

3. ELECTRICAL AND ELECTRONICS ENGINEERING 6/4/26 updated

Electrical Circuits and Fields: Ideal Voltage and Current sources, dependent sources, R,L,C, M elements; Network solution methods: KCL, KVL, Node, Super Node and Mesh, Super mesh analysis; Network Theorems; Transient response of DC and AC networks; sinusoidal steady-state analysis; resonance; two port networks, balanced three phase circuits; Power Measurement, star –delta transformation, complex power, power factor in AC circuits and Locus Diagrams;

Gauss theorem, electric field intensity and potential due to point, line plane and spherical charge distribution, dielectric, capacitance calculations for simple configurations; Ampere's and Biot-Savart' law, inductance calculations for simple configurations. Electromagnetic Fields - Poynting Theorem - Wave Equations - Maxwell Equations

Electrical Machines: Single phase transformer – equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformer –connections; auto transformer; Performance tests & parallel operation principles of energy conversion, windings of rotating machines; D.C generators and motors-characteristics, starting and speed control, armature reaction and commutation: three phase induction motors-performance characteristics, starting and speed control, Braking; single-phase induction motors; synchronous generators – performance, regulation; synchronous motors – starting characteristics, applications, synchronous condensers; fractional horsepower motors: permanent magnet and stepper motors.

Power Systems: Electric Power Generation: Thermal, Hydro, Nuclear, Wind and Solar.

Transmission and Distribution: Structure of electric power system - transmission line parameters, corona discharge - performance of transmission lines, voltage control, Ferranti effect - insulators and cables - mechanical design of lines and grounding.

Power System Analysis: system planning and operational studies - p.u. impedance diagram - Bus incidence matrix, Bus admittance matrix, Bus Impedance matrix - power flow analysis, Gauss-Seidel method, Newton-Raphson method - Symmetrical short circuit analysis, Post fault bus voltages, Fault level, Current limiting reactors - Unsymmetrical Fault Analysis, Sequence networks, computation of post fault currents in symmetrical component and phasor domains - Stability Analysis, rotor angle stability and voltage stability, swing equation, Equal area criterion.

Power System Operation and Control: System load variation, load curves - load forecast - Deregulation, Types of electricity markets - Load Frequency Control (LFC) of single area system, LFC of two area system - Automatic Voltage Regulator (AVR), brushless AC excitation system - voltage drop in transmission line - SVC and STATCOM for voltage control - Economic Operation of Power System, input and output characteristics of thermal plant, optimal operation of thermal units without and with transmission losses - Unit Commitment (UC) problem - computer control of power system - energy control center and functions.

Protection and Switchgear: CT, PT, Buchholz relay - electromagnetic relays - Over current, Directional, Distance and Differential relays - R-X diagram - Protection of transformer, generator, motor, bus bars, feeders and transmission line - static relays and numerical protection - Circuit Breakers, re-striking voltage and recovery voltage - RRRV - current chopping - air, oil, SF6 and vacuum circuit breakers.

Control Systems : Principles of feedback; transfer function; block diagram; signal flow graph- steady -state errors; transient response; stability-Routh and Nyquist criteria; Bode plots; gain and phase margin; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear time Invariant systems.

Power Electronics and Drives: Semiconductor power devices – diodes, transistors, thyristors, triac - MOSFET, IGBTs; Single-phase and three-phase rectifiers, Single-phase and three-phase inverters, DC- DC converters (buck, boost, buck-boost), Converter/Chopper fed DC drives, Induction and Synchronous motor drives

Microprocessor and Microcontrollers: Microprocessor : General 8 bit microprocessor Architecture 8085, 8086 processor – Architecture, Memory, I/O interfacing, Instruction set, Addressing modes, Timing diagram & delays, Machine cycles, Interrupts, counters, Assembly language programming. Microcontrollers: 8 bit microcontroller -8051 architecture, bus configuration, Instruction sets, programming & applications.

High Voltage Engineering: Causes of overvoltages and its effects on power system – Lightning, switching surges and temporary overvoltages – concepts of reflections and refraction of travelling waves. Dielectric breakdown- Gaseous breakdown – Vacuum breakdown, Corona discharges – Generation of high voltage, High current and its measurements – DC, AC, impulse voltages and currents; High Resistance with series ammeter – Dividers, Resistance, Capacitance and Mixed dividers – Peak Voltmeter, CVT, Electrostatic Voltmeters – Sphere Gaps – High current shunts; High voltage testing of electrical power apparatus as per International and Indian standards – Insulation Coordination.

Electric energy – Conservation and utilization: Fundamentals of Electric drives – choice and applications; traction motors – characteristic features – electric braking train movement and energy consumption; Design of illumination systems and various lighting schemes; Electric heating – methods of electric heating and its types – Electric welding - Principles of the conversion of solar radiation into heat; Solar Collectors-flat-plate collectors – concentrating collector – cylindrical parabolic; Wind energy conversion system – basic principles – site selection – basic components – Classification of WECS – Types of wind machines.