

ANNEXURE - II
SYLLABUS

SUB-ENGINEER (ELECTRICAL)

I. ELECTRICAL MACHINES:

TRANSFORMERS: emf equation of single phase transformer, operation of transformer on load, equivalent circuit, vector diagram, open-circuit and short-circuit tests, voltage regulation, losses and efficiency, all-day efficiency, parallel operation of single-phase transformers with equal voltage ratios. Voltage and current relations for three-phase transformer connections. Principle of operation of auto-transformer. Cooling of power transformer, Operation of Buchholz's relay.

D.C. GENERATORS AND MOTORS: Expression for emf equation of D.C. Generator, armature windings, armature reaction, types of generators, characteristics. Torque equation of D.C. Motor, characteristics, speed control, starters, losses and efficiency. Testing of D.C. Machines.

THREE-PHASE INDUCTION MOTORS: Constructional aspects of cage and wound rotor types of induction motors, expression for torque, torque-slip characteristics, full load torque, starting torque and maximum torque, effects of variation of rotor resistance; losses and efficiency; different starting methods; speed control methods.

SINGLE-PHASE INDUCTION MOTORS AND COMMUTATOR MOTORS:

Constructional features and operation of single-phase induction motors: split phase, capacitor and shaded pole types. Principle of operation of A.C. series motor, universal motor, Synchronous motor.

II. SWITCHGEAR AND PROTECTION:

FAULTS AND SWITCHING APPARATUS: Short-circuit calculations; fuses and isolators; circuit breakers: theory of arc interruption and different types of oil circuit breakers; lightning arresters and their selection and location.

PROTECTIVE RELAYING: Basic requirements of protective relaying, primary and back-up protection; classification of electromagnetic relays and their principles of operation; time current characteristic curves; induction type over-current relay, distance relays; Merz price protection, differential protection of transformers, bus bar protection.

III. TRANSMISSION :

LINE CONDUCTORS, LINE SUPPORTS AND SAG CALCULATIONS: Different types of line conductors, conductor sizes commonly used for different voltage levels, Types of line supports, factors influencing the selection, cross-arms; spans, conductor spacings and ground clearances. Sag calculations and stringing charts.

TRANSMISSION LINE PARAMETERS: Determination of inductance and capacitance of round and parallel conductors in single phase and three-phase symmetrically spaced lines.

PERFORMANCE OF LINES: Choice of voltage; short, medium and long lines; calculation of sending-end voltage, regulation and efficiency for short lines; nominal and nominal-T methods; Ferranti effect; corona: critical voltages and factors affecting corona.

INSULATORS AND SUBSTATIONS: Different types of insulators: Pin type, strain type, suspension type and relative merits; voltage distribution across string of suspension insulators, string efficiency and methods of improving arcing horns. Equipment used in substations, bus-bar arrangements.

CABLE AND DISTRIBUTION SYSTEMS : Comparison between overhead lines and under ground cable. Types of cables, insulation resistance; localization of cable faults. Primary and secondary distribution; Feeders and service mains; radial and ring systems of distribution.

IV. MEASURING INSTRUMENTS AND ELECTRIC CIRCUITS:

MEASURING INSTRUMENTS: Indicating instruments: deflecting, controlling and damping torques, pointers and scales; ammeters and voltmeters: moving coil, moving iron, dynamometer, induction types; instrument transformers: C.T and P.T., Wattmeters and measurement of power in three phase systems by two-wattmeter method; measurement of energy: Energy meters; M.D. indicators; trivector meter.

ELECTRIC CIRCUITS: Fundamentals of alternating current quantities, sinusoidal waveform; average and effective values; J-notation for A.C quantities; polar form; single phase series and parallel circuits; impedance triangle, phase, power factor. Active and reactive components of power; series and parallel resonance. Three-phase star and delta balanced systems.

UTILIZATION OF ELECTRICAL ENERGY:

ELECTRIC DRIVES: Factors governing selection of motors; matching of motors with given loads; electric braking; rating of motor; types of enclosures; motors for particular drive.

ILLUMINATION: Definitions of commonly used terms and units; types of lamps; requirements of good lighting; laws of illumination; terms like : depreciation factor, utilization factor, waste light factor, luminous efficiency, specific energy consumption, space height ratio.

ELECTRIC HEATING AND WELDING: Requirements of good heating materials, materials generally employed, resistance heating; electric furnace; induction heating; dielectric heating welding generator and transformers.