Transmission Lines: Line conductors, inductance and capacitance of single phase and three phase lines with symmetrical and unsymmetrical spacing, Composite conductors-transposition, bundled conductors, and effect of earth on capacitance. Corona: Introduction, disruptive critical voltage, corona loss, Factors affecting corona loss and methods of reducing corona loss, Disadvantages of corona, interference between power and Communication lines.

POWER SYSTEMS-II

Performance of Lines: Representation of lines, short transmission lines, medium length lines, nominal T and PI- representations, long transmission lines. The equivalent circuit representation of

a long Line, A, B, C, D constants, Ferranti Effect, Power flow through a transmission line, receiving end power circle diagram. Voltage Control: Methods of voltage control, shunt and series capacitors / Inductors, tap changing transformers, synchronous phase modifiers. Compensation in Power Systems: Concepts of Load compensation – Loadability characteristics of overhead lines– Uncompensated transmission line – Symmetrical line – Radial line with asynchronous load – Compensation of lines. Per Unit Representation of Power Systems: The one line diagram, impedance and reactance diagrams, per unit quantities, changing the base of per unit quantities, advantages of per unit system. Travelling Waves on Transmission Lines: Production of traveling waves, open circuited line, short circuited line, line terminated through a resistance, line connected to a cable, reflection and refraction at T-junction line terminated through a capacitance, capacitor connection at a T-junction, Attenuation of travelling waves. Overvoltage Protection and Insulation Coordination: Over voltage due to arcing ground and Peterson coil, lightning, horngaps, surge diverters, rod gaps, expulsion type lightning arrester, valve type lightning arrester, ground wires, ground rods, counter poise, surge absorbers, insulation coordination, volt-time curves. Symmetrical Components and Fault Calculations: Significance of positive, negative and zero sequence components, Average 3-phase power in terms of symmetrical components, sequence impedances and sequence networks, fault calculations, sequence network equations, single line to ground fault, line to line fault, double line to ground fault, three phase fault, faults on power systems, faults with fault impedance, reactors and their location, short circuit capacity of a bus.

DIGITAL ELECTRONICS

Number system and codes: Analog versus digital, merits of digital system, number systems, base conversions, complements of numbers, weighted and unweighted codes, and error detecting and correcting codes. Switching algebra and switching functions: Boolean algebra, postulates, theorems and switching algebra, completely and incompletely specified switching functions, minimization of Boolean functions using Karnaugh map and Quine McCluskey methods. Logic Families: Characteristic parameters, Transistor-Transistor logic, TTL subfamilies, CMOS logic family, Implementation of Boolean function using CMOS logic, various logic gate ICs. Combinational Logic: Principles and practices, Logic design of combinational circuits code conversion, parity generation and checking, multiplexers, de-multiplexers, encoders, decoders, buffers, tri-state buffers, IC Versions of Combinational logic circuits. Sequential Logic: Review of Flip-Flops, Finite State model of sequential Circuits, modulus counter, shift registers, IC Version of sequential logic circuits. Semiconductor Memories: RAM, ROM (Cell Structures and Organization on Chip) Data Conversion Circuits: D/A converter specifications, A/D converter specifications, D/A converters such as DAC 0808, DAC 1408/1508, Integrated circuit A/D Converters ADC 0808, ICL 7106/7107.

CONTROL SYSTEMS

Introduction: System, control system, types of control systems, open-loop and closed loop systems, types of feedback, feedback and its effects. Concept of linearization with incremental changes.

Mathematical Modelling of Physical Systems: Mathematical modelling of Electrical, Mechanical and Electro-mechanical elements, Synchros D.C. motors, two-phase A.C. motors. Block diagram representation of them. Concept and use of Transfer function. Transfer Function from Block Diagrams and Signal Flow Graphs: Impulse response and its relation with transfer function of linear

systems. Block diagram reduction technique and signal flow graph, Mason's gain formula. State Variable Analysis of Linear Dynamic Systems: State variables, state variable representation of system, dynamic equations, merits for higher order differential equations and solution. Concept of controllability and observability and techniques to test them. Time Domain Analysis of Control Systems: Typical Test signals, time domain indices, steady state error constants, error series, concept of BIBO stability, absolute stability, Routh-Hurwitz Criterion. Effect of P, PI & PID controllers. Root Locus Techniques: Introduction, Root loci theory, Application to system stability studies. Illustration of the effect of addition of a zero and a pole. Frequency Domain Analysis of Control Systems: Polar plots, Nyquist stability criterion, Frequency domain indices (gain margin, phase margin, bandwidth), Bode plots, application of Bode plots, M&N circles, Nichols charts, Application of Nichols charts. Design of Compensators: Need of compensators, design of lag and lead compensators using Bode plots.

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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