

Total Marks: 100

ELECTRICAL AND ELECTRONICS**Each Module carries 20 marks****MODULE-1****1.1. ELEMENTS OF ELECTRICAL ENGG:**

Sources of electrical energy, Electrical current, e.m.f., voltage. Ohm's law, Electrical Resistance, Series- Parallel circuits. Laws of Resistance, Specific Resistance, temperature co-efficient. Work, Power and Energy, Joule's law of heat. Electric charge, Electric flux, Flux density, Electric field, Electric field intensity, Laws of electrostatics, dielectric constant and permittivity, Capacitance. Types of Capacitors, Capacitors in series and parallel, Energy stored in a capacitor. Faraday's laws of Electrolysis: Laws, Cell and a Battery. Lead - Acid Battery- Construction, Grouping of cells. Conductor, Resistor, Insulating and magnetic materials - properties and applications.

1.2. ELECTRICAL CIRCUITS:

Open, closed and short circuit; Linear, non linear circuits, passive active circuits, unilateral, bilateral circuits. Kirchhoff's laws, Star -delta Transformation, Thevenin's Theorem, Reciprocity Theorem, Superposition Theorem Maximum power transfer Theorem. Magnetic circuit, mmf, reluctance, Absolute permeability and Relative permeability, Flux, MMF and Reluctance. Cork Screw Rule and Right Hand Thumb Rule, Faraday's laws of Electromagnetic Induction, Types of induced emfs and their application ; Fleming's Right Hand Rule, Lenz's law; Self induced emf and Mutually induced emf and their application, Self inductance and Mutual inductance. Frequency, Amplitude, Cycle, Time period; Maximum value, RMS value, Average value, Form factor and Peak factor of a sinusoidal wave, Instantaneous value of Voltage and Current , phase and phase difference, Power and Power factor in AC circuits, Represent vectors in Rectangular, Trigonometric and Polar forms, Convert Rectangular form into Polar form and vice-versa. Current and Power in a pure resistive, pure inductive and pure capacitive circuit ; Capacitive reactance , Inductive reactance ,Impedance, Current, Power and Power factor of R-L, R-C, R-L-C series and parallel circuits, Resonance, resonant frequency and Q-factor. Star and Delta Connection in 3-ph system, Relation between line voltage and phase voltage in 3-ph Star, Relation between line voltage and phase voltage in 3-ph Delta system, 3-ph power.

1.3. ELECTRICAL MEASUREMENTS & MEASURING INSTRUMENTS

Characteristics of instruments, types of errors, classification of instruments, types of torques in instruments, Construction and operation of moving coil, moving iron instruments, calibration and range extension of voltmeter, ammeter,

Construction and operation, types, errors, calibration, application of wattmeter and energy meter, measurement of power and energy.

Measurement of Resistance, Inductance and Capacitance. – Wheat stone bridge, Kelvin bridge. Maxwell's bridge , Schering Bridge.

Digital meters – operation and applications of Digital frequency meter, digital synchronoscope, digital non contact type tachometer, digital p.f.meter, digital trivectormeter, digital tong tester, digital LCR meter, digital multimeter and voltmeter.

Transducers, Sensors, Signal conditioning circuits and their application - strain gauges, LVDT, RVDT, Thermocouple, Pyrometer, Peizo-electric, Opto-sensor, Bolometer for measuring AF & RF power measurements

MODULE-II

2.1. DC MACHINES AND ALTERNATORS:

D.C. Generator - Principle, Construction and types, Materials used for construction-properties, Reasons for using these materials, slot insulation materials - properties. Functions of each part, Armature windings-Types of windings, Rules of lap & wave winding, application of lap & Wave windings. E.M.F equation, Armature reaction, De-magnetizing & cross - magnetizing effect, Commutation- methods of improving commutation. Characteristics- separately excited D.C. Generator; shunt Generator - critical resistance - conditions for voltage build up-failure to build up, Efficiency & voltage Regulation-Losses in D.C. Generator.

D.C Motor- Working principle –comparison of motor & Generator action. Back emf & voltage equation, Types of motors, Torque developed, Torque- speed relationship, Characteristics of D.C. Motors, Applications, Speed control, Starting Devices.

Alternator - Principle – Construction – Types. Armature winding, Emf equation, Armature Reaction and its Effects. Voltage regulation, O.C & S.C. tests, effective resistance, leakage reactance & synchronous reactance. Parallel operation, Excitation Systems, Hunting in alternators and its prevention. Cooling in alternators. Principle of working, construction and applications of the following motors - Universal motors, Reluctance motor, Two phase Four pole Permanent magnet Stepper motor, Servo motor, Brushless D.C. Motors and AC/DC Tacho-generator.

2.2. TRANSFORMERS AND AC MOTORS:

Transformers - Working principle, construction and classification. Emf Equation, Operation, Equivalent circuit of transformer, Regulation and Efficiency, Parallel operation, Three Phase transformers- working principle & construction , connections, Cooling of transformer, Auto transformer.

Induction Motors- working principle ,Types, construction ,Torque, slip, Equivalent circuit, Power output, losses, Starting and Speed control of Induction Motors.

Synchronous Motors- Working principle, construction, characteristics, hunting, starting, and applications.

Single Phase Induction Motors- Principle, Operation, types, characteristics, applications, linear induction motor, Magnetic Levitation, Induction Generators.

MODULE-III

3.1. ELECTRICAL POWER GENERATION

Conventional and non-conventional sources, Factors to be considered for selection of site, classification, functions of main component, comparison, advantages and disadvantages, environmental impacts of hydroelectric power plant, thermal power plant, nuclear power plant, diesel power plant, gas turbine power plant, Solar photovoltaic system, Wind power plant, Tidal power plant, Wave energy, Ocean thermal energy, Biomass power plant, Fuel cells, Hybrid PV systems, Urban waste to energy conversion, Power factor improvement.

3.2. TRANSMISSION DISTRIBUTION AND UTILISATION

Transmission system: AC transmission and distribution system, standard transmission and distribution voltages, Advantages and limitations of High voltage transmission, various systems for power transmission and distribution, Transmission through overhead and UG system, Compare HVDC and HVAC system

Overhead lines: Main components, Classification, Line, Short transmission line - equivalent circuit, equations for receiving end voltage, efficiency, voltage regulation and power factor, Corona- definition, formation, factors affecting corona, advantages and disadvantages, methods to reduce corona. Meaning of skin effect. Transposition of conductors.

Underground cables: Classification of UG cables, general construction of a single core UG cable, construction of 3 core XLPE cables. Essential insulating material properties for UG cables. Laying of UG cables- list the methods.

HVDC transmission lines: main components, advantages, Types of HVDC links –

FACTS Controllers- Definition, Objectives, Basic types of FACTS controllers and their functions.

SUBSTATIONS- Meaning of substation, classification, comparison between outdoor and indoor substation, single line diagram MUSS ,components of substation, Bus bar arrangement- list the types- single bus with and without sectionalisation, double bus bar and ring main system. Importance of interconnecting in large power systems. Function of Load Dispatch Stations.

AC distribution system: Classification, connection schemes of distribution system, Meaning of Feeder, distributor and service main, characteristics of Feeder, distributor and service main. Concept of voltage drop in feeders/distributors - simple problem on DC distributor fed at one end. Distribution Automation

SCADA, components of SCADA and their functions and advantages

Electrical heating: Different types of domestic heating appliances, Advantages of electric heating, methods of electrical heating, temperature control methods of resistance heating. **Arc heating-** types, Induction heating-types, eddy current. Applications of eddy current heating. electric heating- principle and applications. Microwave heating-principle only.

Electric welding: Definition , types- resistance and arc welding , resistance welding list the types-spot welding and seam welding ,Arc welding- list the types, AC arc welding machine, Mention the special types of welding-electron beam welding and laser welding.

Electro chemical process- Principles of electro deposition, laws of electrolysis, Electro plating, Factors affecting Electro plating, Factors governing Electro better electro deposition.

Refrigeration: types of refrigerants, State the properties of refrigerants. Vapour compression refrigerator, electric circuit of domestic refrigerator, necessity of thermostat, defrosting-types of defrosting, need for air conditioning, principle of air conditioning, electrical circuit for air conditioning unit, types of air conditioning system.

Illumination: Laws– solid angle, luminous flux and luminous intensity and illumination,, source of light-types of lamps, lighting schemes, Design of lighting scheme - utilization factor, depreciation factor, space to height ratio requirements of good illumination

3.3.SWITCHGEAR AND PROTECTION

Fundamentals of Protection- Sources and Types of faults & Harmful Effects of short circuit current, Symmetrical Faults on Three Phase Systems, Percentage reactance and Base KVA, Reactor, Use of current limiting reactors & their arrangements, Causes of over voltages, Lighting phenomena & over voltage due to lightning, Types of lightning arresters and surge absorbers- their Construction and principle of operation.

Fuse and Circuit Breaker - Features of Switchgear, different Switchgear equipment used for switching and interruption of current, Indoor type and Outdoor type Switchgear, Characteristics of Fuse elements, Types of Fuses, Fuse Element Materials, Important Terms of fuse, HRC fuses –construction, types, working, Merits, Demerits and applications, Arc formation, arc extinction, Trip Circuit Mechanism, Circuit Breaker-rating, terminologies, Classification.

Construction, Working, Merits, Demerits, Applications and Maintenance Schedule of OCB (Plain oil), ACB(Axial blast, cross blast),SF₆ (Sulphur Hexa Fluoride)CB Non Puffer Type, vacuum CB.

Protective Relays - Qualities of Protective Relaying, Necessity for Protection, Primary and Back up protection, Classification of protective Relaying, Important Terms, Construction and working of Induction type Non-directional over current relay, Static Type Over Current Relay, Comparison of Static Relays with Electro-Magnetic Relays, Microprocessor based Over Current Relay, Differential relay- Current differential and Voltage balanced Differential relay, Distance relays- Definite distance and Time-distance Impedance Relay, Numerical relay- working, Advantages and types, Testing Methods for Relays

Protection of Alternators and Transformers- Protection of Alternators- Abnormalities & Faults

Differential protection, Balanced Earth Fault Protection, Stator Inter Turn Protection

Protection of Transformers- Abnormalities & Faults, Protective Systems for Transformers, Buchholz Relay, Earth Fault or Leakage Protection, Combined Leakage and Overload Protection, Circulating Current Scheme for Transformers Protection

Protection of Feeders and Bus-Bars: Feeder Protection- Abnormalities & Faults, Time Graded Over Current Protection, Differential Pilot Wire Protection, Distance Protection, Bus – Bar Protection- Abnormalities & Faults, Differential Protection of Bus –Bars,

Substation and Maintenance: Indoor and outdoor type substation, various units of substation, Testing methods of Circuit Breakers, Testing methods of CT's & PT's, Maintenance Schedule of Relays, Types & importance of Neutral Earthing , Substation Earthing, Principle and applications of Peterson coil

MODULE-IV

4.1. ANALOG ELECTRONICS:

Semiconductors , P N junction Diodes, Zener diode, Varistor and Thermistor, Transistors and MOSFETs, Optoelectronic devices –photo diode, opto isolator, photo voltaic cell, LED, LDR, LCD, opto coupler. Rectifiers, filters and regulators, Amplifiers and Oscillator, CRT.OP-AMP and Timers.

4.2. DIGITAL ELECTRONICS:

IC Logic families, Digital Principles and Number system, Boolean Algebra, De Morgan's theorem, Logic Gates, Karnaugh's map, Adders, Multiplexer, De-Multiplexer, Encoders, Decoders, Flip flops, Shift Registers, Counters, Digital Interfacing, ADC and DAC, Memories

4.3. COMMUNICATION AND COMPUTER NETWORKS

Radio Communication: Elements of communication system, Forms and types of communication, Modulation methods

Electromagnetic spectrum: Relationship between frequency (f) and wavelength (λ), Need for modulation, Electromagnetic spectrum, Bandwidth, Modulation and demodulation circuits

Radio transmitter and Receiver-Transmitter-functions, FM transmitter, Receiver - Super heterodyne receiver.

Multiplexing: FDM- transmitting end, FDM- receiving end TDM-definition.

Transmission lines–types, Co-axial cable, characteristic impedance, characteristic impedance of co-axial cable, Standing Waves, Standing wave ratio, importance of SWR.

Radio wave propagation: ground wave, sky wave, space wave.

Fiber Optic Communication: Elements of fiber-optic communication system, Applications, Benefits, Light rays in a fiber optic cable, construction Mode-definition, classification, ILD optical transmitter, Photodiode optical receiver.

Microwave Techniques: Advantages, Problems faced in microwave communication, Wave guides, Cavity resonators, Microwave semiconductors –problems faced by conventional semiconductor components and their remedies, Microwave tubes, Microwave antennas.

Satellite Communication: Satellite orbits- geo synchronous orbit, Transponder, working, Satellite sub system, Satellite Earth Station, Applications.

GPS - GPS architecture, GPS receiver, Differential GPS, Applications of GPS, GIS –concept, applications.

Mobile and Data Communication: Mobile communication – Multi cell system, frequency reuse, Salient features of GSM, GSM services, GSM system architecture, GSM network area –definitions- cell, location area, MSC/VLR service area, PLMN, GSM operation-call from mobile station, call to a mobile station, Concept of GPRS, Compare 2G with 3G.

Data Communication - Concept, Applications, Modes of Transmission, channel capacity, bandwidth, baud rate, bit rate, Modem - need for modem, FSK-concept, working, PSK - concept, BPSK–concept. BPSK modulator, BPSK demodulator.

MODULE-V

5.1. POWER ELECTRONICS:

Power semiconductor devices- Structure, working, Characteristics, types and applications of Power diode, MOSFET, IGBT, SCR, LASCR, GTO, TRIAC, Turning on methods and commutation of SCR, ratings, reliability, protection & mounting of SCR.

CONVERTERS, CHOPPERS, INVERTERS, CYCLOCONVERTERS - Types, operation and application, advantages and disadvantages

Power supplies and stabilizers-SMPS, Buck, Boost, Buck-Boost and Fly back converter, power line disturbances, Relay type AC voltage stabilizer, AC servo voltage stabilizer, UPS- Battery size, voltage required, ON line and OFF line UPS

Power system applications- Static AC circuit breaker, interconnection of renewable energy sources and energy storage systems to the utility grid, Thyristor switched capacitors and thyristor switched inductors (Reactors),

Industrial applications -SWITCH mode welder, Voltage source series resonant inverters, solid state relay, speed control of shunt wound DC motor, soft starting of Induction motor, static slip recovery system in induction motor(static scherbius drive), speed control of Induction Motor by Variable voltage frequency method

DOMESTIC APPLICATIONS-High frequency lighting system, SCR battery charger.

5.2. INDUSTRIAL DRIVES AND CONTROL

Concept of electric drive, Power modulators, Motors used in drives, types of loads, choice of drives, classification of drives, Multi quadrant operation of Drives, selection of drives for paper mill, cement mill, sugar mill, steel mill, Hoists and cranes, centrifugal pumps and compressors, solar powered pump drives,

CONTROL SYSTEM- Open and closed loop systems,

COMPUTER BASED INDUSTRIAL CONTROL- Hierarchical levels of CIM, Microcontroller based DC Motor speed control, Fuzzy logic, Process control in thermal plant and cement plant

ELECTRIC TRACTION- Traction systems, Tractive effort, nature of traction load, requirements of traction drives, Drives in traction, electric braking, current collection, Train lighting system

5.3.ELECTRICAL ESTIMATION AND COSTING

Estimation- purpose, factors considered, qualities of a good estimator. Specification- importance, factors considered, Standardization and its advantages. Overhead charges, stock incidental charges, contingencies, supervision charges, labour charges, Inspection/Inspectorate charges, transportation charges and miscellaneous charges, Tender/tender notice, quotation, comparative statement, purchase order and work order. Earthing -touch potential, step potential, necessity of earthing, Points to be earthed, earth resistance, types of earthing- Pipe earthing, Plate earthing SERVICE MAINS- types of service mains- Over Head Service Mains, UG Service Mains, current ratings for Aluminium, copper conductors, Types of Towers, ACSR conductors and Number of Disc insulators in suspension string, strain string, span and height of towers for 66 KV, 110 KV, 220 KV transmission lines

5.4. ENERGY MANAGEMENT

Energy management and its importance, energy conservation and its need, Methodology of energy management, energy management techniques, energy crisis, causes of energy crisis, Energy management software(EMS) various stages of EMS, Describe Energy and facility management system(EFMS), purpose of EFMS, Methodology of EFMS Processes in EFMS, block diagram of EFMS components & applications of EFMS, Need of energy conservation in India, ENERGY CONSERVATION ACT 2001, the national role of IRDEA (Indian renewable energy development agency) in energy conservation, Energy conservation in T&D lines., measures to optimize T&D losses, Energy conservation in industries, role of power factor improvement in energy conservation, energy conservation in domestic sector, industrial sector, agriculture

sector, Energy efficiency- its significance, energy efficient devices, energy efficient motors, application s energy efficient motor , selection of electric drives, energy conservation in electric drive , energy efficient lighting sources, power quality, and its parameters, power quality measurable quantities, power quality problems and its remedies , pricing of electricity, Need for energy audit, scope and types of energy audit, Methodology, demand side management (DSM), need for DSM and benefits of DSM, DSM implementation strategy, DSM implementation of program.