

**Syllabus for Recruitment to the post of**  
**INSPECTOR OF FACTORIES**  
**Under Labour, Employment, Skill Development &**  
**Entrepreneurship Department-2018**

**COMPULSORY SUBJECT**

*(Essay Type & MCQ)*

1. General English ..... 100 Marks
2. General Studies (MCQ) ..... 100 Marks

**OPTIONAL SUBJECT**

*(MCQ)*

1. Electrical Engineering– I ..... 200 Marks  
    Electrical Engineering – II ..... 200 Marks  
    Electrical Engineering – III ..... 200 Marks
  
2. Mechanical Engineering – I ..... 200 Marks  
    Mechanical Engineering – II ..... 200 Marks  
    Mechanical Engineering – III ..... 200 Marks

## ***General English (3 hours duration)***

ESSAY TYPE  
**(Full Marks : 100)**

- (i) Comprehension of given passage ..... 20 marks
- (ii) Precis writing ..... 20 marks
- (iii) Usage and vocabulary ..... 40 marks
- (iv) Short Essay ..... 20 marks

## **General Studies (2 hours duration)**

(MCQ)  
**(Full Marks : 100)**

The nature and standard of questions in the General Studies will be such that a well-educated person will be able to answer them without any specialized study. The questions will be such as to test a candidate's general awareness of a variety of subjects, which will have relevance for a career in Engineering Services. The questions are likely to test the candidate's basic understanding of all relevant issues, and ability to analyze, and take a view on conflicting socio-economic goals, objectives and demands.

# ELECTRICAL ENGINEERING

## PAPER – I (2 hours duration)

### OBJECTIVE TYPE (MCQ)

(Full Marks : 200)

#### **a . EM Theory**

Electric and magnetic fields, Gauss's Law and Amperes Law, Fields in dielectrics, conductors and magnetic materials. Maxwell's equations. Time varying fields. Plane – Wave propagating in dielectric and conducting media. Transmission lines.

#### **b. Electrical Materials**

Band Theory, Conductors, Semi-conductors and Insulators, Super-conductivity, Insulators for electrical and electronic applications. Magnetic materials. Ferro and ferri magnetism, Ceramics, Properties and applications. Hall effect and its applications. Special semi conductors.

#### **c . Electrical Circuits**

Circuits elements, Kirchoff's Laws, Mesh and nodal analysis. Network Theorems and applications, Natural response and forced response, Transient response and steady state response for arbitrary inputs, Properties of networks in terms of poles and zeros. Transfer function, Resonant circuits, Three phase circuits, Two-port networks, Elements of two-element network synthesis.

#### **d. Measurements and Instrumentation**

Units and Standards, Error analysis, measurement of current, Voltage, power, Power-factor and energy. Indicating instruments, Measurement of resistance, inductance, Capacitance and frequency, Bridge measurements, Electronic measuring instruments. Digital Voltmeter and frequency counter. Transducers and their applications to the measurement of non-electrical quantities like temperature, pressure, flow-rate displacement, acceleration, noise level etc. Data acquisition systems, A/D and D/A converters.

## PAPER – II (2 hours duration)

### OBJECTIVE TYPE (MCQ)

(Full Marks : 200)

#### **1. Control Systems**

Mathematical modeling of physical systems, Block diagrams and signal flow graphs and their reduction. Time domain and frequency domain analysis of linear dynamical system, Errors for different type of inputs and stability criteria for feedback systems, Stability analysis using Routh-Hurwitz array, Nyquist plot and Bode plot. Root locus and Nicols chart and the estimation of gain and phase margin. Basic concepts of compensator design, State variable matrix design. Sampled data system and performance of such a system with the samples in the error channel. Stability of sampled data system. Elements of non-linear control analysis, Control system components, electromechanical, hydraulic, pneumatic components.

## **2. Electrical Machines and Power Transformers**

Magnetic Circuits – Analysis and Design of Power transformers, Construction and testing. Equivalent circuits, Losses and efficiency, Regulation, Auto-transformer, 3-phase transformer, Parallel operation.

Basic concepts in rotating machines, EMF, torque, basic machine types. Construction and operation, leakage losses and efficiency.

B.C. Machines, Construction, Excitation methods, Circuit models, Armature reaction and commutation, Characteristics and performance analysis, Generators and motors. Starting and speed control, Testing, Losses and efficiency.

Synchronous Machines, Construction, Circuit model, Operating Characteristics and performance analysis. Synchronous reactance, Efficiency, Voltage regulation, Salient-pole machine, Parallel operation. Hunting, Short circuit transients.

Induction Machines, Construction, Principle of operation, Rotating Fields, Characteristics and performance analysis, Determination of Circuit model, Circle diagram, Starting and speed control

Fractional KW motors. Single-phase synchronous and induction motors.

## **3. Power systems**

Types of Power Stations, Hydro, Thermal and Nuclear Stations, Pumped storage plants, Economics and operating factors.

Power transmission lines, Modeling and performance characteristics, Voltage control, Load flow studies, Optimal power system operation, Load frequency control, Symmetrical short circuit analysis, Z-Bus formulation, Symmetrical Components, Per Unit representation, Fault analysis, Transient and steady-state stability of power systems. Equal area criterion.

Power system Transients, Power system Protection Circuit breakers. Relays, HVDC transmission.

### **PAPER – III (2 hours duration)**

#### **OBJECTIVE TYPE (MCQ)**

**(Full Marks : 200)**

## **1. Analog and Digital Electronics and circuits**

Semiconductor device physics, PN junctions and transistors, circuit models and parameters, FET, Zener, tunnel, Schottky, photo diodes and their applications, rectifier circuits, voltage regulators and multipliers, switching behavior of diodes and transistors.

Small signal amplifiers, biasing circuits, frequency response and improvement, multistage amplifiers and feed-back amplifiers, D.C. amplifiers, coupling methods, push pull amplifiers, operational amplifiers, wave shaping circuits, Multivibrators and flip-flops and their applications. Digital logic gate families, universal gates combinational circuits for arithmetic and logic operational, sequential logic circuits. Counters, Registers, RAM and ROMs.

## **2. Microprocessors**

Microprocessor architecture Instruction set and simple assembly language programming. Interfacing for memory and I/O. Applications of Micro-processors in power system.

## **3. Communication Systems**

Types of modulation; AM, FM and PM. Demodulators, Noise and bandwidth considerations. Digital communication systems, Pulse code modulation and demodulation, Elements of sound and vision broadcasting, Carrier communication. Frequency division and time division multiplexing, Telemetry system in power engineering.

## **4. Power Electronics**

Power Semiconductor devices, Thyristor, Power transistor, GTOs and MOSFETs Characteristics and operation, AC to DC Converters; 1-phase and 3-phase DC to DC Converters. AC regulators.

Thyristor controlled reactors; switched capacitor networks.

Inverters; single-phase and 3-phase. Pulse width modulation. Sinusoidal modulation with uniform sampling, Switched mode power supplies.

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# MECHANICAL ENGINEERING

**PAPER – I (2 hours duration)**

**OBJECTIVE TYPE (MCQ)**

**(Full Marks : 200)**

## **1. Thermodynamics:**

Cycles and IC Engines, Basic concepts, Open and Closed systems. Heat and work. Zeroth, First and Second Law, Application to non-Flow and Flow processes. Entropy, Availability, Irreversibility and Tds relations. Claperyron and real gas equations, Properties of ideal gases and vapours. Standard vapour, Gas power and Refrigeration cycles. Two stage compressor. C-I and S.I. Engines. Preignition, Detonation and Diesel-knock, Fuel injection and Carburation, Supercharging. Turbo-prop and Rocket engines, Engine Cooling, Emission & Control, Flue gas analysis, Measurement of Calorific values. Conventional and Nuclear fuels, Elements of Nuclear power production.

## **2. Heat Transfer, Refrigeration and Air-Conditioning:**

Modes of heat transfer. One dimensional steady and unsteady conduction. Composite slab and Equivalent Resistance. Heat dissipation from extended surfaces, Heat exchangers, Overall heat transfer coefficient, Empirical correlations for heat transfer in laminar and turbulent flows and for free and forced Convection, Thermal boundary layer over a flat plate. Fundamentals of diffusive and connective mass transfer, Black body and basic concepts in Radiation, Enclosure theory, Shape factor, Net work analysis. Heat pump and Refrigeration cycles and systems, Refrigerants. Condensers, Evaporates and Expansion devices, Psychrometry, Charts and application to air conditioning, Sensible heating and cooling, Effective temperature, comfort indices, Load calculations, Solar refrigeration, controls, Duct design.

## **3. Fluid Mechanics:**

Properties and classification of fluids, Manometry, forces on immersed surfaces, Center of pressure, Buoyancy, Elements of stability of floating bodies. Kinematics and Dynamics.

Irrotational and incompressible. Inviscid flow. Velocity potential, Pressure field and Forces on immersed bodies. Bernoulli's equation, Fully developed flow through pipes, Pressure drop calculations, Measurement of flow rate and Pressure drop. Elements of boundary layer theory, Integral approach, Laminar and turbulent flows, Separations. Flow over weirs and notches. Open channel flow, Hydraulic jump. Dimensionless numbers, Dimensional analysis, Similitude and modelling. One-dimensional isentropic flow, Normal shock wave, Flow through convergent - divergent ducts, Oblique shockwave, Rayleigh and Fanno lines.

## **4. Fluid Machinery and Steam Generators:**

Performance, Operation and control of hydraulic Pump and impulse and reaction Turbines, Specific speed, Classification. Energy transfer, Coupling, Power transmission, Steam generators Firetube and water-tube boilers. Flow of steam through Nozzles and

Diffusers, Wetness and condensation. Various types of steam and gas Turbines, Velocity diagrams. Partial admission. Reciprocating, Centrifugal and axial flow Compressors, Multistage compression, role of Mach Number, Reheat, Regeneration, Efficiency, Governance. Design of Pump and Pipelines.

**PAPER – II (2 hours duration)**  
**OBJECTIVE TYPE (MCQ)**

**(Full Marks : 200)**

**1. Theory of Machines:**

Kinematic and dynamic analysis of planer mechanisms. Cams. Gears and gear trains. Flywheels. Governors. Balancing of rigid rotors and field balancing. Balancing of single and multicylinder engines, Linear vibration analysis of mechanical systems. Critical speeds and whirling of shafts Automatic controls.

**2. Machine Design:**

Design of Joints: cotters, keys, splines, welded joints, threaded fasteners, joints formed by interference fits. Design of friction drives : couplings and clutches, belt and chain drives, power screws.

Design of Power transmission systems: gears and gear drives shaft and axle, wire ropes.

Design of bearings: hydrodynamics bearings and rolling element bearings.

**3. Strength of Materials:**

Stress and strain in two dimensions, Principal stresses and strains, Mohr's construction, linear elastic materials, isotropy and anisotropy, stress-strain relations, uniaxial loading, thermal stresses. Beams : Bending moment and shear force diagram, bending stresses and deflection of beams. Shear stress distribution. Torsion of shafts, helical springs. Combined stresses, thick-and thin-walled pressure vessels. Struts and columns. Strain energy concepts and theories of failure.

**PAPER – III (2 hours duration)**  
**OBJECTIVE TYPE (MCQ)**

**(Full Marks : 200)**

**1. Engineering Materials:**

Basic concepts on structure of solids. Crystalline maferials. Detects in crystalline materials. Alloys and binary phase diagrams. Structure and properties of common engineering materials. Heat treatment of steels. Plastics, Ceramics and composite materials. Common applications of various materials.

**2. Production Engineering:**

Metal Forming: Basic Principles of forging, drawing and extrusion; High energy rate forming; Powder metallurgy.

Metal Casting: Die casting, investment casting, Shell Moulding, Centrifugal Casting, Gating & Riser design; melting furnaces.

Fabrication Processes: Principles of Gas, Arc, Shielded arc Welding; Advanced Welding Processes, Weldability: Metallurgy of Welding.

Metal Cutting: Turning, Methods of Screw Production, Drilling, Boring, Milling, Gear Manufacturing, Production of flat surfaces, Grinding & Finishing Processes. Computer Controlled Manufacturing Systems-CNC, DNC, FMS, Automation and Robotics.

Cutting Tools Materials, Tool Geometry, Mechanism of Tool Wear, Tool Life & Machinability; Measurement of cutting forces. Economics of Machining. Unconventional Machining Processes. Jigs and Fixtures. Fits and tolerances, Measurement of surface texture, Comparators Alignment tests and reconditioning of Machine Tools.

### **3. Industrial Engineering:**

Production Planning and Control: Forecasting - Moving average, exponential smoothing, Operations, scheduling; assembly line balancing, Product development, Break-even analysis, Capacity planning, PERT and CPM.

Control Operations: Inventory control ABC analysis, EOQ model, Materials requirement planning. Job design, Job standards, Work measurement, Quality Management - Quality analysis and control. Operations Research : Linear Programming - Graphical and Simplex methods, Transportation and assignment models. Single server queueing model.

Value Engineering: Value analysis for cost/value.

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