Syllabus of CBT for Assistant Director exam of IWAI

Section (A) / Technical Questions
(80 MCQ carrying 96 marks)

CIVIL ENGINEERING

Water and Wastewater Engineering

Water and wastewater quality parameters- physical, chemical, bacteriological; sourcing of water- surface and groundwater, types of intakes and wells; water treatment- settling, coagulation flocculation, sedimentation, filtration, hardness removal, disinfection, etc.; water supply engineering- population and forecasting of water demands, reservoirs, networks, its components, etc.; Wastewater collection and conveyance including storm water, sewerage and related components, wastewater treatment - screen, grit chamber, sedimentation, biological treatment process- suspended growth process such as activated sludge process, attached growth process including trickling filter, pond-based treatment process, sludge digestion and dewatering processes, low-cost and onsite sanitation processes.

Surveying

Basic principles and Importance of surveying to engineering projects. Type of maps, scales and uses, plotting accuracy, map sheet numbering, coordinate and map projection. Surveying equipment, levels, compass, theodolites, tachometer, EDM, total Stations and other instruments. Measurement of angles, directions and distances. Determination of elevation, spirit leveling, trigonometrical leveling, and tachometric surveying, contouring. Plane table surveys and mapping. Methods of control establishment, traversing, triangulation, adjustment of survey measurements, computation of coordinates.

Geotech

Physical properties of soils: three phase relationships, GSD, Classification; Compaction: clay mineral, compaction tests, field compaction; Capillarity, permeability and seepage: Determination of permeability (laboratory and field tests), permeability in stratified soils, flow nets, confined and unconfined flows, piping; Compressibility and consolidation: concepts related to 1-D consolidation, coefficient of consolidation, 3-D consolidation, vertical sand drains; Shear

strength of soils: Principle of effective stress, Mohr-Coulomb failure criterion, direct shear test, unconfined compression test, Triaxial shear test : consolidated drained, consolidated undrained, unconsolidated undrained, vane shear test, shear strength of clays and sands, critical void ratio, stress path, pore-pressure coefficient; Soil exploration; Earth pressure and retaining walls (Rankine and Coulomb's earth pressure theories); Shallow foundations: bearing capacity and settlement, Stresses below foundations; Sheeting and bracing of foundation excavation; Pile foundations: load carrying capacity of individual and group of piles, settlement; Well foundations: methods of construction, tilt and shift, bearing capacity and settlement, lateral stability of well foundation; Stability analysis of slopes: infinite slopes, method of slices and Bishop's simplified method.

Transportation

Road and Highway Planning in India; Alignment fixing and surveys; Geometric design of roads and highways - factors affecting, cross-sectional elements, sight distances, horizontal alignment design, vertical alignment design, pedestrian and bicycle facility; Access control; Traffic Engineering - Traffic flow characteristics and their relationships, traffic volume studies, speed studies, delay and travel time studies, parking studies and accident studies and analysis; Traffic control devices - Signs, Markings, Signals, specifications and design process, channelization, types of intersections, types of maneuvers; Capacity of roads - urban roads and rural highways; Road Materials - Soil, Aggregates and bitumen, tests and specifications; Pavements - Flexible and rigid pavements, design factors and concept, IRC design procedure for flexible and rigid pavements

Structures

Strength of Material: Analysis of stress and strains, Axially loaded members, Mechanical properties, Stress transformation, Members subjected to torsional loads, Members subjected to flexural loads, Bending moment and shear force in beams, Bending stress and shear stresses in beams, Deflection in beams, Moment area method, Buckling of column, Unsymmetrical bending and shear center

Design of Concrete elements: Concrete technology, Concepts of working stress and limit state design, Design of beams in flexure, Design for torsion, Design of slabs, Design of compression members, Design of footing, prestressed concrete

Structural Analysis: Degree of indeterminacy, Analysis of statically determinate and indeterminate members, Analysis of three and two hinged arch, Moment distribution method, Slope deflection method, Theorem of three moments, Flexibility method, Matrix displacement method, Moving load analysis, Castigliano's theorem, Conjugate beam method, Unit load method, Plastic analysis,

Design of steel elements: Concepts of limit state design, Bolted connection (ordinary and High strength friction grip), Bracket connection, Design of tension member, Design of compression member, Built of column, Colum base, Design of beams (Laterally supported and unsupported), Design of purlin, Gantry girder, Plate girder

Building materials and construction: Bricks, Cement, Mortar, Steel

Hydraulics

Fluid Mechanics: Properties of fluids, fluid statics; Continuity, momentum, energy and corresponding equations; Potential flow, applications of momentum and energy equations; Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth.

Hydraulics: Forces on immersed bodies; Flow measurement in channels and pipes; Dimensional analysis and hydraulic similitude; Kinematics of flow, velocity triangles; Basics of hydraulic machines, specific speed of pumps and turbines; Channel Hydraulics - Energy-depth relationships, specific energy, critical flow, slope profile, hydraulic jump, uniform flow and gradually varied flow

Hydrology: Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, flood estimation and routing, reservoir capacity, reservoir and channel routing, surface run-off models, ground water hydrology - steady state well hydraulics and aquifers; Application of Darcy's law.

Irrigation & Hydraulic structures: Duty, delta, estimation of evapo-transpiration; Crop water requirements; Design of lined and unlined canals, head works, Design of weirs/barrage on permeable foundation; Types of irrigation systems, irrigation methods; Water logging and drainage; Canal regulatory works, cross-drainage structures, outlets and escapes, gravity and embankment dams, spillways.

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ME - MECHANICAL ENGINEERING

1. Engineering Mathematics

Linear Algebra: Matrix algebra, systems of linear equations, eigenvalues and eigenvectors.

Calculus: Functions of single variable, limit, continuity and differentiability, mean value theorems, indeterminate forms; evaluation of definite and improper integrals; double and triple integrals; partial derivatives, total derivative, Taylor series (in one and two variables), maxima and minima, Fourier series; gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, applications of Gauss, Stokes and Green's theorems.

Differential equations: First order equations (linear and nonlinear); higher order linear differential equations with constant coefficients; Euler-Cauchy equation; initial and boundary value problems; Laplace transforms; solutions of heat, wave and Laplace's equations.

Complex variables: Analytic functions; Cauchy-Riemann equations; Cauchy's integral theorem and integral formula; Taylor and Laurent series.

Probability and Statistics: Definitions of probability, sampling theorems, conditional probability; mean, median, mode and standard deviation; random variables, binomial, Poisson and normal distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations; integration by trapezoidal and Simpson's rules; single and multi-step methods for differential equations.

2. Applied Mechanics and Design

Engineering Mechanics: Free-body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations, collisions.

Mechanics of Materials: Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of

columns; energy methods; thermal stresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness and impact strength.

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope.

Vibrations: Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.

Machine Design: Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.

3. Fluid Mechanics and Thermal Sciences

Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy, forces on submerged bodies, stability of floating bodies; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, StefanBoltzmann law, Wien's displacement law, black and grey surfaces, view factors, radiation network analysis.

Thermodynamics: Thermodynamic systems and processes; properties of pure substances, behaviour of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations.

Applications: Power Engineering: Air and gas compressors; vapour and gas power cycles, concepts of regeneration and reheat. I.C. Engines: Air-standard Otto, Diesel and dual cycles. Refrigeration and air-conditioning: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes. Turbomachinery: Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines.

4. Materials, Manufacturing and Industrial Engineering

Engineering Materials: Structure and properties of engineering materials, phase diagrams, heat treatment, stress-strain diagrams for engineering materials.

Casting, Forming and Joining Processes: Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design. Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy. Principles of welding, brazing, soldering and adhesive bonding.

Machining and Machine Tool Operations: Mechanics of machining; basic machine tools; single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, design of jigs and fixtures.

Metrology and Inspection: Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools.

Production Planning and Control: Forecasting models, aggregate production planning, scheduling, materials requirement planning.

Inventory Control: Deterministic models; safety stock inventory control systems.

Operations Research: Linear programming, simplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

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MARINE ENGINEERING

Introduction to marine machinery -Types of marine power systems-Engine room layout -Marine diesel engines and their cycles, Fuels Super charging, Ignition and combustion problems-Fuel oil, lubricating oil-Compressed air cooling water systems.

Turbines, pumps, their types and characteristics, cavitation etc.

Marine boilers, Composite boilers-Exhaust gas and heat exchangers-Economizers, Super heaters.

Auxiliary machineries-Choice of power systems for ships.

Firefighting, Navigational aids, Steering gear, shafting, stern tubes and transmission system.

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MARINE /NAVAL ARCHITECTURE

(i) Basics of ship, submarine and floating systems

(ii) Hydrostatic stability of ships and submarines

(iii) Ship resistance

(iv) Propulsion of marine vehicles

(v) Dynamics of ships in waves

(vi) Maneuvering of ships and submarines

(vii) Static structural analysis of a ship subject to weight and buoyancy forces.

(viii) Design aspects of a ship

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Section (B) / Non Technical Part etc.
(20 MCQ carrying 24 marks)

The topics for 20 marks (common for all examinations including Civil Engg.), will be on the following :

1. Quantitative aptitude (simple maths)
2. Data interpretation
3. Analytical reasoning
4. Logical reasoning
5. Simple English