

SYLLABUS FOR ELECTRICAL & MECHANICAL ENGINEERING

SYLLABUS FOR PROFESSIONAL EXAMINATION OF MAHARASHTRA STATE ENGINEERING OFFICERS AND ENGINEERING SUBORDINATES IN THE ELECTRICAL WING AND ELECTRICAL AND MECHANICAL WING.

PAPER I

General – Electrical and Mechanical Engineering

Part I – Generation, Transmission, Distribution of electrical energy.

- 1) Load Surveys and Load Forecasts: Collection of data for estimating the requirements of electrical energy in a given area or region, analysis of data collected and preparation of load development charts. Plotting of load curves and evaluating diversity factor, load factor etc. and determining the block of power, required to be supplied.
- 2) Installation of power plant: Preliminary studies for planning installation of a power station to meet the load demand and preliminary studies regarding appropriate Hydel, steam or Diesel type of power plant as such as :-

Hydel Generation: Study of hydrology of catchment to estimate the regulated and unregulated flow in streams, possibility of storage works, construction of hydraulic conduit system and ancillary works. Availability of a fall, site for generating station and sub station including line outlets. Hydraulic turbines and their characteristics. Hydraulic governors. Operation and maintenance of Hydel plants.

Steam Generation: Study of available fuels and their characteristics and transport and handling facilities, disposal of ash and other waste products, availability of water for cooling and feed water system, types of boilers, turbo generators, condensers, auxiliaries, coal and ash handling equipment, feed water system, water treatment plants, preparation of power station layout, operation and maintenance of a thermal generating stations.

Diesel generation: availability of fuels and its transport, and storage, characteristics of small, medium and large diesel engines including 2 strokes and 4 strokes cycles units, supercharged engines; Engine generators and their parallel operation. Cooling arrangement and water treatment, lubrication system, intake and exhaust systems. Preparation of layout of the power station, operation and maintenance of diesel power plants.

- 3) Overhead Transmission and Distribution lines: survey for line routes, plotting of profiles, collection of data regarding wind velocities, maximum and minimum temperatures, presence of corrosive smoke and /or foggy atmosphere, isocronic levels, soil conditions including ground resistivity and suitability for foundations of structures.

Design and construction of low and medium pressure transmission and distribution lines, strength of supports, lengths of spans, sag, spacing of conductors, arrangement of cross-arms, determination of proper voltage for transmission or distribution of a given block of power and working out the economics of number of

circuit, size of conductors and their spacing. Selection of wood poles or steel or RCC supports, towers, structures, design of cross-arms, stays etc. earthing and other safety devices, lightning arresters.

Testing and location of faults on overhead transmission and distribution lines.

- 4) Underground cables: Choice of cables for the work, determination of proper size number of cores, insulation and mechanical protection etc. for the cable. General principles for routing and laying cables direct in ground, in troughs or in pipes; bending, jointing and plumbing of cables in medium pressure and high pressure system. Testing and fault location in cable systems.
- 5) Sub stations: Design and of substations, indoor and outdoor layouts of transformers, circuit breakers isolators, busbars etc. grounding system. Provision of lightning arresters. Installation of synchronous condensers or station capacitors for voltage regulation and power factor corrections.

Construction of substations including sub stations for conversion of A.C. to D.C. or vice versa, procedure for drying out and commissioning of large transformers, synchronous condensers, relays and switchgear.

- 6) Control and protective Equipment: Choice of local, remote or sequential automatic control equipment.

Equipment and apparatus to protect power plants transmission and distribution lines and substations from the following.

- i) Overvoltage arising from atmospheric lightning switching surges or other causes.
 - ii) Over currents unbalanced operation arising from short circuits, tripping of other units from the system or overloading of the units.
 - iii) Other causes, such as fires, flooding over speeding of machines due to governor failures, wrong operation of equipment from ignorance or other earthing.
- 7) Communication: Determination of appropriate provision of communication facilities by P&T telephones or telegraphs, special wired telephones, power carrier telephones or by wireless. General knowledge of these systems.
 - 8) Circuit diagrams: Preparation of single line diagrams for a complete installations including a generating station, transmission line, sub station and distribution outlets etc. showing the equipment and switchgear at different points.

Preparation of detailed circuit diagrams showing the control and relay circuits for generators or transformers, convertors etc.

PART II

General features of design and construction of electrical machinery and equipments such as:

- 1) Generators: D.C. Generators of shunt, series and compound type. Their characteristics and utility, parallel operation and voltage regulation.
A.C. Generators (alternators), synchronous and induction type and their application. Parallel operation, and voltage regulation. Types of regulators in use in modern station.
- 2) Transformers: types of transformers such as shell or core type, vector groups, various cooling methods used, viz. self cooled forced oil cooled forced oil, water cooled, or fan cooled etc. Transformer characteristics such as resistance, reaction and impedances off load on load tap changing equipment.
- 3) Convertors: Principles of operation of rotary convertors, motor generators and mercury are or semiconductor rectifiers. Their characteristics and utility.
- 4) Switchgear:
 - a) Circuit breakers: Type of breakers: such as air break, oil air blast etc. Knowledge about operating duty and fault duty are extension and restrike characteristics of different types.
Choice of breakers.
 - b) Disconnecting switches: Distinction between load disconnects, and off load disconnects. Single pole and gang operated disconnects. Fuse disconnects, horizontal and vertical blade or pantographic type operators.
 - c) Fans: Renewable element and cartridge type fuses their characteristics and utility.
- 5) Electric motors: shunt, series and compound type D.C. motors, their characters and utility, squirrel cage, and slip ring and commutator type 3 phase motors for A.C. use., their characteristic and utility. Single phase A.C. motor and their starting devices. Motor starting equipments: Types of starters required for different types of motors, their construction and application.
- 6) D.C. Batteries: Different types of batteries such as lead acid, nickel, iron, nickel cadmium etc. their characteristics and application. Battery charging equipment for different ;types of batteries.
- 7) Domestic and Industrial Installation: Wiring layouts of different types, such as cleat, lead covered, casing and capping C.T.S., conduct etc. for lighting and power installation in residential, non residential and industrial premises, special consideration for concealed wiring, its layouts and construction in co-ordination with the civil works in progress. Estimates for capital expenditure for electric installations for a given data.
- 8) Domestic appliances and small power miscellaneous equipment: Refrigeration, gaysers, water boilers, cooking range, stoves, electric irons, room conditioners, fans, table lamps etc. repairs and maintenance of the above.
- 9) Lifts: Drawing out specifications for a lift suitable for residential or non residential premises. Safety requirements in a lift installation as per lift Act and Regulations. Erection and maintenance of lift installations.

- 10) Air conditioning: Calculations of heat load, heating and humidifying requirements. Cooling and dehumidifying requirement. Design of air ducts study of refrigerant controls. Expansion valves float valves, solenoid valves, back pressure valves and pressure switches. Maintenance of air conditioning equipment.
- 11) **Pumps**: General knowledge of construction of various types of pumps for water supply and irrigation works, calculations to determine size of the pump, horse power of the pump motor for a given duty. Efficiency and performance tests on pumps.
- 12) Other motive power installation in industrial units: General considerations regarding choice of equipment, protective and safety measures Cranes and haulage equipment :special requirements and characteristics of motors with speed control equipment, cranes, wireless ropes, hooks etc.

Workshop equipment: Installation and maintenance of electric welding equipment, lathes, drilling machines, grinders, etc.

2) Hydro Generations:

- 1) Knowledge of toposheets.
- 2) Rainfall characteristics and run-off computations.
- 3) Selection of site for river gauging.
- 4) Methods for accurate measurement of river flows.
- 5) Preliminary investigations for locations of storage, power channel penstocks, power house and tailrage.
- 6) Principles of water planning and determination of storage capacities.
- 7) Considerations for fixing the size and number of generating units.
- 8) Selection of site from considerations of foundations and accessibility.
- 9) Quantity of steel and design for penstocks.
- 10) Fabrication and tests before penstocks installation.
- 11) Preliminary layouts for power stations.
- 12) Selection of turbines.
- 13) Preliminary design for turbines and generators.
- 14) Weights and loadings on foundations.
- 15) Governing and lubrication system of turbines.
- 16) Station auxiliaries.
- 17) Thrust bearings and thrust pressures.

- 18) Cable layout.
- 19) Control equipment for generators and turbines.
- 20) Protective gear for generators.
- 21) Selection of site for switchyard.
- 22) Preparation of estimates and project reports.

Thermal Generations:

- 1) Sources of fuel and testing of their energy values.
- 2) Installed capacities and load demands.
- 3) Selection of site
- 4) Layout of power station.
- 5) Requirements of cooling water.
- 6) Requirements of coal and ash handling.
- 7) Storage and fuel oil.
- 8) Boiler capacities and efficiencies.
- 9) Quality of feed water for boilers.
- 10) Steam pressures and temperatures.
- 11) Steam turbines and their efficiencies'.
- 12) Governor and lubricating oil system.
- 13) Condensers.
- 14) Common faults in boilers and condensers.
- 15) Turbo alternator.
- 16) Cooling and ventilation system of alternators.
- 17) Feed heating plant.
- 18) Arrangement of switchgear.
- 19) Station power supply equipment.
- 20) General earthing of station.
- 21) Common faults in the electrical system.
- 22) Protective gear for generator and main switchgear.
- 23) Layout of diesel power stations.

24) Output and efficiencies of internal combustion engine.

Transmission and Distribution:

- 1) Different system and principles of power transmission.
- 2) Standard transmission voltage.
- 3) Rules and regulations regarding transmission line construction.
- 4) Materials for conductors and insulators.
- 5) Determination of economic conductor size.
- 6) Calculation of sag and tension in conductors.
- 7) Types and design of supports.
- 8) Other line materials.
- 9) Earthing of line.
- 10) Electrical design of transmission line.
- 11) Voltage drop and regulation.
- 12) Computation of line characteristics and maximum power.
- 13) Transmission losses.
- 14) Lightning and other surges on transmission lines.
- 15) Protection of transmission lines.
- 16) L.T. distribution practice.
- 17) Laying underground cables.

PAPER III - Accounts

Syllabus same as of Accounts paper for Civil wing.