

Maharashtra Public Service Commission

Civil Services Exam – Mains Optional

Civil Engineering

(Code No : 403)

Paper - I

Standard : B.E. Degree in Civil Engineering

Total Marks : 200

Nature of Paper : Conventional Type

Duration : 3 Hours

- Note :**
- 1) Answers to this paper must be written in English only.
 - 2) This paper will test the candidate's ability to comprehend, to analyse, to interpret, to criticise and to appraise subject matter related to the topics/sub topics mentioned below.
 - 3) For judging candidates' conceptual understanding, appropriate number of numerical problems will be asked pertaining to the topics/sub topics mentioned below.
 - 4) It is expected from candidates to study the latest and recent developments and happenings pertaining to the topics/sub topics mentioned below.

Section - A (Marks : 50)

Engineering Mechanics, Strength of Materials and Structural Analysis

- 1) **.01) Statics :**
concurrent, non-concurrent and parallel forces in a plane, moment of force and Varignon's theorem, free body diagram, conditions of equilibrium, Principle of virtual work, equivalent force system. First and second moment of area, mass moment of inertia.
- .02) Kinematics and Kinetics :**
kinematics in Cartesian and polar co-ordinates, motion under uniform and non-uniform acceleration, motion under gravity. Kinetics of particle: momentum and energy principles, D'Alembert's principle, collision of elastic bodies, rotation of rigid bodies, simple harmonic motion.
- 2) **.01) Strength of Materials :**
simple stress and strain, elastic constants, axially loaded compression members, Shear force and bending moment, theory of simple bending, Shear Stress distribution across cross sections, Beams of uniform strength, Strain Energy in direct stress, bending & shear. Principal stresses and strains in two dimensions, Mohr's circle, introduction to theories of elastic failure, thin cylinder- stresses due to internal and external pressure.
- .02) Torsion and Elastic stability of columns :**
torsion of shafts, transmission of power, close coiled helical springs. Elastic stability of columns, Euler's, Rankine's and secant formulae.
- .03) Deflection of beams:**
Mecaulay's method, Mohr's moment area method, unit load method.
- 3) **.01) Structural Analysis :**

Castigliano's theorems I and II, unit load method of consistent deformation applied to beams and pin jointed trusses. slope-deflection method and moment distribution method applied to indeterminate beams and rigid frames. rolling loads and influences lines, influences lines for shear force and bending moment at a section of beam. criteria for maximum shear force and bending moment in beams traversed by a system of moving loads.

.02) Arches :

three hinged, two hinged and fixed arches, rib shortening and temperature effects.

.03) Matrix methods of analysis :

Force method and displacement method of analysis of indeterminate beams and rigid frames, applications limited to two degrees of freedom.

.04) Plastic Analysis of beams and frames:

Theory of plastic bending, plastic analysis, applications to beams and frames.

Section - B (Marks : 50)

Design of Steel, Concrete and Masonry Structures

4) Structural Steel Design :

factors of safety and load factors. welded joints and connections. design of tension and compression member, beams of built up section, welded plate girders, gantry girders, stanchions with battens and lacings, slab and gusseted column bases, detailing of joints.

5) .01) Reinforced Concrete Structures :

Working stress and limit state method of design – recommendations of I.S. codes, design of one way and two way slabs, stair-case slabs, simple and continuous beams of rectangular, T and L sections. compression members under direct load with or without eccentricity, isolated and combined footings. earthquake considerations and reinforcement detailing, cantilever and counter fort type retaining walls.

.02) Water tanks :

Design requirements for rectangular and circular tanks resting on ground and elevated reservoirs.

.03) Prestressed concrete:

methods and systems of prestressing, anchorages, losses in prestressed concrete, analysis and design of sections for flexure based on limit state and working stress methods as per IS Codes.

6) Design of Masonry Structures :

Design of brick masonry, earthquake consideration and codal provisions, serviceability and strength requirements. design of masonry retaining walls.

Section - C (Marks : 50)

Geo Technical Engineering

7) .01) Soil properties and soil classification:

Types of soil, phase relationships, consistency limits, particle size distribution, classifications of soil, structure and clay mineralogy.

.02) Seepage through soils:

Capillary water and structural water, effective stress and pore water pressure, Darcy's law, factors affecting permeability, determination of permeability, permeability of stratified soil deposits. seepage pressure, quick sand condition,

.03) Compressibility and consolidation:

Compressibility and consolidation, Terzaghi's theory of one dimensional consolidation, consolidation test, compaction of soil, field control of compaction. total stress and effective stress parameters, pore pressure coefficients. shear strength of soils, Mohr Coloumb failure theory, shear tests.

.04) Earth pressure:

Earth pressure at rest, active and passive pressures, Rankine's theory, Coloumb's wedge theory, earth pressure on retaining wall, sheet-pile walls, braced excavation.

.05) Soil exploration:

Subsurface exploration, methods of boring, sampling, penetration test, pressure meter test. laboratory testing of soils, analysis & interpretation of results.

.06) Foundations:

(i) bearing capacity, Terzaghi and other important theories, net and gross bearing pressure, essential features of foundation, types of foundation, design criteria, choice of type of foundation, stress distribution in soils, Boussinessq's theory, Newmark's chart, pressure bulb, contact pressure, applicability of different bearing capacity theories, evaluation of bearing capacity from field tests, allowable bearing capacity, settlement analysis, allowable settlement. methods of improving bearing capacity.

(ii) proportioning of footing, isolated and combined footings, rafts, buoyancy rafts, Pile foundation, types of piles, pile capacity, static analysis, design of pile groups, pile load test, settlement of piles, lateral capacity. ground improvement techniques—preloading, sand drains, stone column, grouting, soil stabilisation. load cells.

Section - D (Marks : 50)

Construction Technology, Equipment and Management

8) .01) Construction Materials :

Physical properties of construction materials: stones, bricks and flooring tiles; cement mortars; cement Concrete, use of fly ash & micro silica Properties of freshly mixed and hardened concrete, concrete mix design (IS Code), high strength concrete and light weight concrete. high performance concrete, damp-proofing and water proofing materials, termite proofing, paints, epoxy coatings and resins, materials for low cost housing.

.02) Building components and their functions:

brick masonry : bonds, jointing, plastering, pointing. types of floors & roofs. ventilators, introduction to repairs and retrofitting in buildings.

.03) Functional planning of building:

building orientation, circulation, grouping of areas, privacy concept and design of energy efficient building; provisions of National Building Code.

building estimates and specifications, cost of works , valuation.

9) Construction Equipment :

Standard and special types of equipment, preventive maintenance and repair, factors affecting selection of equipment, economical life, productivity, operational cost, owning and hiring costs. concrete weigh batcher, mixer, vibrator, batching plant, concrete pumps, power shovel, hoe, bulldozer, dumper, trailer, grader and tractor, roller, pile driving equipment, crane.

10) .01) Construction Management :

construction planning and scheduling, job layout, bar chart, organization for

projects, cost and quality control, supervision. network analysis : CPM, float times, compression of network for cost optimization, up dating, cash flow analysis and resource allocation and levelling.

.02) Elements of Engineering Economics :

methods of appraisal, present worth, annuity, annual cost, benefit-cost, incremental analysis. economy of scale and size. choosing between alternatives including levels of investments. project profitability, project financing and private participation like BOT, BOOT etc.

Paper - II

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Section - A (Marks : 50)

Fluid Mechanics, Open Channel Flow and Hydraulic Machines

1) .01) Properties of Fluid and Fluid Statics :

Fluid properties and their role in fluid motion, fluid statics including forces acting on plane and curved surfaces, fluids subjected to horizontal and angular acceleration.

.02) Kinematics and Dynamics of Fluid flow :

velocity and acceleration, stream lines, continuity equation, ir-rotational and rotational flow, velocity potential and stream functions, flow net, methods of drawing flow net, sources and sinks, flow separation, free and forced vortices, impact of jet on plane and curved surfaces.(Static & moving)

.03) Equations of Fluid flow and Applications:

control volume, continuity, momentum, energy and moment of momentum equations from control volume equation, Navier-Stokes equation, Euler's equation of motion, pipe flow, sluice gates, weirs, orifice meters and venturi meters, mouth pieces (submerged and free discharge), emptying of tanks.

.04) Dimensional Analysis and Similitude:

Buckingham's π -theorem, dimensionless parameters, similitude theory, model laws, undistorted and distorted models.

2) .01) Laminar and Turbulent Flow :

Laminar flow between parallel, stationary and moving plates, flow through tubes. laminar and turbulent boundary layer on a flat plate, laminar sub layer, smooth and rough boundaries, drag and lift.

.02) Turbulent flow through pipes :

Characteristics of turbulent flow, velocity distribution and variation of pipe friction factor, hydraulic grade line and total energy line, siphons, expansion and

contractions in pipes, pipe networks, water hammer in pipes and surge tanks. Moody's diagram and its applications.

3) Open channel flow :

Uniform and non-uniform flows, momentum and energy correction factors, specific energy and specific force, critical depth, resistance equations and variation of roughness coefficient, rapidly varied flow, flow in contractions, flow at sudden drop, hydraulic jump and its applications, surges and waves, gradually varied flow, classification of surface profiles, control section, step method of integration of varied flow equation, moving surges and hydraulic bore.

4) Hydraulic Machines and Hydropower :

- .01) Centrifugal pumps: types, characteristics, Net Positive Suction Height (NPSH), specific speed. Pumps in parallel.
- .02) Reciprocating pumps, air vessels, hydraulic ram, efficiency parameters, rotary and positive displacement pumps, diaphragm and jet pumps.
- .03) Hydraulic turbines, types, classification, choice of turbines, performance parameters, controls, characteristics, specific speed.
- .04) Principles of hydropower development. type, layouts and component works. Surge tanks, types and choice. flow duration curves and dependable flow. storage and pond age. pumped storage plants. special features of mini, micro-hydel plants.

Section - B (Marks : 50)

Hydrology and Water Resources Engineering

5) Hydrology and ground water flow :

- .01) Hydrological cycle, precipitation, evaporation, transpiration, depression storage, infiltration, overland flow, hydrograph, flood frequency analysis, flood estimation, flood routing through a reservoir, channel flow routing.
- .02) Specific yield, storage coefficient, coefficient of permeability, confined and unconfined aquifers, aquitards, radial flow into a well under confined and unconfined conditions, tube wells, pumping and recuperation tests, ground water potential.

6) Water Resources Engineering : ground and surface water resource, single and multipurpose projects, storage capacity of reservoirs, reservoir losses, reservoir sedimentation, economics of water resources projects.

7) .01) Water requirements of crops :

Consumptive use, quality of water for irrigation, duty and delta, irrigation methods and their efficiencies.

.02) Canals :

Distribution systems for canal irrigation, canal capacity, canal losses, alignment of main and distributory canals, most efficient section, lined canals, their design, regime theory, critical shear stress, bed load, local and suspended load transport, cost analysis of lined and unlined canals, drainage behind lining.

.03) Canal structures :

Design of cross regulators, head regulators, canal falls, aqueducts, metering flumes and canal outlets, diversion head works, principles and design of weirs of permeable and impermeable foundation, sediment excluders.

.04) Storage works :

Types of dams, design principles of rigid gravity and earth dams, stability analysis, foundation treatment, joints and galleries, control of seepage.

spillways : spillway types, crest gates, energy dissipation.
 river training : objectives of river training, methods of river training.

.05) Water logging :

Causes and control, drainage system design, salinity.

Section – C (Marks : 50)

Surveying and Transportation Engineering

8) Surveying :

.01) common methods of distance and angle measurements, plane table survey, levelling, traverse survey, triangulation survey, corrections, and adjustments, contouring, topographical map.

.02) Surveying instruments for above purposes. tacheometry. circular and transition curves. principles of photogrammetry, introduction to GPS and GIS.

9) Railways : permanent way, sleepers, rail fastenings, ballast, points and crossings, design of turn outs, stations and yards, turntables, signals, and interlocking, level-crossing. construction and maintenance of permanent ways.

10) .01) Highway Engineering:

principles of highway planning, highway alignments. geometrical design : cross section, camber, super elevation, horizontal and vertical curves vertical curves. design speed and sight distance, classification of roads, flexible pavements, rigid pavements. design concepts of pavements, pavement construction and equipments, evaluation of pavement failure, methods of repairs and strengthening. drainage of roads

.02) Traffic Engineering :

Forecasting techniques, origin and destination survey, highway capacity. channelised and non channelised intersections, rotary design elements, markings, signs and signals, street lighting; traffic surveys, traffic field studies and their uses, prevention of road accidents.

Section - D (Marks : 50)

Environmental Engineering

11) .01) Water Supply :

Estimation of surface and subsurface water resources, predicting demand for water, impurities of water and their significance, physical, chemical and bacteriological analysis, standards for potable water, water conservation measures and rain water harvesting methods.

.02) Intake of water :

Pumping and gravity schemes. Water treatment : principles of coagulation, flocculation and sedimentation; slow; rapid, and pressure filters; chlorination, softening, removal of taste, odour and salinity.

.03) Water storage and distribution :

Storage and balancing reservoirs : types, location and capacity. Distribution system : layout, hydraulics of pipe lines, pipe fittings, valves including check and pressure reducing valves, meters, analysis of distribution systems, leak detection, maintenance of distribution systems, pumping stations and their operations, pumping required for water supply systems.

12) .01) Sewerage systems :

Domestic and industrial wastes, storm sewage–separate and combined systems, flow through sewers, design of sewers, sewer appurtenances, manholes, inlets,

junctions, siphon.

.02) Sewage characterisation :

BOD, COD, solids, dissolved oxygen, nitrogen and TOC. standards of disposal in normal water course and on land.

.03) Sewage treatment :

Working principles, units, chambers, sedimentation tanks, trickling filters, oxidation ponds, activated sludge process, septic tank, disposal of sludge, recycling of waste water.

.04) Plumbing in public buildings:

Service connection, fixtures, simultaneous flow, design.

.05) Solid waste :

Collection and disposal in rural and urban contexts, management of municipal waste.

13) Environmental pollution :

Sustainable development. hazardous wastes and disposal. environmental impact assessment for thermal power plants, mines, river valley projects. air and noise pollution. pollution control acts.