

Electrical Engineering (Module 2)

Part II :

Engineering Codes & Specifications (Electrical)

10 Marks

1. Indian Electricity Act - 2003
2. Indian Electricity Rules - 1956
3. National Electrical Code, Energy Conservation, Energy Audit, Fire avoidance, Fire detection system, alarm, disaster management, causes of electrically induced fire and precautions.
4. Relevant BIS Standards on
 - i. Electrical equipment & auxiliaries used for Electrical Power System viz. Fuse & Switch Gear, Transformer, Busbar, Generator, Motor, Power Board, Capacitor, Reactor, Rectifier, Cable, Wires & Conductors, Insulator, Battery, UPS, Protective Relays & Device, Instrument, Control, Instrumentation & Metering Equipment etc. Testing of Equipment.
 - ii. Electrical apparatus for industrial use and associated control equipment viz. Lift & Hoist, Furnace, Electrical heating & welding, Transportation, Mines etc. and for medical use.
 - iii. Components and Accessories used for Control and Distribution Board, Electrical Wirings and Installation, Illumination System etc.
 - iv. Materials used in Electrical Equipment Manufacturing.
 - v. Electrical appliances for domestic use.
5. Relevant BIS code of practices on selection, operation and maintenance of electrical equipment, installation and protective earthing etc.
6. International Standards viz. IEC, IEEE, NEMA, BS.
7. Electrical Safety – Relevant Practices, Building Codes, Siesmic related precautions, Safety Drills.

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Part III :

Technical Knowledge (Electrical Engineering)

50 Marks

(A candidate has to select any one of the following three groups as per his area of specialisation)

Group A:

(a) Electrical Machines

Transformer (1-Phase and 3-Phase) Construction, Principle of operation, Equivalent circuit, Phasor diagram, Voltage regulation, Testing, Efficiency, Auto Transformer, Phasor Group (3 phase transformer), Parallel operation.

DC machines Construction, Principle of operation, Armature reaction, Commutation, Generator and motor characteristics, Starting and Speed Control, Testing, efficiency.

Induction machine (3 phase) Construction, Principle of operation, Equivalent circuit, Phasor diagram output power, Torque, Maximum torque equation, Slip-torque characteristics, Starting and Speed control, Efficiency, Testing, Induction Generator.

Synchronous machines Construction, EMF equation, pitch factor Distribution factor for fundamental and harmonics. Different excitation methods, Armature reaction effects. Alternator voltage regulation- Syn. Impedance method, zero p.f. method, determination steady state parameters by test, X_s , X_d , X_q . Short circuit of Syn. Machines, Transient reactances. Determination of sequence reactance X_1 , X_2 and X_0 . Grid connected and stand alone generators. Synchronisation, Power angle characteristics, Synchronising Power. Stable operation of Syn. Machine, Excitation characteristics, V-curves, parallel operation. Synchronous dynamics – Swing equation of a Syn. Machine, Free and forced oscillation with small rotor angle variation, pulling in phenomenon Synchronous motor – Power developed, V-curves and O curves, Syn. Motor starting, speed control.

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Single Phase and Special machines -AC series motor or – Construction, phasor diagram, characteristics, Performance on both ac and dc supply. Single phase induction motor-double revolving field theory, starting methods, characteristics, Stepper motor / Reluctance motor / Hysteresis motor/Permanent Magnet motor/Switched Reluctance Motor – Construction, operating principle and applications.

(b)Power Electronics Drives

Solid State Rectifier (controlled and uncontrolled) I-phase and 3-phase rectification schemes, Transformer utilization factor, Line current harmonics Different firing circuit schemes of SCRs – AC power control with SCR back to back / Triac Inverters : 6-step, USI and CSI, selected harmonic elimination, Power inverters.Different dc chopper circuit schemes and analysis.Electrical Heating (induction heating di-electric heating, Arc heating, resistance heating), Electric Traction. Solid state control of DC, induction and synchronous motor. Variable Frequency Drives (VFDs).Different PLC organizations and applications.Static power supplies – UPS, SMPS, Invertors.

Group B :

(a) Control System (Linear Control Theory)

Dynamic Models: Transfer functions of electrical, mechanical, electromechanical systems, Heat and Fluid flow models. Basic properties of feedback control systems. Time response analysis, performance indices and design specifications. Time response of first and second order systems, steady-state errors and Error constants. Concept of stability, Routh-Hurwitz stability criterion. Frequency response analysis. Phase margin and Gain margin. Nyquist stability criterion. Closed loop frequency response. Root locus technique. Preliminary consideration of classical design. Classical three-term controller: Proportional, Proportional Integral (PI), Proportional Integral Derivative (PID) feedback control. Derivative feedback, control, Realization of basic compensators.

(b) Electrical Instrumentation

PMMC instruments, moving iron instrument, electrodyamometer instruments, Induction type energy meters, Current transformers, potential transformers. Kelvin double bridge, Megger, series and shunt type ohm meters.

DC Potentiometer: Working principle and applications.

Cathode Ray Oscilloscopes : Working principle and applications.

AC Bridge : Schering bridge, Owen bridge, Wien bridge.

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Digital Measurements : A/D converters : Successive approximation type and dual slope integrating type. D/A converters: Resistor Ladder type. Digital frequency meter, Smart instruments.

Transducers : Strain gauges, metal resistance thermometers, thermistors and thermo-couples.

Virtual Instrumentation.

Group C :

(a) Power System

- (i) Generation
Power Station : Type, Location, size and no of units.
Type : Thermal, Nuclear, Hydro, – their process, main and auxiliary equipment, operation and control of Real and Reactive Power.
- (ii) Transmission : Line parameter,
Transmission Structure, Conductor, Insulator, Design and Operation, HVDC, EHV/HV cable, Cables, Insulators and Bushing (condenser and non-condenser), String efficiency, voltage distribution in string, Corona discharge / inception voltage, loss etc. Electric stress in cables, XLPE cable insulations. Travelling waves of transmission line, Reflection and Refraction and Ladder diagram.
- (iii) Substation :
Type, Layout, Equipment, Erection, Testing, Safety and Earthing.
- (iv) Distribution :
System design, Network equipment, selection, Installation & Testing. Demand side management
- (v) Power System Protection, Control and Switchgear
Protection devices and relays schemes of protection for electrical power equipment, power line carrier and microwave link for protection, monitoring and control of power system application, Equipment for control of T&D, substation.
Switchgear: Types, application, testing.
Different form of overvoltages in PS.
Protection of Power System against overvoltage, Lighting arrestor, Surge suppressors, Basic impulse level. Insulation Coordination, Grounding methods. Grounding system for power stations and substations
- (vi) Power System Analysis
Short circuit studies, load flow studies, stability studies

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- (vii) Load dispatch Centre – Electricity tariff, Power Trading policies and availability based tariff
- (viii) Power quality- causes of pollution of power quality and remedies, Effect of non linear loads. Harmonic elimination, STATCOM

(b) Renewable /Non-Conventional Energy Systems and Energy Conservation

Types of Non Conventional Energy Sources,-Solar, Wind, Small Hydro, Biofuels, Solar thermal & Solar PV systems and Applications, Types of Solar energy convertors, Wind Energy Conversion Systems, Wind data analysis, Grid connected systems, active and reactive power management, Characteristics of Wind Turbine, Maximum power tracking, Electric generators for wind systems-characteristics. Mini/Micro/Pico hydel systems-Turbines, Pump as turbine, generators, characteristics, Grid connected and stand alone systems, load controllers, Types Bio fuels-Biogas.Bio mass.Bio diesel, Gassifiers, Engines,generators and control.

Energy conservation and Energy Efficiency, Energy efficient motors, efficiency labeling, Variable frequency Drives (VFD), Energy saving in lighting. Transmission loss minimization. Latest energy saving techniques- intelligent buildings, Energy saving in different types of loads-motor drives, HVAC, Illumination. Recent codes.

Standby power, Cogeneration

(c) Utilisation of Electric Power & Illumination Engineering

Lamps – its different parameters, operational features.

Ballast – its parameters.

Laws of lighting calculation

Lux meter, luminance meter, distribution photometer

Indian Standard Recommendation of lighting level – lux values for different task. Office lighting, Residential lighting, Industrial lighting – Design considerations. Road lighting, Flood lighting, Sports lighting – Design constructions.

Domestic Appliances and Office equipment

Traction, Elevators, escalators, Electric Vehicles

Induction Heating