PAPER – 2

(COMMON FOR CIVIL/ MECHANICAL)

1.ENGINEERING MECHANICS:

FORCE RESOLUTION:

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

CENTER OF GRAVITY AND MOMENT OF INERTIA:

Center of gravity and moment of inertia. Simple plane figures.

SIMPLE MACHINES:

Simple machines, law of machine, Mechanical advantage, velocity ratio and efficiency, wheel and axle, pulleys and simple screw jack-problems.

2.STRENGTH OF MATERIAL:

i) **Simple Stresses and strains:** 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 stressess.

ii) **COMPLEX STRESSES :**

Principal stresses and principal planes. Mohr's circle of stress.

iii) **SFD BMD:** Shear force and bending moment diagrams for simply supported, over hanging and cantilever beams. Relation between intensity of loading, shear force and bending moment.

IV) BENDING STRESS DISTRIBUTION

Theory of simple bending: assumptions, basic flexure formula, bending stresses, modulus of section, and moment of resistance. Circular bending.

V) SHEAR STRESS DISTRIBUTION:

Distribution of shear stress in common structural sections.

VI) TORSIONAL STRESS DISTRIBUTION:

Torsion: Assumptions, basic formula of torsion, power transmission by shafts of uniform circular sections **close-coiled springs,**

VII) Slope and deflection of beams:

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) strain-energy :

STRAIN ENERGY in simple beams and shafts, sudden and impact loading

ix) Compression members:

Columns and struts: Direct and bending stresses, cone of section. Shaft and long columns under axial loading – various end-conditions. Euler and Rankine formulae. Slenderness ratio, **simple built-up columns.**

X) THIN CYLINDERS AND SHELLS:

thin cylindrical shells, longitudinal and circumferential stresses and volume changes. Thin cylinders under internal pressure stresses and volume changes.

XI) TRUSS ANALYSIS:

Simple plane and pin-jointed trusses: stresses by method of joints and method of sections

XII) Rivetted and welded connections:

stressesRiveted and welded joints, different modes of failures, efficiency of joints

FLUID MECHANICS:

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

Fluid statics:

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

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

Fluid kinematics:

Flow of fluids: Type of flow-uniform flow, non-uniform flow, stream line flow, Turbulent flow, steady flow and unsteady flow.

FLUID DYNAMICS AND EQUIPMENTS:

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 venture meter – Orifice meter.

Flow through orifices and Mouth Pieces: Definitions of orifice, types of orifices, Vena contracta, coefficient of velocity, coefficient of contraction, coefficient of discharge. Submerged and partially submerged orifices. Flow through orifices.

Under variable heads - Time of emptying a rectangular tank through orifices. Mouthpieces-different types of problems.

Notches and Weirs: Definition of notch, types of notches - Rectangular notch, Triangular notch and trapezoidal notch. Discharge over a rectangular, triangular and a trapezoidal notches.

Water hammer and its effect.

LAMINAR AND TURBULENT FLOW:

Laminar and turbulent flow in pipes-Critical velocity and Reynolds number.

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's formula and Darcy'sformula.Hydraulic gradient and total energy line. Discharge through parallel pipes and branched pipes connected to a reservoir. Flow through syphonpipe.Hydraulictransmissionofpower-flowthroughnozzleattheendofapipeline-diameterofnozzle for Max H.P. availableImpact of jets:

IMPACT OF JETS

Formulae for the force of jet on a fixed vertical flat plate, fixed inclined flat plates, moving flat plates, and series of flat plates fixed on the rim of a wheel. Force of jet striking at the center 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.

HYDRAULIC MACHINES:

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 ofturbines.

Centrifugal pump: Installation, mountings and other accessories. Priming of centrifugal pump. Efficiency, cavitation. Simple problems on work, power andefficiency.

PAPER – 3
(COMMON FOR ENVIRONMENTAL/CIVIL)

1. 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, demineralization of water, R.O. process, principles and design of various water treatmentunits;

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.

2. **(i) Waste Water 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 anoxic 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 liquiddischarge;

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;

3. **(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 solidwaste;

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 ofIndia.

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 ofLCA;

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.

4. WATER RESOURCES ENGINEERING

i) Fluid Mechanics and hydraulicMachines

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, cross-drainage works, canal lining; Sediment transport in canals.

5. 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.

6. SOIL MECHANICS AND FOUNDATIONENGINEERING

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.

7. TRANSPORTATIONENGINEERING

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.

8. SOLID MECHANICS AND ANALYSIS OFSTRUCTURES

i) SolidMechanics

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) StructuralAnalysis

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.

9. DESIGN OFSTRUCTURES

i) Reinforced ConcreteStructures

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.

10. BUILDING MATERIALS AND CONSTRUCTIONPRACTICE

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, Resourceallocation.