

## **MECHANICAL ENGINEERING**

### **PAPER-I** (For both objective and conventional type papers)

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. Pre-ignition, 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 and Refrigeration and Airconditioning. 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 shock-wave, 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 Fire-tube 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.

## **MECHANICAL ENGINEERING PAPER – II**

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### **5. 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.

## **6. 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.

## **7. 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.

## **8. ENGINEERING MATERIALS :**

Basic concepts on structure of solids. Crystalline materials. Defects 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.

## **9. 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.

## **10. 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.

## **11. ELEMENTS OF COMPUTATION :**

Computer Organisation, Flow charting, Features of Common computer Languages - FORTRAN, d Base III, Lotus 1-2-3, C and elementary Programming.

## **CIVIL ENGINEERING PAPER - I**

(For both objective and conventional type papers)

### **1. BUILDING MATERIALS**

**Timber :** Different types and species of structural timber, density-moisture relationship, strength in different directions, defects, influence of defects on permissible stress, preservation, dry and wet rots, codal provisions for design, Plywood.

**Bricks :** Types, Indian Standard classification, absorption, saturation factor, strength in masonry, influence of mortar strength on masonry strength.

**Cement :** Compounds of, different types, setting times, strength.

**Cement Mortar :** Ingredients, proportions, water demand, mortars for plastering and masonry.

**Concrete :** Importance of W/C Ratio, Strength, ingredients including admixtures, workability, testing for strength, elasticity, non-destructive testing, mix design methods.

### **2. SOLID MECHANICS**

Elastic constants, stress, plane stress, Mohr's circle of stress, strains, plane strain, Mohr's circle of strain, combined stress; Elastic theories of failure; Simple bending, shear; Torsion of circular and rectangular sections and simple members.

### **3. STRUCTURAL ANALYSIS**

Analysis of determinate structures - different methods including graphical methods.

Analysis of indeterminate skeletal frames - moment distribution, slope-deflection, stiffness and force methods, energy methods, Muller-Breslau principle and application.

Plastic analysis of indeterminate beams and simple frames - shape factors.

### **4. DESIGN OF STEEL STRUCTURES**

Principles of working stress method. Design of connections, simple members, Built-up sections and frames, Design of Industrial roofs. Principles of ultimate load design. Design of simple members and frames.

### **5. DESIGN OF CONCRETE AND MASONRY STRUCTURES**

Limit state design for bending, shear, axial compression and combined forces. Codal provisions for slabs, beams, walls and footings. Working stress method of design of R.C. members.

Principles of prestressed concrete design, materials, methods of prestressing, losses. Design of simple members and determinate structures. Introductions to prestressing of indeterminate structures.

Design of brick masonry as per I.S. Codes.

## **6. CONSTRUCTION PRACTICE, PLANNING AND MANAGEMENT**

### **Concreting Equipment:**

Weight Batcher, Mixer, vibrator, batching plant, concrete pump.  
Cranes, hoists, lifting equipment.

### **Earthwork Equipment :**

Power shovel, hoe, dozer, dumper, trailers and tractor, rollers, sheep foot rollers, pumps.

### **Construction, Planning and Management :**

Bar chart, linked bar chart, work-break down structures, Activity - on - arrow diagrams.  
Critical path, probabilistic activity durations; Event-based networks.

PERT network: Time-cost study, crashing; Resource allocation.

## **CIVIL ENGINEERING PAPER-II**

(For both objective and conventional type papers)

### **1. (a) FLUID MECHANICS, OPEN CHANNEL FLOW, PIPE FLOW:**

Fluid Properties, Pressure, Thrust, Buoyancy; Flow Kinematics; Integration of flow equations; Flow measurement; Relative motion; Moment of momentum; Viscosity, Boundary layer and Control, Drag, Lift; dimensional Analysis, Modelling; Cavitation; Flow oscillations; Momentum and Energy principles in Open channel flow, Flow controls, Hydraulic jump, Flow sections and properties; Normal flow, Gradually varied flow; Surges; Flow development and losses in pipe flows, Measurements; Siphons; Surges and Water hammer; Delivery of Power Pipe networks.

### **(b) HYDRAULIC MACHINES AND HYDROPOWER:**

Centrifugal pumps, types, performance parameters, scaling, pumps in parallel; Reciprocating pumps, air vessels, performance parameters; Hydraulic ram; Hydraulic turbines, types, performance parameters, controls, choice; Power house, classification and layout, storage, pondage, control of supply.

### **2. (a) HYDROLOGY :**

Hydrological cycle, precipitation and related data analyses, PMP, unit and synthetic hydrographs; Evaporation and transpiration; Floods and their management, PMF; Streams and their gauging; River morphology; Routing of floods; Capacity of Reservoirs.

### **(b) WATER RESOURCES ENGINEERING :**

Water resources of the globe: Multipurpose uses of Water: Soil-Plant-Water relationships, irrigation systems, water demand assessment; Storages and their yields, ground water yield and well hydraulics; Waterlogging, drainage design; Irrigation revenue; Design of rigid boundary canals, Lacey's and Tractive force concepts in canal design, lining of canals;

Sediment transport in canals; Non-Overflow and overflow sections of gravity dams and their design, Energy dissipators and tailwater rating; Design of headworks, distribution works, falls, cross-drainage works, outlets; River training.

## **ENVIRONMENTAL ENGINEERING**

### **3. (a) WATER SUPPLY ENGINEERING :**

Sources of supply, yields, design of intakes and conductors; Estimation of demand; Water quality standards; Control of Water-borne diseases; Primary and secondary treatment, detailing and maintenance of treatment units; Conveyance and distribution systems of treated water, leakages and control; Rural water supply; Institutional and industrial water supply.

### **(b) WASTE WATER ENGINEERING:**

Urban rain water disposal; Systems of sewage collection and disposal; Design of sewers and sewerage systems; pumping; Characteristics of sewage and its treatment, Disposal of products of sewage treatment, streamflow rejuvenation Institutional and industrial sewage management; Plumbing Systems; Rural and semi-urban sanitation.

### **(c) SOLID WASTE MANAGEMENT**

Sources, classification, collection and disposal; Design and Management of landfills.

### **(d) AIR AND NOISE POLLUTION AND ECOLOGY:**

Sources and effects of air pollution, monitoring of air pollution; Noise pollution and standards; Ecological chain and balance, Environmental assessment.

## **4 (a) SOIL MECHANICS:**

Properties of soils, classification and interrelationship; Compaction behaviour, methods of compaction and their choice; Permeability and seepage, flow nets, Inverted filters; Compressibility and consolidation; Shearing resistance, stresses and failure; soil testing in laboratory and in-situ; Stress path and applications; Earth pressure theories, stress distribution in soil; soil exploration, samplers, load tests, penetration tests.

### **(b) FOUNDATION ENGINEERING :**

Types of foundations, Selection criteria, bearing capacity, settlement, laboratory and field tests; Types of piles and their design and layout, Foundations on expansive soils, swelling and its prevention, foundation on swelling soils.

## **5. (a) SURVEYING :**

Classification of surveys, scales, accuracy; Measurement of distances - direct and indirect methods; optical and electronic devices; Measurement of directions, prismatic compass, local attraction; Theodolites - types; Measurement of elevations - Spirit and trigonometric levelling; Relief representation; Contours; Digital elevation modelling concept; Establishment of control by triangulations and traversing - measurements and adjustment of observations, computation of coordinates; Field astronomy, Concept of global positioning system; Map preparation by plane tabling and by photogrammetry; Remote sensing concepts, map substitutes.

### **(b) TRANSPORTATION ENGINEERING :**

Planning of highway systems, alignment and geometric design, horizontal and vertical curves, grade separation; Materials and construction methods for different surfaces and

maintenance: Principles of pavement design; Drainage.

Traffic surveys, Intersections, signalling: Mass transit systems, accessibility, networking. Tunnelling, alignment, methods of construction, disposal of muck, drainage, lighting and ventilation, traffic control, emergency management.

Planning of railway systems, terminology and designs, relating to gauge, track, controls, transits, rolling stock, tractive power and track modernisation; Maintenance; Appurtenant works; Containerisation.

Harbours - layouts, shipping lanes, anchoring, location identification; Littoral transport with erosion and deposition; sounding methods; Dry and Wet docks, components and operational Tidal data and analyses.

Airports - layout and orientation; Runway and taxiway design and drainage management; Zoning laws; Visual aids and air traffic control; Helipads, hangers, service equipment.

## **ELECTRONICS & TELECOMMUNICATION ENGINEERING PAPER - I**

(For both objective and conventional type papers)

### **1. Materials and Components :**

Structure and properties of Electrical Engineering materials; Conductors, Semiconductors and Insulators, magnetic, Ferroelectric, Piezoelectric, Ceramic, Optical and Super-conducting materials. Passive components and characteristics Resistors, Capacitors and Inductors; Ferrites, Quartz crystal Ceramic resonators, Electromagnetic and Electromechanical components.

### **2. Physical Electronics, Electron Devices and ICs:**

Electrons and holes in semiconductors, Carrier Statistics, Mechanism of current flow in a semiconductor, Hall effect; Junction theory; Different types of diodes and their characteristics; Bipolar Junction transistor; Field effect transistors; Power switching devices like SCRs, GTOs, power MOSFETS; Basics of ICs - bipolar, MOS and CMOS types; basic of Opto Electronics.

### **3. Signals and Systems**

Classification of signals and systems: System modelling in terms of differential and difference equations; State variable representation; Fourier series; Fourier transforms and their application to system analysis; Laplace transforms and their application to system analysis; Convolution and superposition integrals and their applications; Z-transforms and their applications to the analysis and characterisation of discrete time systems; Random signals and probability, Correlation functions; Spectral density; Response of linear system to random inputs.

### **4. Network theory**

Network analysis techniques; Network theorems, transient response, steady state sinusoidal response; Network graphs and their applications in network analysis; Tellegen's theorem. Two port networks; Z, Y, h and transmission parameters. Combination of two ports, analysis of common two ports. Network functions : parts of network functions, obtaining a network function from a given part. Transmission criteria : delay and rise time, Elmore's and other definitions effect of cascading. Elements of network synthesis.

## **5. Electromagnetic Theory**

Analysis of electrostatic and magnetostatic fields; Laplace's and Poisson's equations; Boundary value problems and their solutions; Maxwell's equations; application to wave propagation in bounded and unbounded media; Transmission lines : basic theory, standing waves, matching applications, microstrip lines; Basics of wave guides and resonators; Elements of antenna theory.

## **6. Electronic Measurements and instrumentation**

Basic concepts, standards and error analysis; Measurements of basic electrical quantities and parameters; Electronic measuring instruments and their principles of working : analog and digital, comparison, characteristics, application. Transducers; Electronic measurements of non electrical quantities like temperature, pressure, humidity etc; basics of telemetry for industrial use.

## **ELECTRONICS & TELECOMMUNICATION ENGINEERING PAPER – II**

(For both objective and conventional type papers)

### **1. Analog Electronic Circuits :**

Transistor biasing and stabilization. Small signal analysis. Power amplifiers. Frequency response. Wide banding techniques. Feedback amplifiers. Tuned amplifiers. Oscillators. Rectifiers and power supplies. Op Amp, PLL, other linear integrated circuits and applications. Pulse shaping circuits and waveform generators.

### **2. Digital Electronic Circuits :**

Transistor as a switching element; Boolean algebra, simplification of Boolean functions, Karnaguh map and applications; IC Logic gates and their characteristics; IC logic families : DTL, TTL, ECL, NMOS, PMOS and CMOS gates and their comparison; Combinational logic Circuits; Half adder, Full adder; Digital comparator; Multiplexer Demulti-plexer; ROM an their applications. Flip flops. R-S, J-K, D and T flip-flops; Different types of counters and registers Waveform generators. A/D and D/A converters. Semiconductor memories.

### **3. Control Systems :**

Transient and steady state response of control systems; Effect of feedback on stability and sensitivity; Root locus techniques; Frequency response analysis. Concepts of gain and phase margins: Constant-M and Constant-N Nichol's Chart; Approximation of transient response from Constant-N Nichol's Chart; Approximation of transient response from closed loop frequency response; Design of Control Systems, Compensators; Industrial controllers.

### **4. Communication Systems :**

Basic information theory; Modulation and detection in analogue and digital systems; Sampling and data reconstructions; Quantization & coding; Time division and frequency division multiplexing; Equalization; Optical Communication : in free space & fiber optic; Propagation of signals at HF, VHF, UHF and microwave frequency; Satellite Communication.

### **5. Microwave Engineering :**

Microwave Tubes and solid state devices, Microwave generation and amplifiers, Waveguides and other Microwave Components and Circuits, Microstrip circuits, Microwave Antennas, Microwave Measurements, Masers, lasers; Microwave propagation.

Microwave Communication Systems terrestrial and Satellite based.

**6. Computer Engineering :**

Number Systems. Data representation; Programming; Elements of a high level programming language PASCAL/C; Use of basic data structures; Fundamentals of computer architecture; Processor design; Control unit design; Memory organisation, I/o System Organisation.

Microprocessors : Architecture and instruction set of Microprocessors 8085 and 8086, Assembly language Programming. Microprocessor Based system design : typical examples. Personal computers and their typical uses.