ASSISTANT ENGINEERS (Civil) & ASSISTANT TECHNICAL OFFICERS (Civil)
COMMON TO CIVIL AND MECHANICAL ENGINEERING

Qualification: DIPLOMA

1) SOLID MECHANICS:

i) Forces: Different types of forces, gravitational, frictional, axial, tensile or compressive. Law of Parallelogram and triangle of forces, polygon of forces, problems.

ii) Centre of gravity and moment of inertia. Simple plane figures, Simple machines, law of machine, Mechanical advantage, velocity ratio and efficiency, wheel and axle, pulleys and simple screw jack-problems.

iii) Simple Stresses and strailns: Different types of stresses and strains, stress-strain diagram for ductile materials. Factor of safety, ultimate strength and working strength, elastic constants, Poisson ratio. Deformations, volume changes. Relations between elastic constants. Hooke's Law. Compound rods, temperature stresses, strain energy, impact loading.

iv) Riveted and welded joints, different modes of failures, efficiency of joints, thin cylindrical shells, longitudinal and circumferential stresses and volume changes.

v) Shear force and bending moment diagrams for simply supported, over hanging and cantilever beams. Relation between intensity of loading, shear force and bending moment.

vi) Theory of simple bending: Assumptions, basic flexure formula, bending stresses, modulus of section, moment of resistance. Circular bending. Distribution of shear stress in common structural sections.

vii) Deflection in cantilever and simply supported beams under simple loading-propped cantilever beams subjected to simple loading, determination of reaction. SF and BM diagrams.

viii) Simple plane and pin-jointed trusses: Stresses by method of joints and method of sections.

ix) Torsion: Assumptions, basic formula of torsion, power transmission by shafts of uniform circular sections close-coiled springs, strain-energy in simple beams and shafts, sudden and impact loading. Principal stresses and principal planes. Moher's circle of stress.

x) Thin cylinders under internal pressure stresses and volume changes.

xi) Columns and struts: Direct and bending stresses, core of section. Short and long columns under axial loading-various end-conditions. Euler and Rankine formulae, Slenderness ratio, simple built-up columns.

2) FLUID MECHANICS:

i) Introduction: Scope of hydraulics in Engineering. Definition and properties of fluid.

ii) Fluid pressure and its measurement: Atmospheric pressure, Gauge pressure and absolute pressure. Piezometer, Manometer-U-tube, Inverted U-tube, and differential manometers.

iii) Pressure on plane surface immersed in liquid-Horizontal, vertical and inclined plane surface.

iv) Flow of fluids: Type of flow-uniform flow, non-uniform flow, streamline flow, Turbulant flow, steady flow and unsteady flow, Energies in fluid motion-Datum head, pressure head and velocity head. Total energy of fluid in motion - Bernoulli's theorem. Practical application of Bernoulli's theorem - flow measurement- pitot tube venturimeter - Orificemeter.

v) Flow through orifices and Mouth Pieces: Definition of orifice, types of orifices, Vena contracta, coefficient of velocity, coefficient of contraction, coefficient of discharge. Submerged and partially submerged orifices. Flow through orifices
vi) under variable heads - Time of emptying a rectangular tank through orifices. Mouth pieces - different types of problems.
vii) Notches and Weirs: Definition of notch, types of notches - Rectangular notch, Tringular notch and trapezoidal notch. Discharge over a rectangular, triangular and a trapezoidal notches.
viii) Flow through pipes: Major and minor losses - Loss of head at entrance, loss of head due to sudden enlargement, due to sudden contraction, loss of head at exit of the pipe. Frictional loss in pipe-Chezy formula and Daycy's formula.
ix) Hydraulic gradient and total energy line. Discharge through parallel pipes and branched pipes connected to a reservoir. Flow through syphon pipe.
x) Hydraulic transmission of power-flow through nozzle at the end of a pipe line-diameter of nozzle for Max H.P. available. Water hammer and its effect. Laminar and turbulent flow in pipes-Critical velocity and Reynold number.
xi) Impact of jets: Formulae for the force of jet on a fixed vertical flat plate, fixed inclined flat plates, moving flat plates, series of flat plates fixed on the rim of a wheel. Force of jet striking at the centre and at the top of a fixed curved blade and moving curved blade, velocity triangles. Work done, power and efficiency in the above cases. Simple problems. Water turbines: Introduction to water turbines. Use of water turbines in Hydroelectric power stations line sketch showing layout of hydro-electric power plant with head race, dam, sluice gate, pen stock turbine, generator and tail race. Classification of turbines - impulse and reaction turbines brief sub-classification of axial, radial and tangential flow type. Pelton wheel, Francis turbine and Kaplan turbine, power and efficiency of turbines.
xii) Centrifugal pump: Installation, mountings and other accessories. Priming of centrifugal pump. Efficiency, cavitation. Simple problems on work, power and efficiency

3.Water Supply Engineering

Sources of water: surface and sub-surface water, aquifers, yield from wells, Infiltration galleries, types of intakes and design of intakes, collection and conveyance of water; water demand and it's variations, estimation of water demand; quality of water, characteristics, water-borne diseases, water sampling and analysis, water quality standards;
Water Treatment: unit operations and processes for water treatment, sedimentation, coagulation and flocculation, filtration, disinfection, water softening, removal of colour, iron and manganese; aeration, Defluoridation of water, demineralisation of water, R.O. process, principles and design of various water treatment units;
Distribution of treated water, systems of water distribution, layouts of distribution systems, components of distribution systems, valves, analysis and design of the water distribution systems, Storage and distribution reservoirs; leakages and control in water distribution system; Rural water supply;

4.(i) Wastewater Engineering

Systems of sewage collection, conveyance, and disposal; estimation of quantity of sewage and storm water, sewerage systems, sewer appurtenances, material for sewers, laying of sewers, Design of sewers, operation and maintenance of sewerage systems; pumping of sewage; Characteristics of sewage, sampling and analysis of sewage, unit operations and process for wastewater treatment, aerobic, anaerobic, facultative and anoixic processes, principles and design of various wastewater

treatment units, principles and design of septic tanks, disposal of septic tank effluent; Common Effluent Treatment Plants, Zero liquid discharge;
Disposal of products of sewage treatment; Sludge handling, treatment and disposal; self purification of streams; Building drainage, Plumbing Systems; Rural and semi-urban sanitation;
Urban storm water management, Impact of storm water, Management of storm water runoff, design of storm water drainage systems;

ii) Air and Noise Pollution

Air pollution, classification of air pollutants, sources and effects of air pollution, Factors influencing air pollution, air quality standards; Meteorology and air pollution; Wind roses, lapses rates, mixing depth, plume behaviour, effective stack height; Monitoring of air pollution; air pollution dispersion, estimation of ground level concentration of air pollutants; Engineered systems for air pollution control: control of particulate matter and gaseous pollutants;
Noise pollution, characteristics, sources of noise pollution, measurements of noise, impacts of noise pollution; Noise pollution monitoring, standards; control measures;

5.(i) Solid Waste Management

Sources of solid waste, classification, characteristics, generation, on-site segregation and storage, collection, transfer and transportation of solid waste; principles and engineering systems for solid waste management, treatment and processing of solid waste; landfills and their classification, principles, design and management of landfills; Leachate management, disposal of solid waste;
Hazardous waste characteristics, handling, storage, collection and transportation, treatment and disposal; e-waste: sources, collection, treatment and reuse;

ii) Environmental Impact Assessment (EIA) and Sustainable Development

Objectives and concepts of EIA, types of EIAs, components of EIA, framework of EIA, policies and legal provisions of EIA in India; Planning of EIA studies, methodology for identification of impacts on environment; Environmental settings, indices, prediction and assessment of impacts, mitigation aspects; Environmental Impact Statement; Environmental Management Plan, preparation, implementation, and review; public participation in EIA, review and evaluation of EIA; Environmental audit; Environmental protection acts of India.
Ecosystems, classification of ecosystems, structural and functional interactions of environmental ecosystems; Ecosystem stability, biogeochemical cycles, nutrient cycles, ecological niche and ecotone, pesticides and bioaccumulation, water pollution, soil pollution, wetlands, methods for conservation of biodiversity;
Sustainable Development, objectives and principles of sustainable development, indicators of Sustainability; Strategies and barriers to sustainability, clean development mechanism, carbon credit, carbon sequestration, carbon trading, Life Cycle Assessment (LCA), Elements of LCA;
Global environmental issues, climate change and its impact on environment; mitigation of impacts; adaptability and climate resilience; ecological foot print, major environmental problems related to the conventional energy resources

6. WATER RESOURCES ENGINEERING

i) Fluid Mechanics and hydraulic Machines

Physical properties of fluids, fluid statics; fluid flow concepts, Kinematics of flow, continuity, momentum and energy principles and corresponding equations; Flow measurement; dimensional analysis and hydraulic similitude; flow through pipes and open channel hydraulics; Hydraulic jump, Surges and Water hammer;

Basic principles of hydraulic machines, turbines and pumps, types, selection, performance parameters, controls, scaling, pumps in parallel; Hydraulic ram;

ii) Hydrology

Hydrological cycle, precipitation and its estimation, evaporation and transpiration, runoff estimation; hydrographs;

Floods estimation and routing, flood management; streams and their gauging; capacity of Reservoirs. Watershed management and rainwater harvesting; ground water hydrology: steady state well hydraulics and application of Darcy's law, recuperation test for well yield, ground water management;

iii) Irrigation

Water resources of the earth, irrigation systems, advantages and disadvantages of irrigation, duty, delta, crop water requirements; Water logging and drainage, Design of canals, head works, canal distribution works, falls, crossdrainage works, canal lining; Sediment transport in canals;

7. SURVEYING

Principles of surveying, classification of surveys; Measurement of distances and directions, direct and indirect methods; optical and electronic devices; chain and compass survey; levelling and trigonometric levelling, Contours; Theodolite and tachometric survey; Total station, triangulations and traversing; measurements and adjustment of observations, errors and their adjustments, computation of coordinates; minor instruments; area and volumes; curve setting, horizontal and vertical curves;

Digital elevation modelling concept; basic concepts of remote sensing, GIS and global positioning system;

8. SOIL MECHANICS and FOUNDATION ENGINEERING

Physical and index properties of soil, classification and interrelationship; Permeability and seepage, Darcy's law; flow nets, uplift pressure, piping; Compressibility and consolidation; Compaction behaviour, methods of compaction and their choice; Shear strength of soils, stresses and failure, Mohr's circle; Earth pressure theories, stability analysis of slopes, retaining structures, stress distribution in soil; site investigations and sub-surface exploration;

Types of foundations, selection criteria, bearing capacity, effect of water table, settlement, laboratory and field tests; principles and design considerations of shallow and deep foundations; Types of piles, their design and layout, pile load tests, Caissons, Foundations on expansive soils, swelling and its prevention;

9. TRANSPORTATION ENGINEERING

Planning and development of highway, classification of roads, highway alignment and geometric design, cross-sectional elements, sight distance, horizontal and vertical alignment, grade separation; Highway materials, their properties and quality tests, construction of earthen, W.B.M., Bitumen and cement concrete roads; bitumen mix design; Maintenance of all types of roads, disposal of muck, highway drainage, Street lighting; design of flexible and rigid pavements using IRC recommendations;

Traffic engineering, traffic characteristics, traffic surveys, traffic control devices, intersections, signaling; Mass transit systems, accessibility, traffic control, emergency management.

Airports, layout and orientation, site selection; runway and taxiway design; drainage management; Zoning laws; Helipads, Airport obstructions, Visual aids and air traffic control;

10. SOLID MECHANICS and ANALYSIS OF STRUCTURES

i) Solid Mechanics

Simple stress and strain relationships, Bending moment flexural and shear stresses in statically determinate beams; Elastic theories of failure; Torsion of circular and rectangular sections and simple members; buckling of column, combined and direct bending stresses.

ii) Structural Analysis

Analysis of statically determinate and indeterminate structures by force/ energy methods; Method of superposition; Analysis of trusses, arches, beams, cables and frames; Analysis of thin and thick cylinders; Slope deflection, moment distribution, and Stiffness and flexibility methods of structural analysis; Influence lines;

11. DESIGN OF STRUCTURES

i) Reinforced Concrete Structures

Concepts of working stress, limit state and ultimate load design methods; IS code specifications for design of beams, slabs, columns, footings, and walls; design of beams, slabs, columns; Analysis of beam sections at transfer and service loads; ~~Design of wall footings, foundations, retaining walls, and water tanks~~ Principles of prestressed concrete, methods of prestressing; design of simple members; Design of brick masonry

ii) Steel Structures

Concepts of Working stress and Limit state design methods; Design of tension and compression members, beams, columns and column bases; Connections - simple and eccentric, beam-column connections, plate girders and trusses;

12. BUILDING MATERIALS and CONSTRUCTION PRACTICE

Building Materials: composition and properties of timber, bricks, cement, concrete, structural steel, plywood; mix design, short-term and long-term properties of concrete and mortar; Bitumen; Brick masonry, influence of mortar strength on masonry strength. Importance of W/C Ratio, Strength, ingredients including admixtures, workability, testing for strength, elasticity, nondestructive testing, mix design methods in concrete; Green building concepts construction Management: Types of construction projects; Concreting Equipment, Earthwork Equipment, Tendering and construction contracts; Rate analysis and standard specifications; Cost estimation; Project planning and network analysis: PERT and CPM, Resource allocation.

Assistant Executive Engineer (Civil)
COMMON TO CIVIL AND MECHANICAL ENGINEERING

QUALIFICATION – BE / B.Tech

1. Strength of Material:
Forces, moments, Equilibrium; Applying the Equation of Equilibrium, Planar Trusses; Friction.
Simple Stresses & Strains: Elasticity and plasticity, Types of stresses & strains, Generalized Hooke's law–stress –strain diagram for mild steel – Working stress – Factor of safety –Lateral strain, Poisson's ratio & volumetric strain – Elastic modulii & the relationship between them – Bars of varying section – composite bars – Temperature stresses. Strain energy –Resilience – Gradual, sudden, impact and shock loadings.
Shear Force (S.F) and Bending Moment (B.M): Definition of beam – Types of beams –Concept of shear force and bending moment – S.F and B.M for cantilever, simply-supported and overhanging beams subjected to point loads, U.D.L., Uniformly varying loads and combination of these loads –Point of contraflexure –Relation between S.F., B.M and rate of loading at a section of a beam.
Flexural Stresses: Theory of simple bending -Assumptions – bending equation: Neutral axis – bending stresses –section modulus of different sections –Design of simple beam sections. Shear Stresses: Derivation of formula – Shear stress distribution across various beam sections
Principal Stresses and Strains: Stresses on an inclined section of a bar under axial loading – Compound stresses – Normal and tangential stresses on an inclined plane for biaxial stresses – Two perpendicular normal stresses accompanied by a state of simple shear –Mohr's circle of stresses – Principal stresses and strains – Analytical and graphical solutions. Different theories of Failure: Various theories of failure. Columns and struts – Euler's column theory – types of end conditions; critical load on the column - derivations – Rankin's formula for columns. Lifting machines, definitions, Law of machine, study of important lifting machines; virtual work principal.
Torsion of Circular Shafts: Theory of pure torsion – Torsion Equations: Assumptions made in the theory of pure torsion – Torsional moment of resistance – Polar section modulus – Power transmitted by shafts – Combined bending and torsion and end thrust. Springs-Helical and leaf springs
Thin & Thick Cylinders and Spherical shells: Thin seamless shells – Formula for longitudinal and circumferential stresses and max shear stresses – hoop, longitudinal and volumetric strains – changes in diameter, and volume of thin shells.
2) Fluid Mechanic and Machinery
Fluid statics: Dimensions and units: physical properties of fluids-specific gravity, viscosity, and surface tension - Vapour pressure and their influence on fluid motion - atmospheric, Pascal's law, gauge and vacuum pressures – measurement of pressure - Piezometer, U-tube and differential manometers. Hydrostatics, Fluid forces on planes and curved surfaces, submerged and floating bodies, Buoyancy and stability. Fluid kinematics: description of flow pattern and types of fluid flows – Velocity and acceleration: convective, temporal, tangential and normal accelerations, control volume - basic principles of fluid flow, continuity equation for 3-D, 2-D, 1-D flow. Rotational and irrotational motion, Velocity potential, stream function, flow net.

Fluid dynamics: Surface and body forces –Euler's and Bernoulli's equations for flow along a stream line and its applications, momentum equation and its applications. Flow measurement devices – Gross measurement: Venturimeter, Orificemeter, Turbine flow meters, Rotameters; Pressure measurement: Pitot tubes, Hot wire/film anemometer, their measurement principles and sources of errors; calibration.
Closed conduit flow: Reynolds experiment - Major and Minor losses in pipes-pipes in series and pipes in parallel-total energy line-hydraulic gradient line, water hammer. Boundary Layer Concepts: Definition, thicknesses, characteristics along thin plate, laminar and turbulent boundary layers boundary layer in transition, separation of boundary layer, submerged objects – Drag and lift.
Basics of turbo machinery: Hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, velocity diagrams, work done and efficiency, Hydraulic Turbines: Classification of turbines, Heads and efficiencies, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design – Draft tube theory-functions and efficiency. Performance of hydraulic turbines: Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, Cavitation. Centrifugal pumps: Classification, working, work done – barometric head-loss and efficiencies specific speed-performance characteristic curves, NPSH. Selection of pumps and economic evaluation of pumping. Hydraulic Directional Control –Check Valves, Shuttle Valves, two-three- and four-Way Directional Control Valves, Directional Control Valve Actuation. Hydraulic Pressure Control – Pressure Relief Valves, Unloading Valves, Pressure Reducing Valves, Sequence Valves, Counterbalance Valves, Pressure Compensated Pumps.
Hydro Projects And Plant: Classification – Typical layouts – plant auxiliaries – plant operation, pumped storage plants. Hydro Electric Power Plant: Water power – Hydrological cycle / flow measurement – drainage area characteristics – Hydrographs – storage and Pondage – classification of dams and spill ways.
3. BUILDING MATERIALS: Timber: Different types and species of structural timber, density moisture relationship, strength in different directions, defects, preservations, and 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, mix design methods, non-destructive testing.
4. STRUCTURAL ANALYSIS: General theorems: theorems relating to elastic structures, principles of virtual work, strain energy in elastic structures, complementary energy, Castigliano's theorem, Betti's and Maxwell's reciprocal theorems.
Analysis of determinate structures – Deflection of determinate beams by double integration Macaulay's moment area and conjugate beam methods, Analysis of indeterminate skeletal frames-Moment distribution, Slope deflection, Kani's, Stiffness and force methods, Energy methods, Plastic analysis of indeterminate beams and simple portal frames. Influence lines;.
5. DESIGN OF STEEL STRUCTURES: Principles of limit state method. Plastic sections, Design of bolted and welded connections, Design of tension, compression members and beams, axially and eccentrically loaded joints, Simple connection of

bracket plates to columns, beam to beam and beam to column connections, design of framed, un-stiffened and stiffened seat connections. Design of industrial roofs. Principles of ultimate load design. Design of simple members.

6. DESIGN OF CONCRETE AND MASONRY STRUCTURES: Limit state design for bending, Shear, Axial compression and combined forces. Codal provision for slabs, Beams, Columns and footings. Principles of pre-stressed concrete design, Materials, Methods of pre-stressing, losses. Design of simple members and determinate structures. Design of brick masonry as per IS codes. Design of wall footings, foundations, retaining walls, and water tanks

7. 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.

8. HYDRAUICS, AND WATER RESOURCE ENGINEERING: Open Channel flow : types of flows Type of channels – Velocity distribution – Energy and momentum correction factors, uniform flow and calculation of uniform flow, most economical section, Specific energy, critical flow conditions, critical depth computation, Non-Uniform flow: Assumptions and Equation for Gradually varied flow, types of channel bottom slopes, classification of surface profiles. Rapidly varied flow, hydraulic jump, energy dissipation. Hydraulic Similitude: Dimensional analysis-Rayleigh's method and Buckingham's pi theorem- –Geometric, kinematic and dynamic similarities - dimensionless numbers – model and prototype relations. Distorted and non-distorted models.

Hydrological cycle and its components, Precipitation and related data analysis, Evaporation and transpiration; S-hydrograph, Unit hydrographs. Floods and their management, Probable maximum Flood; Streams and their gauging; Routing of floods; Capacity of reservoirs.

Multipurpose uses of water; Soil-Plant-Water relationships, Irrigation systems, Water demand assessment; Storages and their yields, Ground water yield and well Hydraulics; Water logging, drainage design. 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 section of gravity dams and their design, Energy dissipaters, tail water rating; Design of head works, Distribution works, Falls, Cross-drainage works, Outlets, River training.

9. ENVIRONMENTAL ENGINEERING: Water Supplying 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. Conveyance and distribution systems of treated water, Leakages and control. Rural water supply. Institutional and industrial water supply.

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. Plumbing systems. Rural and semi-urban sanitation.

Solid Waste Management: Sources and effects of air pollution, Monitoring of air pollution, Noise pollution, Standards, Ecological chain and balance. Environmental impact assessment.

10. SOIL MECHANICS AND FOUNDATION ENGINEERING: Properties and classification of soil, Compaction, Permeability and Seepage, Flow nets, Compressibility and consolidation. Stress distribution in soils, Shearing resistance, Stresses and failure. Soil testing in laboratories and insitu, Earth pressure theories,

Soil exploration. Types of foundations, Selection criteria, bearing capacity, Settlement, laboratory and field tests, Design of shallow foundations. Types of piles and their design and layout. Foundations on expansive soils.

11. SURVEYING AND TRANSPORT ENGINEERING: 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 leveling, Contours, Digital elevation modeling concept, Establishment of control by triangulations and traversing, Measurement 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.

Planning of Highway systems, Alignment and geometric design, Horizontal and vertical curves, Grade separation, Highway Materials and construction methods for different surfaces and maintenance. Principles of pavement design, Drainage. Traffic surveys, Intersections, Signaling, Mass transit systems, Accessibility, Networking.