Syllabus for the Post of Junior Engineering Assistant (Electrical) -Level F1

Essential Qualification: 3 years Diploma in Electrical Engineering. Should have Valid Certificate of Competency as Electrical Supervisor

Part (A): General Mental Ability and Aptitude	20% (20 questions carrying 1 mark each)

General Mental Ability and Aptitude to test the following:

- Interpersonal Skills
- Logical reasoning/Analytical/Comprehension ability
- Basic Numeracy and Data Interpretation Skills
- General Awareness

Part (B): Subject/Domain Related	80 % (80 questions carrying 1 mark each)

INTRODUCTION TO ELECTRIC GENERATION SYSTEMS

Unit – I Thermal Power Plants: **Coal, Gas/ Diesel and Nuclear-based**

Layout and working of a typical thermal power plant with steam turbines and electric generators. Properties of conventional fuels used in the energy conversion equipment used in thermal power plants: Coal, Gas/ diesel, Nuclear fuels –fusion and fission action Safe Practices and working of various thermal power plants: coal-based, gas-based, diesel-based, nuclear-based. Functions of the following types of thermal power plants and their major auxiliaries: Coal fired boilers: fire tube and water tube. Gas/diesel based combustion engines Types of nuclear reactors: Disposal of nuclear waste and nuclear shielding. Thermal power plants in Maharashtra.

Unit – II Large and Micro-Hydro Power Plants

Energy conversion process of hydro power plant. Classification of hydro power plant: High, medium and low head. Construction and working of hydro turbines used in different types of hydro power plant: a. High head – Pelton turbine b. Medium head – Francis turbine c. Low head – Kaplan turbine. Safe Practices for hydro power plants. Different types of micro- hydro turbines for different heads: Pelton, Francis and Kaplan turbines Locations of these different types of large and micro-hydro power plants in Maharashtra Potential locations of micro-hydro power plants in Maharashtra.

Unit– III Solar and Biomass based Power Plants

Solar Map of India: Global solar power radiation. Solar Power Technology a. Concentrated Solar Power (CSP) plants, construction and working of: Power Tower, Parabolic Trough, Parabolic Dish, Fresnel Reflectors b. Solar Photovoltaic (PV) power plant: layout, construction, working. Biomass-based Power Plants a. Layout of a Bio-chemical based (e.g. biogas) power plant: b. Layout of a Thermo-chemical based (e.g. Municipal waste) power plant c. Layout of an Agro-chemical based (e.g. bio-diesel) power plant Features of the solid, liquid and gas biomasses as fuel for biomass power plant.

Unit– IV Wind Power Plants

Wind Map of India: Wind power density in watts per square meter Layout of Horizontal axis large wind power plant: Geared wind power plant. Direct-drive wind power plant. Salient Features of

electric generators used in large wind power plants: Constant Speed Electric Generators: Squirrel Cage Induction Generators (SCIG), Wound Rotor Induction Generator (WRIG) Variable Speed Electric Generators: Doubly-fed induction generator (DFIG), wound rotor synchronous generator (WRSG), permanent magnet synchronous generator (PMSG)

Unit– V Economics of Power Generation and Interconnected Power System

Related terms: connected load, firm power, cold reserve, hot reserve, spinning reserve. Base load and peak load plants; Load curve, load duration curve, integrated duration curve Cost of generation: Average demand, maximum demand, demand factor, plant capacity factor, plant use factor, diversity factor, load factor and plant load factor. Choice of size and number of generator units, combined operation of power station. Causes and Impact and reasons of Grid system fault: State grid, national grid, brownout and black out; sample blackouts at national and international

ELECTRIC CIRCUITS

Unit – I Single Phase A.C Series Circuits

Generation of alternating voltage, Phasor representation of sinusoidal quantities R, L, C circuit elements its voltage and current response R-L, R-C, R-L-C combination of A.C series circuit, impedance, reactance, impedance triangle, Power factor, active power, reactive power, apparent power, power triangle and vector diagram Resonance, Bandwidth, Quality factor and voltage magnification in series R-L, R-C, R L-C circuit

Unit – II Single Phase A.C Parallel Circuits

R-L, R-C and R-L-C parallel combination of A.C. circuits. Impedance, reactance, phasor diagram, impedance triangle R-L, R-C, R-L-C parallel A.C. circuits power factor, active power, apparent power, reactive power, power triangle Resonance in parallel R-L, R-C, R-L-C circuit, Bandwidth, Quality factor and voltage magnification

Unit– III Three Phase Circuits

Phasor and complex representation of three phase supply Phase sequence and polarity Types of three-phase connections, Phase and line quantities in three phase star and delta system Balanced and unbalanced load, neutral shift in unbalanced load Three phase power, active, reactive and apparent power in star and delta system.

Unit– IV Network Reduction and Principles of Circuit Analysis

Source transformation, Star/delta and delta/star transformation, Mesh Analysis and Node Analysis

Unit– V Network Theorems

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Reciprocity theorem and Duality in electric circuits

ELECTRICAL AND ELECTRONIC MEASUREMENTS

: Unit – I Fundamentals of Measurements

Measurement: Significance, units, fundamental quantities and standards, Classification of Instrument Systems: Null and deflection type instruments, Absolute and secondary instruments, Analog and digital instruments, Static and dynamic characteristics, types of errors, Calibration: need and procedure, Classification of measuring instruments: indicating, recording and integrating instruments. Essential requirements of an indicating instruments

Unit – II Measurement of voltage and current

DC Ammeter: Basic, Multi range, Universal shunt; DC Voltmeter: Basic, Multi-range, concept of loading effect and sensitivity; AC voltmeter: Rectifier type (half wave and full wave); CT and PT: construction, working and applications. Clamp-on meter.

Unit– III Measurement of Electric Power

Analog meters: Permanent magnet moving coil (PMMC) and Permanent magnet moving iron (PMMI) meter, their construction, working, salient features, merits and demerits; Dynamometer type wattmeter: Construction and working ; Range: Multiplying factor and extension of range using CT and PT; Errors and compensations; Active and reactive power measurement: One, two and three wattmeter method; Effect of Power factor on wattmeter reading in two wattmeter method; Maximum Demand indicator

Unit– IV Measurement of Electric Energy

Single and three phase electronic energy meter: Constructional features and working principle. Errors and their compensations. Calibration of single phase electronic energy meter using direct loading.

Unit– V Circuit Parameter Measurement, CRO and Other Meters

Measurement of resistance: Low resistance: Kelvin's double bridge, Medium Resistance: Voltmeter and ammeter methodHigh resistance: Megger and Ohm meter: Series and shunt Measurement of inductance using Anderson bridge (no derivation and phasor diagram) Measurement of capacitance using Schering bridge (no derivation and phasor diagram) Single beam/single trace CRO, Digital storage Oscilloscope: Basic block diagram, working, Cathode ray tube, electrostatic deflection, vertical amplifier, time base generator, horizontal amplifier, measurement of voltage/ amplitude/ time period/ frequency/ phase angle delay line, specifications. Other meters: Earth tester, Digital Multimeter; L-C-R meter, Frequency meter (ferromagnetic and Weston type), Phase sequence indicator, power factor meter (single phase and three phase dynamometer type), Synchro scope, Tri-vector meter Signal generator: need, working and basic block diagram. Function generator: need, working and basic block diagram, function of symmetry

ELECTRIC MOTORS AND TRANSFORMERS

Unit – I DC Generators

DC generator: construction, parts, materials and their functions. Principle of operation of DC generator: Fleming's right hand rule, schematic diagrams, e.m.f. equation of generator, armature reaction, commutation and. Applications of DC generators. Classification of measuring instruments: indicating, recording and integrating instruments.

Unit – II D.C. Motors

DC motor: Types of DC motors. Fleming's left hand rule, Principle of operation of, Back e.m.f. and its significance, Voltage equation of DC motor. Torque and Speed; Armature torque, Shaft torque, BHP, Brake test, losses, efficiency. DC motor starters: Necessity, two point and three point starters. Speed control of DC shunt and series motor: Flux and Armature control. Brushless DC Motor: Construction and working.

Unit– III Single Phase Transformers

Types of transformers: Shell type and core type; Construction: Parts and functions, materials used for different parts: CRGO, CRNGO, HRGO, amorphous cores, Transformer: Principle of operation, EMF equation of transformer: Derivation, Voltage transformation ratio, Significance of transformer ratings Transformer No-load and on-load phasor diagram, Leakage reactance, Equivalent circuit of transformer: Equivalent resistance and reactance. Voltage regulation and Efficiency: Direct loading, OC/SC method, All day efficiency.

Unit– IV Three Phase Transformers

Bank of three single phase transformers, Single unit of three phase transformer Distribution and Power transformers. Construction, cooling, Three phase transformers connections as per IS:2026 (part IV)-1977, Three phase to two phase conversion (Scott Connection), Selection of transformer as per IS: 10028 (Part I)-1985, Criteria for selection of distribution transformer, and power transformer, Amorphous Core type Distribution Transformer, Specifications of three-phase distribution transformers as per IS:1180 (part I)-1989 Need of parallel operation of three phase transformer, Conditions for parallel operation. Polarity tests on mutually inductive coils and single phase transformers; Polarity test, Phasing out test on Three-phase transformer.

Unit– V Special Purpose Transformers

Single phase and three phase auto transformers: Construction, working and applications. Instrument Transformers: Construction, working and applications of Current transformer and Potential transformer. Isolation transformer: Constructional Features and applications. Single phase welding transformer: constructional features and applications. Pulse transformer: constructional features and applications. 'K' factor of transformers: overheating due to non-linear loads and harmonics.

Renewable Energy Power Plants:

Unit – I Solar PV and Concentrated Solar Power Plants

Solar Map of India: Global solar power radiation, Solar PV Concentrated Solar Power (CSP) plants, construction and working of: Power Tower, Parabolic Trough, Parabolic Dish, Fresnel Reflectors Solar Photovoltaic (PV) power plant: components layout, construction, working. Rooftop solar PV power system

Unit – II Large Wind Power Plants

Wind Map of India: Wind power density in watts per square meter Lift and drag principle; long path theory. Geared type wind power plants: components, layout and working. Direct drive type wind power plants: components, layout and working. Constant Speed Electric Generators: Squirrel Cage

Induction Generators (SCIG), Wound Rotor Induction Generator (WRIG); Variable Speed Electric Generators: Doubly-fed induction generator (DFIG), wound rotor synchronous generator (WRSG), permanent magnet synchronous generator (PMSG).

Unit– III Small Wind Turbines

Horizontal axis small wind turbine: direct drive type, components and working Horizontal axis small wind turbine: geared type, components and working Vertical axis small wind turbine: direct drive and geared, components and working Types of towers and installation of small wind turbines on roof tops and open fields. Electric generators used in small wind power plants

Unit– IV Micro-hydro Power Plants

Energy conversion process of hydro power plant. Classification of hydro power plant: High, medium and low head. Layouts of micro-hydro power plants Construction and working of hydro turbines used in different types of hydro power plant: o High head – Pelton turbine o Medium head – Francis turbine o Low head – Kaplan turbine. Safe Practices for micro hydro power plants.

Unit– V Biomass-based Power Plants

Properties of solid fuel for biomass power plants: bagasse, wood chips, rice husk, municipal waste Properties of liquid and gaseous fuel for biomass power plants: Jatropha, bio-diesel gobar gas Layout of a Bio-chemical based (e.g. biogas) power plant: Layout of a Thermo-chemical based (e.g. Municipal waste) power plant Layout of a Agro-chemical based (e.g. bio-diesel) power plant

Fundamentals of Power Electronics

Unit – I Power Electronic Devices

Power electronic devices Power transistor: construction, working principle, V-I characteristics and uses. IGBT: Construction, working principle, V-I characteristics and uses. Concept of single electron transistor (SET) - aspects of Nano- technology.

Unit – II Thyristor Family Devices

SCR: construction, two transistor analogy, types, working and characteristics. SCR mounting and cooling. Types of Thyristors: SCR, LASCR, SCS, GTO, UJT, PUT, DIAC and TRIAC Thyristor family devices: symbol, construction, operating principle and V-I characteristics. Protection circuits: over-voltage, over-current, Snubber, Crowbar.

Unit– III Turn-on and Turn-off Methods of Thyristors

SCR Turn-On methods: High Voltage thermal triggering, Illumination triggering, dv/dt triggering, Gate triggering. Gate trigger circuits – Resistance and Resistance-Capacitance circuits. SCR triggering using UJT, PUT: Relaxation Oscillator and Synchronized UJT circuit. Pulse transformer and opto-coupler based triggering. SCR Turn-Off methods: Class A- Series resonant commutation circuit, Class B-Shunt Resonant commutation circuit, Class C-Complimentary Symmetry commutation circuit, Class D – Auxiliary commutation, Class E- External pulse commutation, Class F- Line or natural commutation.

Unit– IV Phase Controlled Rectifiers

Phase control: firing angle, conduction angle. Single phase half controlled, full controlled and midpoint controlled rectifier with R, RL load: Circuit diagram, working, input- output waveforms,

equations for DC output and effect of freewheeling diode.Different configurations of bridge controlled rectifiers: Full bridge, half bridge with common anode, common cathode, SCRs in one arm and diodes in another arm.

Unit– V Industrial Control Circuits

Applications: Burglar's alarm system, Battery charger using SCR, Emergency light system, Temperature controller using SCR and; Illumination control / fan speed control TRIAC. SMPS. UPS: Offline and Online SCR based AC and DC circuit breakers.

ELECTRIC POWER TRANSMISSION AND DISTRIBUTION

Unit – I Basics of Transmission and Distribution

Single line diagrams with components of the electric supply transmission and distribution systems. Classification of transmission lines: Primary and secondary transmission; standard voltage level used in India. Classification of transmission lines: based on type of voltage, voltage level, length and others Characteristics of high voltage for power transmission. Method of construction of electric supply transmission system – 110 kV, 220 kV, 400 kV. Method of construction of electric supply distribution systems – 220 V, 400V, 11 kV, 33 kV

Unit – II Transmission Line Parameters and Performance

Line Parameters: Concepts of R, L and C of line parameters and types of lines. Performance of short line: Efficiency, regulation and its derivation, effect of power factor, vector diagram for different power factor. Performance of medium line: representation, nominal 'T', nominal 'π' and end condenser methods. Transposition of conductors and its necessity. Skin effect and proximity effect.

Unit– III Extra High Voltage Transmission

Extra High Voltage AC (EHVAC) transmission line: Necessity, high voltage substation components such as transformers and other switchgears, advantages, limitations and applications and lines in India. Ferranti and Corona effect. High Voltage DC (HVDC) Transmission Line: Necessity, components, advantages, limitations and applications. Layout of monopolar, bi-Polar and homo-polar transmission lines. Lines in India. Features of EHVAC and HVDC transmission line. Flexible AC Transmission line: Features, d types of FACTS controller. New trends in wireless transmission of electrical power.

Unit– IV A.C Distribution System

AC distribution: Components classification, requirements of an ideal distribution system, primary and secondary distribution system. Feeder and distributor, factors to be considered in design of feeder and distributor. Types of different distribution schemes: radial, ring, and grid, layout, advantages, disadvantages and applications. Voltage drop, sending end and receiving end voltage. Distribution Sub-Station: Classification, site selection, advantages, disadvantages and applications. Single Line diagram (layout) of 33/11KV Sub-Station, 11KV/400V sub-station, Symbols and functions of their components.

Unit– V Components of Transmission and Distribution Line

Overhead Conductors: Properties of material, types of conductor with trade names, significance of sag. Line supports: Requirements, types of line structures and their specifications, methods of erection. Line Insulators: Properties of insulating material, selection of material, types of insulators and their applications, causes of insulator failure, derivation of equation of string efficiency for string of three suspension insulator, methods of improving string efficiency. Underground Cables: Requirements, classification, construction, comparison with overhead lines, cable laying and cable jointing

INDUCTION, SYNCHRONOUS AND SPECIAL ELECTRIC MACHINES:

Unit – I Three Phase Induction Motor

Working principle: production of rotating magnetic field, Synchronous speed, rotor speed and slip. Constructional details of 3 phase induction motors: Squirrel cage induction motor and Slip ring induction motor. Rotor quantities: frequency, induced emf, power factor at starting and running condition. Characteristics of torque versus slip (speed), Torques: starting, full load and maximum with relations among them. Induction motor as a generalized transformer with phasor diagram. Four quadrant operation, Power flow diagram Starters: need and types; stator resistance, auto transformer, star delta, rotor resistance and soft starters. Speed control methods: stator voltage, pole changing, rotor resistance and VVVF. Motor selection for different applications as per the load torque-speed requirements. Maintenance of three phase induction motors

Unit – II Single phase induction motors

Double field revolving theory, principle of making these motors self-start. Construction and working: Resistance start induction run, capacitor start induction run, capacitor start capacitor run, shaded pole, repulsion type, series motor, universal motor, hysteresis motor. Torque-speed characteristics for all of the above motors. Motor selection for different applications as per the load torque-speed requirements. Maintenance of single phase induction motors

Unit– III Three phase Alternators

Principle of working, moving and stationary armatures. Constructional details: parts and their functions, rotor constructions. Windings: Single and Double layer. E.M.F. equation of an Alternator with numerical by considering short pitch factor and distribution factor. Alternator loading: Factors affecting the terminal voltage of alternator; Armature resistance and leakage reactance drops. Armature reaction at various power factors and synchronous impedance. Voltage regulation: direct loading and synchronous impedance methods. Maintenance of alternators

Unit– IV Synchronous motors

Principle of working /operation, significance of load angle. Torques: starting torque, running torque, pull in torque, pull out torque. Synchronous motor on load with constant excitation (numerical), effect of excitation at constant load (numerical). V-Curves and Inverted V-Curves. Hunting and Phase swinging. Methods of Starting of Synchronous Motor. Losses in synchronous motors and efficiency (no numerical). Applications areas

Unit– V Fractional horse power (FHP) Motors

Construction and working: Synchronous Reluctance Motor, Switched Reluctance Motor, BLDC, Permanent Magnet Synchronous Motors, stepper motors, AC and DC servomotors. Torque speed characteristics of above motors. Applications of above motors

MICROCONTROLLER APPLICATIONS

Unit – I Introduction to Microcontrollers

Evolution of MicrocontrollersBlock diagram of Microcomputer, elements of Microcomputer, types of buses Von Neuman and Harward Architecture Compare Microprocessor and Microcontrollers Need of Microcontroller Family of Microcontrollers and their specifications Versions of Microcontroller 8951, 89C1051, 89C2051, 89C4051 with their specifications and comparison

Unit – II Architecture of Microcontroller8051

Block diagram of 8051, function of each block Pin diagram, function of each pin Concept of Internal memory and External memory (RAM and ROM) Internal RAM structure Reset and clock circuit Various registers and SFRs of 8051

Unit– III 8051 Instruction Set and Programs

Overview of 8051 instruction set Various addressing modes Classification of instructions Data transfer instructions Arithmetic instructions Logical instructions Branching instructions Bit manipulation instructions Stack, subroutine and interrupt related instructions Programs based on above instructions.

Unit– IV Assembly Language Programming

Software development steps Software development tools like Editor, Assembler, Linker, Loader and Hex converters. Role of various files created at various levels in running a Assembly program using simulators like RIDE or KEIL. Various directives of Assembly language programming Programs using directives.

Unit– V 8051 Internal Peripherals and Related Programs

I/O ports- List, diagram, read write operation, instructions and related SFRs Timers/counters – list, related SFRs, programming modes, operations with diagram. Serial communication- Basics of serial communication, baud rate, related SFRs, programming modes, operations with diagram.Interrupts- related SFRs, types, operations with diagram. Power saving operation- modes, related SFR

ENERGY CONSERVATION AND AUDIT

Unit – I Energy Conservation Basics

Energy Scenario: Primary and Secondary Energy, Energy demand and supply, National scenario. Energy conservation and Energy audit; concepts and difference Indian Electricity Act 2001; relevant clauses of energy conservation BEE and its Roles MEDA and its Roles Star Labelling: Need and its benefits.

Unit – II Energy Conservation in Electrical Machines

Need for energy conservation in induction motor and transformer. Energy conservation techniques in induction motor by: Improving Power quality. Motor survey Matching motor with loading.

Minimizing the idle and redundant running of motor. Operating in star mode. Rewinding of motor. Replacement by energy efficient motor Periodic maintenance Energy conservation techniques in Transformer. Loading sharing Parallel operation Isolating techniques. Replacement by energy efficient transformers. Periodic maintenance. Energy Conservation Equipment: Soft starters, Automatic star delta convertor, Variable Frequency Drives, Automatic p. f. controller (APFC), Intelligent p. f. controller (IPFC) Energy efficient motor; significant features, advantages, applications and limitations Energy efficient transformers, amorphous transformers; epoxy Resin cast transformer / Dry type of transformer.

Unit– III Energy conservation in Electrical Installation systems

Aggregated Technical and commercial losses (ATC); Power system at state, regional, national and global level. Technical losses; causes and measures to reduce by. a) Controlling I2R losses. b) Optimizing distribution voltage c) Balancing phase currents d) Compensating reactive power flow Commercial losses: pilferage, causes and remedies Energy conservation equipment: Maximum Demand Controller , kVAR Controller, Automatic Power Factor controller(APFC) Energy Conservation in Lighting System a) Replacing Lamp sources. b) Using energy efficient luminaries. c) Using light controlled gears. d) Installation of separate transformer / servo stabilizer for lighting. e) Periodic survey and adequate maintenance programs. Energy Conservation techniques in fans, Electronic regulators.

Unit– IV Energy conservation through Cogeneration and Tariff

Co-generation and Tariff; concept, significance for energy conservation Co-generation Types of cogeneration on basis of sequence of energy use (Topping cycle, Bottoming cycle) Types of cogeneration basis of technology (Steam turbine cogeneration, Gas turbine cogeneration, Reciprocating engine cogeneration). Factors governing the selection of cogeneration system. Advantages of cogeneration. Tariff: Types of tariff structure: Special tariffs; Time-off-day tariff, Peak-off-day tariff, Power factor tariff, Maximum Demand tariff, Load factor tariff. Application of tariff system to reduce energy bill.

Unit– V Energy Audit of Electrical System

Energy audit (definition as per Energy Conservation Act) Energy audit instruments and their use. Questionnaire for energy audit projects. Energy flow diagram (Sankey diagram) Simple payback period, Energy Audit procedure (walk through audit and detailed audit). Energy Audit report format.

BUILDING ELECTRIFICATION

Unit – I Wiring Tools and Accessories

Various tools required for wiring- screwdrivers, pliers, Try square, saws, hacksaw, chisel, hammers, mallet, rawl punch, hand drill machine, portable drilling machine, files, plumb bob, line thread, electricians knife, test lamp, tester and their BIS specifications, application, care & maintenance of tools. Classification of electrical accessories- controlling, holding, safety, outlet BIS symbols of following electrical accessories.

Switch – Their types according to construction such as surface switch, flush switch, and pull switch, rotary switch, knife switch, pendent switch, Main-switch (ICDP, ICTP). Their types according to

working such as single pole, double pole, two-way, two-way centre off, intermediate, series parallel switch

Holders- Their types such as bayonet cap lamp holder, pendent holder, batten lamp holder, angle holder, bracket holder, tube light holder, screw type Edison and goliath Edison lamp holder, swivel lamp holder.

Socket outlets and plugs- two pin, three-pin, multi pin sockets, two-pin and three-pin plug.

Others- Iron connector, adaptor, and ceiling rose, distribution box, neutral link, bus-bar chamber. Wooden/ mica boards, Moulded/ MS Concealed boxes of different sizes. Modular accessories.

Unit – II Electrical Wires and Underground Cables

Conductors: - wire, cable, bus bar, stranded conductor, cable, armoured cable, flexible cable, solid conductor, PVC wires, CTS wire, LC wire, FR (Fire retardant) wire, Size of wire according to BIS. Tools used for measurement of wire size, Wire jointing methods. Classification of cables, low tension, high tension, and extra high tension cables, solid, oil filled and gas filled type Cable insulation materials – vulcanized rubber (VIR), polyvinyl chloride (PVC), cross linked polythene (XLPE), impregnated paper, Selection of suitable cable size and type from standard data Cable jointing methods Cable laying methods. Factors determining selection of electric cables

Unit– III Wiring Methods and wiring layout

Factors determining the selection of wiring methods. Classification of wiring methods. PVC casing-capping wiring- wiring rules according to IS: 732-1983 Conduit wiring- Types of conduit, comparison between Metal and PVC conduit, types of conduit wiring (Surface/Concealed). Conduit wiring accessories, BIS rules for Metal and PVC conduit wiring. Comparison of various wiring systems. General BIS rules for domestic installations. Design, working and drawing of following electrical circuits: Simple light and fan circuits, Stair case wiring, Go-down wiring circuit, Bedroom lighting circuit, Corridor lighting circuit, Series parallel circuit, Master switch control circuit, Different lighting circuit using - Intermediate switch, Call bell circuit using bell indicator, Design of wiring circuits according to user's requirement

Unit– IV Residential Building Electrification

Domestic Dwellings/Residential Buildings: reading of Civil Engineering building drawing, Interpretation of electrical installation plan and electrical diagrams, electrical symbols as per IS: 732. Electrical installation for residential building as per part I section 9 of NEC-2011 Difference between residential and industrial load, rules/requirements related to lighting load followed in electrical installations, Positioning of equipment. Lighting and power circuits: Light and fan circuit, Power circuit Wiring and circuit Schematic diagram according to IS: 2042(Part-I)-1962: multiline and single line representation Load assessment: Selection of size of conducto, Selection of rating of main switch and protective switch gear. Design and drawing, estimation and costing of a residential installation having maximum 5 KW load; Sequence to be followed for preparing estimate; Calculation of length of wire and other materials, labour cost Testing of wiring installation as per IS: 732-1982: Insulation resistance - between earth and conductors, between conductors, polarity test of single pole switches. Testing of earth continuity path. Residential building Service Connection- types Underground and overhead. Calculation of Material required for service connection

Unit– V Protection of Electrical Installation

Fuse in electric circuit: fuse element, fuse current rating, minimum fusing current, cut-off current, fusing factor, Fuse material Types of fuses –Re-wirable, cartridge fuses (HRC and LRC), Fuse material Selection of fuse. Miniature circuit Breaker (MCB)-Construction, Principle rating and uses, Earth Leakage Circuit Breaker (ELCB)-Construction, Principle rating and uses. System and equipment earthing and its requirements, Earth, earth electrode, earth current, earth terminal, earthing wire, earthing lead, fault current, leakage current, Measurement of earth resistance using earth tester, Methods of reducing earth resistance, Methods of earthing as per IS 3043: 1987 and their procedure- Driven pipe, pipe and plate earthing, modern methods of earthing,

Unit– V Illumination in Residential Installation

Concept of Luminous flux, Luminous intensity, Lumen, Illumination or illuminance, Lux, Space-height ratio, utilization factor, depreciation factor, luminous efficiency- values for different luminaries. Laws of Illumination-Inverse Square Law, Cosine Law, illumination received directly underneath, horizontal screen and screen moved horizontally at certain distance Factors affecting the illumination. Different types of lighting arrangements, Luminous flux of different types of light sources, Lux level required for different places as per SP 72: 2010

INDUSTRIAL INSTRUMENTATION AND CONDITION MONITORING

Unit – I Fundamentals of instrumentation

Basic purpose of instrumentation. Basic block diagram (transduction, signal conditioning, signal presentation) and their function. Construction, working and application of switching devices- Push button, limit switch, float switch, pressure switch, thermostat, electromagnetic relay.

Unit – II Transducers

Distinguish between Primary and Secondary, Electrical and Mechanical, Analog and Digital, Active and Passive. Mechanical devices pry. And sec. transducers Advantages of electric transducers Required characteristics of transducers. Factors affecting the choice of transducers Construction and principle of resistive transducer-Potentiometer –variac and strain gauges -No derivation. Only definition and formula for gauge factor Types of strain gauges like unbonded, bonded and semiconductor. Construction and principle of Inductive transducers-L.V.D.T. and R.V.D.T, their applications. Construction, principle and applications of transducers – Piezo-Electric transducer, photoconductive cells, photo voltaic cells.

Unit– III Measurement of Non-Electrical Quantities

Temperature measurement - Construction and Working of RTD, Thermistor and Thermocouple, radiation pyrometer, technical specifications and ranges. Pressure measurement – Construction and working of bourdon tube, bellow diaphragm and strain gauge, Combination of diaphragm and inductive transducer, Bourdon tube and LVDT, bellow and LVDT, diaphragm capacitance and bridge Circuit. Construction and Working of Speed Measurement by contacting and non-Contact Type- DC tachometer, photo- electric tachometer, toothed rotor tachometer Generator - magnetic pickup and Stroboscope. Construction and Working of Vibration measurement by accelerometer-LVDT accelerometer, Piezo electric type. Construction and Working of Flow measurement by electromagnetic and Turbine Flow meter. Construction and Working of Liquid level measurement by resistive, inductive, Capacitive gamma rays and Ultrasonic methods. Construction and Working of Thickness measurement by resistive, inductive, capacitive, ultrasonic and Nuclear methods.

Unit– IV Signal Conditioning

Basic Concept of signal conditioning System. Draw pin configuration of IC 741. Define Ideal OP-AMPand Electrical Characteristics of OP-AMP. Different Parameters of op-amp:-Input offset voltage, Input offset current, Input bias current, Differential input resistance, CMMR, SVRR, voltage gain, output voltage, slew rate, gain bandwidth. Output, short circuit current. Use of op-amp as inverting, non- inverting mode, adder, subtractor, and Working of Differential amplifier and instrumentation amplifier. Filters: Types of RC filters and frequency response -no derivation. Sample and hold circuits - operation and its application.

Unit– V Data Acquisition System

Generalized DAS- Block diagram and description of Transducer, signal conditioner, multiplexer, converter and recorder Draw Single Channel and Multi-channel DAS- Block diagram only. Difference between Signal Channel and Multi-Channel DAS. Data conversion- Construction and Working of Analog to digital conversion- successive approximation method, ramp type method. Digital to Analog conversion- Construction and Working of binary weighted resistance method. Concept and methods of data transmission of electrical and electronic transmission. Construction and principle of telemetry system and its type - Electrical telemetering systemDigital display device- operation and its application of seven segment display, dot matrix display and concept of 3½, 4½ digits, LED and LCD applications

Unit– VI Condition Monitoring and Diagnostic Analysis

Definition of condition monitoring Insulation deterioration Mechanism- factors affecting occurrence and rate of deterioration, types of stresses responsible for deterioration Different tests on transformer, their purpose, and the necessary condition of machine. Tests on Circuit breaker, purpose and required condition of machine Tests on CT, purpose, item to be tested and required condition of machine. Power factor, capacitance /tan delta test Insulation and Polarization index, DC winding resistance test, Turns Ratio test Tools and equipment used in Condition monitoring

INDUSTRIAL AUTOMATION AND CONTROL

Unit – I Introduction to Industrial Automation

Automation: Need and benefits. Types of automation system: Fixed, Programmable, Flexible Different systems used for Industrial automation: PLC, HMI, SCADA, DCS, Drives. Evolution of PLC.

Unit – II PLC Fundamentals

Building blocks of PLC: CPU, Memory organization, Input- output modules (discrete and analog), Specialty I/O Modules, Power supply Fixed and Modular PLC and their types, Redundancy in PLC moduleI/O module selection criteria Interfacing different I/O devices with appropriate I/O modules

Unit– III PLC Programming and Applications

PLC I/O addressing, PLC programming Instructions: Relay type instructions, Timer instructions: On delay, off delay, retentive, Counter instructions: Up, Down, High speed, Logical instructions, Comparison Instructions, Data handling Instructions, Arithmetic instructions. PLC programming language: Functional Block Diagram (FBD), Instruction List. Structured text, Sequential Function Chart (SFC), Ladder Programming. Simple Programming examples using ladder logic: Language based on relay, timer counter, logical, comparison, arithmetic and data handling instructions. PLC Based Applications: Motor sequence control, Traffic light control, Elevator control, Tank Level control,

Conveyor system, Stepper motor control, Reactor Control Gate trigger circuits – Resistance and Resistance-Capacitance circuits.

Unit– IV Electric Drives and special machines

Electric drives: Types, functions, characteristics, four quadrant operation. DC and AC drive controls: V/F control, Parameters, direct torque control. Drives: Specifications, Applications- Speed control of AC motor /DC Motor.

Unit– V Supervisory Control and Data Acquisition System (SCADA)

Introduction to SCADA: Typical SCADA architecture/block diagram, Benefits of SCADA Various editors of SCADA Interfacing SCADA system with PLC: Typical connection diagram, Object Linking & embedding for Process Control(OPC) architecture, Steps in Creating SCADA Screen for simple object, Steps for Linking SCADA object (defining Tags and Items) with PLC ladder program using OPC. Applications of SCADA: Traffic light control, water distribution, pipeline control.

INDUSTRIAL DRIVES

Unit – I Electric Drives

Need of Electric Drives, Functional Block diagrams of an electric drives. DC Motors, Motor Rating a. Series, Shunt and compound DC motors. b. Universal motor c. Permanent magnet motor d. DC servo motor e. Moving coil motor f. Torque motor. Starting and Braking of DC MotorsBrushless DC Motors for servo applications. Maintenance procedure.

Unit – II AC Motors

Single phase AC Motors a) Resistance split phase motors b) Capacitor run motors c) Capacitor start motors d) Shaded pole motors; Three phase Induction Motors a) Squirrel cage Induction motor b) Slip ring Induction Motor c) Starting methods of Induction Motor d) Braking methods of Induction Motor; Determination of Motor Rating, Maintenance procedure.

Unit– III DC Drives

Single phase SCR Drives a) Half wave converter b) Full wave converter c) Semi converter d) Dual converter; Three Phase SCR Drives a) Half wave converter b) Full wave converter c) Semi converter d) Dual converter; Reversible SCR Drives. Speed control methods of DC series Motor Chopper Controlled DC Drives Solar and battery powered vehicles Maintenance procedure.

Unit– IV AC Drives

Starting and Braking of Induction motors. Stator voltage control, Variable Frequency Control, Voltage Source Inverter Control, Current Source Inverter Control, Rotor Resistance Control, Slip Power Recovery, Solar powered pump drives, Maintenance procedure for AC drives, Sequences of stages & drives required in each stage for following applications: a) Textile mills b) Steel rolling mills c) Paper mills d) Sugar mills

Unit– V Advanced Techniques of Motor Control

Microcontroller/ Microprocessor based control for drives, Phase locked loop control of DC motor. AC/DC motor drive using Microcomputer control, AC/DC motor drive using Microcontroller control.

Synchronous Motor drives. Ratings & specifications of stepper motor. Stepper motor drives employing microcontroller (No programming)

COMMUNICATION TECHNOLOGIES

Unit – I Data Communication and Modulation

Block diagram of communication system, Types of communication system: synchronous and asynchronous, simplex, half-duplex, Full duplex, serial and parallel communication; Classification of communication technique: AM, FM, & PM on the basis of definition, waveform, bandwidth, modulation index; Modulation and demodulation: Block diagram of AM, FM and PM; Pulse Modulation: Block diagram for waveform generation of PAM,PWM& PPM, working principle, advantages, disadvantages and applications. Advantages of pulse modulation over AM and FM.

Unit – II Digital Modulation Techniques

Digital Communication: Block diagram and working principle, waveforms, strength and limitations; Sampling process Nyquist sampling theorem, quantization process, quantization error, quantization noise; PCM: Block diagram, working principle, waveforms, advantages, disadvantages, application of PCM. Principle of ASK, PSK, FSK. Application of ASK, PSK, FSK

Unit– III Data Communication Media

Baud rate, Bit rate, types of errors in data communication and error correction techniques. Types of communication media and frequency band of operation. Guided media: Types of cable-twisted pair cable, co-axial cable, fiber optic cable. Unguided media: Microwave communication, Infrared communication.

Unit– IV Fibre Optics

Introduction to Fiber optic communication. Strength and limitations of fiber optic system. Light propagation : reflection, refraction, Snell's law; Light propagation through cable: Mode of propagation, index profile; Fibre optic cables: cable construction, fibre optics cable modes, single mode, step index fibre, multimode index fibre, multimode graded index fibre, fibre cable losses. Light source and Detector: Light emitting diode (LED), Photo Transistor, Laser diode, optocoupler.

Unit– V Data Communication Protocols and Interfacing Standard

OSI (Open Systems Interconnection) Reference model; Introduction to protocol, FTP, SMTP, TCP/IP, UDP; LAN standards. Introduction to IEEE Standards for LAN and GPIB; RS-232 standard: Introduction, and working principle; Network topologies, introduction star, ring, tree, bus, mesh, hybrid; Basic functions of networking devices: modem, switches, routers, repeaters, hubs, bridges, gateway.

Unit– VI Advanced Data Communication

Introduction to Wi-Fi and Wi- Max; Bluetooth architecture and its layers, Universal serial bus (USB) architecture. Bluetooth and USB

ELECTRICAL TESTING AND COMMISIONING

Unit – I Electrical Safety and Insulation

Do's and don'ts regarding safety in domestic electrical appliances as well for substation/ power station operators; Electrical safety in industry/power stations/ substations at the time of operation/ control/ maintenance. Fire detection alarm, fire-fighting equipments; Factors affecting life of insulating materials, classifications of insulating materials as per IS:1271-1958; Measuring insulation resistance by different methods such as i) Polarization, ii) Dielectric absorption, iii) Megger and to predict the condition of insulation; Reconditioning of insulation, Insulating oil - properties of insulating oil, causes of deterioration of oil, testing of transformer oil as per IS 1866-1961

Unit – II Installation and Erection

Concept of foundation for installation of machinery. Requirements of foundation for static and rotating electrical machinery. Concept of leveling and aligning Procedure for leveling and aligning alignment of direct coupled drive, effects of mis-alignment; Installation of transformer as per I.S.-1886-1967 and procedure of installation of transformer, Requirements of installation of pole mounted transformer; Requirements of installation of rotating electrical machines as per I.S. 900 – 1965; Devices and tools required for loading, unloading, lifting, and carrying heavy equipment and precautions to be taken while handling them.

Unit– III Testing and Commissioning

Concept of testing, Objectives of testing. Roles of I.S.S. in testing of electrical equipment, Types of tests and concepts, Routine tests, type tests, supplementary test, special tests, Methods of testing - Direct/Indirect/Regenerative testing. Tolerances for the various items for equipment –transformer, induction motor, dc motor, synchronous machines ; Commissioning, Tests before Commissioning for transformer, induction motor, alternator; Testing of transformer as per I.S.1886- 1967 and I.S.2026-1962; Testing of three-phase Induction motor as per I.S.325 - 1970. Testing of single-phase induction motor as per I.S.990-1965. Testing of synchronous machines as per ISS. Testing of D.C. machines

Unit– IV Troubleshooting Plans

Internal and external causes for failure / abnormal operation of equipment. List of mechanical faults, electrical faults and magnetic faults in the electrical equipment remedies, applications; Use of tools like bearing puller filler gauges, dial indicator, spirit level, megger, earth tester, and growler. Common troubles in electrical equipments and machines. Preparation of trouble shooting charts for D.C. Machines, AC Machines and transformers.

Unit– V Maintenance

Concept of maintenance, types of maintenance, Routine, preventive and breakdown maintenance. Causes of failure of electrical machines; Preventive maintenance-procedure or developing maintenance schedules for electrical machines. Factors affecting preventive maintenance schedules, Concept of TPM, Pillars of TPM; Identification of different types of faults developed such as mechanical/ electrical/ magnetic faults; Maintenance schedules of the following as per I.S.S. a) Distribution transformer as per I.S.1886-1967 b) Single phase and three phase Induction motors as per I.S.900-1965. c) Batteries

ELECTRICAL ESTIMATION AND CONTRACTING

Unit – I Electric Installation and Safety

Scope and features of National electric code 2011; Types of electrical installation; Fundamental principles for electrical installation; Permit to work, safety instructions and safety practices; Purpose of estimating and costing.

Unit – II Estimation and Costing

Meaning and purpose of- Rough estimate, detailed estimate, supplementary estimate, annual maintenance estimate and revised estimate; Factors to be considered while preparation of detailed estimate and economical execution of work; Contracts- Concepts of contracts, types of contracts, contractor, role of contractor; Tenders and Quotations- Type of tender, tender notice, preparation of tender document, and method of opening of tender; Quotation, quotation format, comparison between tender and quotation; Comparative statement, format comparative statement. Order format, placing of purchasing order. Principles of execution of works, planning, organizing and completion of work, Billing of work

Unit– III Non-Industrial Installations

Types of Non-industrial installations-- Office buildings, shopping and commercial centre, residential installation, Electric service and supply; Design consideration of electrical installation in commercial buildings. Design procedure of installation- steps involved in detail, Estimating and costing of unit; Earthing of commercial installation. Design electrical installation scheme of commercial complex. Erection, Inspection and testing of installation as per NEC

Unit– IV Industrial Installation

Classification of industrial buildings Classification based on power consumption,Drawing of wiring diagram and singleline diagram for single phase and three phase Motors. Design consideration in industrial installations Design procedure of installation-detailed steps;Design electrical installation scheme of factory/ small industrial unit, Preparation of material schedule and detailed estimation; Installation and estimation of agricultural pump and flourmill

Unit– V Public Lighting Installation

Classification of outdoor installations streetlight/ public lighting installation; Street light pole structures. Selection of equipments, sources used in street light installations. Cables, recommended types and sizes of cable. Control of street light installation. Design, estimation and costing of streetlight; Preparation of tenders and abstracts.

Unit– VI Distribution Lines and LT Substation

Introduction to overhead and underground distribution line. Materials used for distribution line HT and LV; Cables used for distribution line, factors determining selection of LT/ HT power Cables, cable laying and cable termination method according to IS; Design, estimation and costing of HT LT overhead line and underground cabling. Types of 11 KV Distribution substations their line diagram, Estimation of load, Load factor, diversity factor and determination of rating of distribution. Transformer. Design, estimation and costing of outdoor and indoor 11 KV substation

ILLUMINATION PRACTICES

Unit – I Fundamentals of illumination

Basic illumination, Terminology, Laws of illumination Polar curves, polar curve: its meaning and applications for designing the lamp. Concept of Photometry, Measurement of illumination Lighting calculation methods, Watt /m2 method, Lumens or light flux method, Point to point method Standards for illumination

Unit – II Types of lamps

Incandescent lamp, ARC lamps – AC and DC arc lamps, Fluorescent lamp Types of other lamps: Mercury vapour lamp, HPMV lamp, Mercury iodide lamp, Sodium vapour lamp, Halogen Lamps, Ultraviolet Lamps, Neon Lamps. Neon Sign Tubes. Metal halides, HID and Arc lamps LED lamps, CFL, Lasers Selection Criteria for lamps

Unit– III Illumination Control and Control Circuits

Purpose of lighting control, and Dimmer, Resistance type Salt water Dimmer Working principle and operation of Dimmer Transformer and their types, Dimmer Transformer, Auto transformer dimmer, Two winding transformer dimmer Electronic Dimmer: working principle and operation a. Thyristor operated dimmer b. Triac operated dimmer Control of Enhance Lighting, Methods used for light control, Control circuits for lamps (refer): ON/OFF control Control circuits for lamps: single lamp controlled by single switch, two switches. Single Lamp control by two point method, three point method and four point method,

Unit– IV Illumination for Interior Applications

Standard for various locations of Interior Illumination Design considerations for Interior location of residences (1/2/3/4 BHK), Commercial, Industrial premises Illumination scheme for different Interior locations of Residential, Commercial, industrial unit

Unit– V Illumination for Interior Applications

Factory Lighting Street Lighting (Latest Technology), Flood Lighting Railway Lighting Lighting for advertisement /Hoardings/sports lighting, Agriculture and Horticulture lighting, Health Care Centres / Hospitals, Decorating Purposes, Stage Lighting, Aquariums and Shipyards Special purpose lamps used in photography video films

SWITCHGEAR AND PROTECTION

Unit – I Basics of Protection

Necessity, functions of protective system. Normal and abnormal conditions. Types of faults and their causes. Protection zones and backup protection Short circuit fault calculations in lines fed by generators through transformers Need of current limiting reactors and their arrangements.

Unit – II Circuit Interruption Devices

Isolators- Vertical break, Horizontal break and Pantograph type. HRC fuses – Construction, working, characteristics and applications. Arc formation process, methods of arc extinction (High resistance and Low resistance), Arc voltage, Recovery voltage, Re-striking voltage, RRRV. HT circuit breakers (Sulphur-hexa Fluoride (SF6), Vacuum circuit breaker) - Working, construction, specifications and applications. L.T. circuit breaker (Air circuit breakers (ACB), Miniature circuit breakers (MCB), Moulded case circuit breakers (MCCB) and Earth leakage circuit breaker (ELCB)) - Working and

applications. Selection of LT and HT circuit breakers (ratings), Selection of MCCB for motors. Gas insulated switchgear.

Unit– III Protective Relays

Fundamental quality requirements: Selectivity, Speed, Sensitivity, Reliability, Simplicity, Economy. Basic relay terminology- Protective relay, Relay time, Pick up, Reset current, current setting, Plug setting multiplier, Time setting multiplier. Protective relays: Classification, principle of working, construction and operation of – Electromagnetic (Attracted armature type, Solenoid type, Watt-hour meter type) relay, Thermal relay. Block diagram and working of Static relay. Overcurrent relay-Time current characteristics Microprocessor based over current relays: Block diagram, working. Distance relaying- Principle, operation of Definite distance relays. Directional relay: Need and operation. Operation of current and voltage differential relay.

Unit– IV Protection of Alternator and Transformer

Alternator Protection : Faults, Differential protection Over current, earth fault, overheating and field failure, protection. Reverse power protection.

Transformer Protection: Faults, Differential, over current, earth fault, over heating protection, Limitations of differential protection. Buchholz relay: Construction, operation, merits and demerits.

Unit– V Protection of Motors, Bus-bar and Transmission Line Motor

Faults. Short circuit protection, Overload protection, Single phase preventer.

Bus bar and Transmission line : Faults on Bus bar and Transmission Lines. Bus bar protection: Differential and Fault bus protection. Transmission line: Over current, Distance and Pilot wire protection.

SOLAR POWER TECHNOLOGIES

Unit – I Solar Energy

Solar Map of India: Global solar power radiation; Different types of Solar water heaters: Construction, working, specifications and installation; Solar Heating systems; Solar drying and different types of Solar cookers; Solar lighting. Preventive maintenance of all of the above.

Unit – II Concentrated Solar Power (CSP)

Concentrated Solar Power (CSP) plants or solar thermal electric systems; Parabolic Trough: Construction, working and specifications; Parabolic Dish: Construction, working and specifications; Power Tower, Fresnel Reflectors: Construction, working and specifications; Solar Stirling engines; Preventive maintenance of all of the above

Unit– III Solar PV Systems

Solar PV cell: Types construction, working, Typical specifications of solar cells; Solar PV working principle: Series and parallel connections of solar modules; Solar Photovoltaic (PV) system: components layout and working. Solar modules, arrays and their standard specifications; Roof top and streetlight solar PV systems and typical specifications; Maintenance of these systems

Unit– IV Solar PV Electronics

Solar Charge controllers: working and specifications, switchgear and cables; Batteries: Different types for solar PV systems, maintenance and specifications; Solar Inverters: working and specifications; Signal conditioning systems: working and specifications; Solar Power tracking: construction, working, tilt angle, solar radiation, I-V, P-V characteristics, maximum power point tracking (MPPT); Maintenance of these systems.

Unit– V Solar PV Off-grid and Grid Tied Systems

Solar off grid systems: layout and specifications; Solar Grid tied (on grid) systems: Working principle of grid-tied dc-ac inverter, grid synchronization and active power export; Net metering: main features and working ;Solar-wind Hybrid systems: Layout and specifications.

WIND POWER TECHNOLOGIES

Unit – I Wind Energy and Wind Power Plants

Wind power scenario in the world and India

Characteristics of Wind Energy: Wind movement, wind profile, roughness, effects of obstacles in wind path.

Types of Wind Power Plants (WPPs): Small and large wind turbines; Horizontal and Vertical axis; Upwind and Downwind, One, Two and Three blades; constant and variable Speed; Geared, Direct-Drive and Semi-Geared (Hybrid) WPPs; WECS, WEGs, WTs, WPPs,

WPP Tower Types: Lattice; tubular: steel, concrete, hybrid, ladders, cables.

WPP substation: Switchgear, transformers, inside layouts of Electric electronic panels at block level.

Unit – II Construction and Working of Large Wind Power Plants

Wind Turbine Terminologies: Cut-in, cut-out and survival wind speeds, Threshold wind speeds, rated power, nominal power, Wind Power Curve,

Major parts and Functions of WPP: Rotor blades, hub, nacelle, tower, electric sub-station, nacelle layouts of Geared, Direct-Drive and Semi-Geared WPPs, Main shaft, gearbox, electric generator, electronic control panels

Rotation principles: Drag and Lift principle, thrust and torque of wind turbine rotor.

Different types of Sensors: Anemometer, wind vane, rpm sensors of main shaft and generator, temperature sensors of nacelle, gearbox and generator; cable untwisting and vibration sensors. **Different types of Actuators**: Electric and hydraulic pitching and yawing mechanisms, cable untwisting and braking mechanisms

Unit– III Aerodynamic Control, Electric Generators and Grid Connection

Aerodynamic Control of WPPs: Stall Pitch and Active Stall. Braking mechanisms of large WPPs. Electric Generator Types: Working of Squirrel-Cage rotor Induction Generator (SCIG), Wound-Rotor Induction Generator (WRIG), Doubly-Fed Induction Generator (DFIG), wound rotor and permanent magnet synchronous generators. Electric grid connection of WPPs: Local Impacts and system wide impact

Unit– IV Maintenance of Large Wind Power Plants

General maintenance of WPPs: preventive maintenance schedule of actuators such as yaw control, pitch control, braking mechanisms and sensors; oiling and greasing; electric and electronic equipment related; tower related; minor repairs, some tips,

Scheduled Maintenance: of Stall and Pitch and Active Pitch controlled WPPs

Unscheduled maintenance: operational factors, design faults, wear and tear of components, spurious trip, Major repairs. Software related, warranty and insurance related issues

Unit– V Construction and Working Small Wind Turbines

Types and working of different type of small wind turbines (SWT): Classification: Horizontal and Vertical axis, Upwind and Downwind, One, Two and Three blades; Constant and Variable Speed; Direct-Drive and Geared; braking of SWTs

Parts of SWTs: Rotor, generator, gearbox, tower, electric control panel, tale vane, anemometer, wind vane, temperature and rpm sensors.

Working SWTs: Direct-drive and Geared.

Electrical generators in SWTs: permanent magnet synchronous generators, induction generators SWT towers: Lattice tubular type, hydraulic towers, ladders, cables,

Unit– VI Maintenance of Small Wind Turbines

Small wind turbine assembly. Installation of different types of small wind turbines (SWT): tubular and lattice types. SWT Routine maintenance: Tips; Preventive maintenance schedule of: braking mechanisms, sensors; oiling and greasing related; electric and electronic equipment related; tower related; software related, minor repairs; Power electronic devices and converters in different types of SWTs: thyristors, power transistors; Common electrical and mechanical faults in SWTs

BIOMASS AND MICRO-HYDRO POWER PLANTS

Unit– I Basics of Biomass-based Power Plants

Properties of solid fuel for biomass power plants: bagasse, wood chips, rice husk, municipal waste; Properties of liquid and gaseous fuel for biomass power plants: Jatropha, bio-diesel gobar gas; Layout of a Bio-chemical based (e.g. biogas) power plant: Layout of a Thermo-chemical based (e.g. Municipal waste) power plant; Layout of a Agro-chemical based (e.g. bio-diesel) power plant; Selection of biomass power plants.

Unit– II Biomass Gasification Power Plants

The basic principle to convert Agriculture and forestry products and wood processing remains (including rick husks, wood powder, branches, offcuts, corn straws, rice straws, wheat straws, cotton straws, fruit shells, coconut shells, palm shells, bagasse, corncobs) into combustible gas; General Construction and working of a typical gasifier; Power generating in gas engine: Strengths and limitations of Agriculture and forestry products gasifier; Preventive maintenance steps different types of biomass gasifiers.

Unit– III Different Types of Gasifiers

Construction and working of the following types of gasifiers: Rice Husk Gasification Power Plant and their specifications; Straw Gasification Power Plant and their specifications; Bamboo Waste, Bamboo Chips Gasification Power Plantand their specifications; Coconut shell, coconut peat, coconut husk, Gasification Power Plantand their specifications; Bagasse/Sugar Cane Trash Gasification Power Plantand their specifications; Gobar gas plant and its specifications; Breakdown maintenance of biomass power plant at the module level.

Unit– IV Micro-hydro Power Plants

Locations of microhydro power plant; Energy conversion process of hydro power plant. Classification of hydro power plant: High, medium and low head. General Layouts of typical micro-hydro power plant. Strengths and limitations of microhydro power plants

Unit– V Different types of Microhydopower plants

Construction and working of High head – Pelton turbineand their specifications; Construction and working of Medium head – Francis turbine and their specifications; Construction and working of Low head – Kaplan turbine and their specifications; Preventive and breakdown maintenance of microhydro power plants; Safe Practices for microhydro power plants

ELECTRIC VEHICLES

Unit – I Introduction to Hybrid Electric Vehicles

Evolution of Electric vehicles; Advanced Electric drive vehicle technology Vehicles-Electric vehicles (EV), Hybrid Electric drive (HEV), Plug in Electric vehicle (PIEV), Components used Hybrid Electric Vehicle; Economic and environmental impacts of Electric hybrid vehicle; Parameters affecting Environmental and economic analysis; Comparative study of vehicles for economic, environmental aspects

Unit – II Dynamics of hybrid and Electric vehicles

General description of vehicle movement; Factors affecting vehicle motion- Vehicle resistance, tyre ground adhesion, rolling resistance, aerodynamic drag, equation of grading resistance, dynamic equation; Drive train configuration, Automobile power train, classification of vehicle power plant ; Performance characteristics of IC engine, electric motor, need of gear box; Classification of motors used in Electric vehicles; Basic architecture of hybrid drive trains, types of HEVs; Energy saving potential of hybrid drive trains; HEV Configurations-Series, parallel, Series-parallel, complex.

Unit– III DC-DC Converters for EV and HEV Applications

EV and HEV configuration based on power converters; Classification of converters –unidirectional and bidirectional; Principle of step down operation; Boost and Buck- Boost converters; Principle of Step-Up operation; Two quadrant converters; multi quadrant converters

Unit– IV DC-AC Inverter & Motors for EV and HEVs

DC-AC Converters; Principle of operation of half bridge DC-AC inverter (R load, R-L load); Single phase Bridge DC-AC inverter with R load, R-L load; Electric Machines used in EVs and HEVs, principle

of operation, working &control; Permanent magnet motors, their drives, switched reluctance motor; Characteristics and applications of above motors

Unit– V Batteries

Overview of batteries; Battery Parameters, types of batteries; Battery Charging, alternative novel energy sources-solar photovoltaic cells, fuel cells, super capacitors, flywheels; Control system for EVs and HEVs, overview, Electronic control unit ECU; Schematics of hybrid drive train, control architecture; Regenerative braking in EVs

ELECTRIC TRACTION

Unit – I Basics of Traction

General description of Electrical Traction system in India. Advantages and Disadvantages of Electric Drive, Diesel Electric Drive, Battery Drive; Problems associated with AC traction System and remedies for it. Voltage balance, current balance, production of harmonics, induction effects. Metro rail system, features

Unit – II Power Supply Arrangements

Constituents of supply system: Substation: layout, list of equipment and their functions ; Feeding post: list of equipment and their functions; Feeding and sectioning Arrangements ; Sectioning and paralleling post ; Sub sectioning and Paralleling post ; Sub sectioning post ; Elementary section

Major equipment at substation, Miscellaneous equipment at control post or Switching station Protection system for traction transformer and 25 kV centenary construction

Unit– III Overhead Equipment

Different types of overhead equipments; Pentagonal OHE Centenary Construction; Different Types of Centenary according to speed Limit; OHE Supporting Structure, Cantilever assembly diagram; Overhead system- Trolley collector, Bow collector, Pantograph Collector; Types and construction of pantograph

Unit– IV Electric Locomotive

Classification and Nomenclature of Electric Locomotive; Block diagram of AC locomotive; Power Circuit of AC Locomotive; Equipment (List and Function only) used in auxiliary circuit of AC Locomotive; Loco bogie classification according to wheel arrangements; Maintenance of AC systems

Unit– V Traction Motors and Train Lighting

Desirable characteristics of traction motor. Types of motors used for traction with their characteristics and features; Control of motors used for traction and methods to control; Requirements of braking, types of braking; Electric braking, Regenerative braking; Systems of train lighting, Single battery, double battery parallel block system; SG, HOG, End on generation

Unit VI Signalling and Supervisory Control

Requirements of signaling systems; Types of signals, track circuits; Advantages of remote control; Systems of remote control, equipment and network ;Metro rail-supply systems, advantages, schemes in India

Note: The above syllabus is indicative and the questions in the test may include similar other topics pertaining to the level and content of essential qualification.