CE Civil Engineering

Section 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, local maxima and minima; Taylor series; Evaluation of definite and indefinite integrals, application of definite integral to obtain area and volume; Partial derivatives; Total derivative; Gradient, Divergence and Curl, Vector identities; Directional derivatives; Line, Surface and Volume integrals.

Ordinary Differential Equation (ODE): First order (linear and non-linear) equations; higher order linear equations with constant coefficients; Euler-Cauchy equations; initial and boundary value problems.

Partial Differential Equation (PDE): Fourier series; Separation of variables; solutions of one-dimensional diffusion equation; first and second order one-dimensional wave equation and two-dimensional Laplace equation.

Probability and Statistics: Basic concepts of probability – axioms and theorems, statistical independence; Conditional probability; Descriptive statistics – Mean, median, mode and standard deviation; Random Variables – Probability mass function, probability density function, cumulative distribution function; Poisson and Normal Distribution; Linear regression.

Numerical Methods: Error analysis. Numerical solutions of linear and nonlinear algebraic equations; Newton's and Lagrange polynomials; numerical differentiation; Integration by trapezoidal and Simpson's rule; Single and multi-step methods for firstorder differential equations.

Section 2: Structural Engineering

Engineering Mechanics: System of forces, free-body diagrams, equilibrium equations; Internal forces in structures; Frictions and its applications; Centre of mass.

Solid Mechanics: Bending moment and shear force in statically determinate beams; Transformation of stress (Mohr's circle); Simple stress and strain relationships; Simple bending theory, flexural and shear stresses, shear centre; Uniform torsion; Combined stresses; Column buckling.

Structural Analysis: Principle of superposition; Work and energy methods: Principle of virtual work, Castigliano's second theorem; Deflections of statically determinate beams, frames, and trusses; Analysis of statically indeterminate structures by force and displacement methods (method of consistent deformations, slope-deflection method, moment distribution method); Influence lines and moving loads; Stiffness matrix method; Analysis of determinate arches and cables.

Concrete Structures: Working stress and limit state design concepts; Design and detailing of beams, slabs, columns, and isolated footings; Bond and development length.

Steel Structures: Working stress and limit state design concepts; Design of tension and compression members, beams and beam-columns, column bases; Connections – simple and eccentric, beam-column connections; Concept of plastic analysis – beams and portal frames.

Section 3: Geotechnical Engineering

Three-phase system and phase relationships, index properties; Unified and Indian standard soil classification system; Permeability – one dimensional flow, Seepage through soils – two-dimensional flow, flow nets, uplift pressure, piping, capillarity, seepage force; Principle of effective stress and quicksand condition; Compaction of

soils; One-dimensional consolidation, time rate of consolidation; Shear Strength, Mohr's circle, effective and total shear strength parameters; Stress-strain characteristics of clays and sand; Stress paths.

Sub-surface investigations – Drilling bore holes, sampling, plate load test, standard penetration and cone penetration tests; Earth pressure theories – Rankine and Coulomb; Stability of slopes – Finite and infinite slopes, Bishop's method; Sheet Piles; Stress distribution in soils – Boussinesq's theory; Pressure bulbs; Shallow foundations – Terzaghi's and Meyerhof's bearing capacity theories, effect of water table; Combined footing and raft foundation; Contact pressure; Settlement analysis in sands and clays; Deep foundations – static formulae, axial load capacity of piles in sands and clays, pile load test, pile under lateral loading, pile group efficiency, negative skin friction; Ground improvement techniques.

Section 4: Water Resources Engineering

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

Hydraulics: Forces on immersed bodies; Flow measurement in channels and pipes; Dimensional analysis and hydraulic similitude; Channel Hydraulics – Energy-depth relationships, specific energy, critical flow, hydraulic jump, uniform flow, gradually varied flow and water surface profiles; Prismatic and mobile channels, steady and unsteady flows, rapidly varied flow and hydraulic jump; Flow past sharp crested weirs.

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

Irrigation: Types of irrigation systems and methods; Crop water requirements – Duty, delta, evapo-transpiration; Gravity dams and spillways; Lined and unlined canals, Design of weirs on permeable foundation; cross drainage structures; River training structures; Earthen dams; Seepage through dams; Well irrigation.

Section 5: Environmental Engineering

Water and Waste Water Quality and Treatment: Basics of water quality standards – Physical, chemical and biological parameters; Water quality index; Unit processes and operations; Water requirement; Water distribution system; Drinking water treatment.

Sewerage system design, quantity of domestic wastewater, primary, secondary and tertiary treatment. Effluent discharge standards; Sludge treatment and disposal; Reuse of treated sewage for different applications.

Air Pollution: Types of pollutants, their sources and impacts, air pollution control, air quality standards, Air quality index and limits.

Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/recycle, energy recovery, treatment and disposal); Basics of landfill design and operation.

Section 6: Transportation Engineering

Transportation Infrastructure: Geometric design of roadways using IRC codes – crosssectional elements, sight distances, classifications of roadways, design vehicle, horizontal and vertical alignments.

Geometric design of railway Track – Speed and cant.

Concept of airport runway length, calculations and corrections; taxiway and exit taxiway design.

Highway Pavements: Highway materials – desirable properties and tests; Desirable properties of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible and rigid pavement using IRC codes.

Traffic Engineering: Traffic studies on flow and speed, peak hour factor, accident study, statistical analysis of traffic data; Microscopic and macroscopic parameters of traffic flow, fundamental relationships; Traffic signs; Signal design by Webster's method; Types of intersections and interchanges; Highway capacity and level of service.

Transportation Planning: Four step travel demand modelling – trip generation, trip distribution, mode choice, traffic assignment and its applications.

Section 7:	Geomatics Engineering

Principles of surveying; Plane and geodetic surveying, GNSS surveying, errors and their adjustment; Maps – Scale, coordinate system; Distance and angle measurement – Levelling and trigonometric levelling; Traversing and triangulation survey; Total station; Principles of topographic, cadastral, engineering; Introduction to cartography, map projections.

Photogrammetry – Introduction to photogrammetry, digital photogrammetry, photographic scale, flying height; Space resection, parallax equations, elevations by parallax differences, camera calibration.

Section 8:	Construction Materials and Management

Construction Materials: Steel – Composition, material properties and behaviour; Cement – composition, hydration and microstructure, chemical and mineral admixtures; Concrete – Constituents, mix design, short-term and long-term properties.

Construction Management: Types of construction projects; Estimation and costing – Quantity estimation using long wall and short wall method, center line method, analysis of rates; Project planning and scheduling: AOA and AON network analysis – PERT and CPM; Project updating and monitoring; Construction equipment – Equipment for earthwork, concreting, hoisting and transportation of materials; Types of contracts.