Civil Engineering Optional Syllabus

Description

Paper I

1. Engineering Mechanics, Strength of Materials, and Structural Analysis

1.1 Engineering Mechanics:

- **Units and Dimensions**: SI Units, Vectors.
- **Concepts**: Force, Particle and Rigid Body, Concurrent, Non-Concurrent, and Parallel Forces in a Plane.
- **Moment of Force**: Free Body Diagram, Conditions of Equilibrium.
- **Principle of Virtual Work**: Equivalent Force System.
- **First and Second Moment of Area**: Mass Moment of Inertia, Static Friction.

Kinematics and Kinetics:

- **Kinematics**: Cartesian Coordinates, Motion Under Uniform and Non-Uniform Acceleration, Motion Under Gravity.
- **Kinetics of Particle**: Momentum and Energy Principles, Collision of Elastic Bodies, Rotation of Rigid Bodies.

1.2 Strength of Materials:

- **Stress and Strain**: 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.
- **Deflection of Beams**: Methods include Macaulayâ??s Method, Mohrâ??s Moment Area Method, Conjugate Beam Method, and Unit Load Method.
- **Torsion of Shafts**: Elastic Stability of Columns, Eulerâ??s, Rankineâ??s, and Secant Formulae.

1.3 Structural Analysis:

- **Castiglianoâ??s Theorems**: Theorems I and II, Unit Load Method, Consistent Deformation Applied to Beams and Pin-Jointed Trusses.
- **Slope-Deflection, Moment Distribution**: Rolling Loads and Influence Lines for Shear Force and Bending Moment.
- **Arches**: Three-Hinged, Two-Hinged, and Fixed Arches, Rib Shortening and Temperature Effects.

- **Matrix Methods of Analysis**: Force Method, Displacement Method for Indeterminate Beams and Rigid Frames.
- **Plastic Analysis of Beams and Frames**: Theory of Plastic Bending, Plastic Analysis, Statical Method, Mechanism Method.
- **Unsymmetrical Bending**: Moment of Inertia, Product of Inertia, Position of Neutral Axis and Principal Axes, Bending Stresses Calculation.

2. Design of Structures: Steel, Concrete, and Masonry Structures

2.1 Structural Steel Design:

- **Structural Steel**: Factors of Safety, Load Factors, Riveted, Bolted, and Welded Joints and Connections.
- **Design of Members**: Tension and Compression Members, Beams of Built-up Sections, Riveted and Welded Plate Girders, Gantry Girders, Stancheons with Battens and Lacings.

2.2 Design of Concrete and Masonry Structures:

- **Concept of Mix Design**: Reinforced Concrete Design using Working Stress and Limit State Method (as per I.S. Codes).
- **Design of Concrete Structures**: Design of One-Way and Two-Way Slabs, Staircase Slabs, Simple and Continuous Beams of Rectangular, T, and L Sections.
- **Compression Members**: Under Direct Load with or Without Eccentricity, Cantilever and Counterfort Type Retaining Walls.
- **Water Tanks**: Design Requirements for Rectangular and Circular Tanks Resting on Ground.
- **Prestressed Concrete**: Methods and Systems of Prestressing, Anchorages, Analysis and Design of Sections for Flexure (based on Working Stress), Loss of Prestress.
- **Design of Brick Masonry**: As per I.S. Codes.

3. Fluid Mechanics, Open Channel Flow, and Hydraulic Machines

3.1 Fluid Mechanics:

- **Fluid Properties**: Role in Fluid Motion, Fluid Statics including Forces Acting on Plane and Curved Surfaces.
- **Kinematics and Dynamics of Fluid Flow**: Velocity and Accelerations, Streamlines, Equation of Continuity, Irrotational and Rotational Flow, Velocity Potential, and Stream Functions.
- **Equations**: Continuity, Momentum, Energy Equations, Navier-Stokes Equation, Eulerâ??s Equation of Motion, Applications to Fluid Flow Problems, Pipe Flow, Sluice Gates, Weirs.

3.2 Dimensional Analysis and Similitude:

- **Buckinghamâ??s Pi-Theorem**: Dimensionless Parameters.

3.3 Laminar Flow:

- **Laminar Flow**: Between Parallel, Stationary and Moving Plates, Flow Through Tube.

3.4 Boundary Layer:

- **Laminar and Turbulent Boundary Layers**: On a Flat Plate, Laminar Sub-layer, Smooth and Rough Boundaries, Drag and Lift.
- **Turbulent Flow Through Pipes**: Characteristics of Turbulent Flow, Velocity Distribution, Variation of Pipe Friction Factor, Hydraulic Grade Line, Total Energy Line.

3.5 Open Channel Flow:

- **Uniform and Non-Uniform Flows**: Momentum and Energy Correction Factors, Specific Energy and Specific Force, Critical Depth, Rapidly Varied Flow, Hydraulic Jump, Gradually Varied Flow.
- **Classification of Surface Profiles**: Control Section, Step Method of Integration of Varied Flow Equation.

3.6 Hydraulic Machines and Hydropower:

- **Hydraulic Turbines**: Types, Classification, Choice of Turbines, Performance Parameters, Controls, Characteristics, Specific Speed.
- **Principles of Hydropower Development**.

4. Geotechnical Engineering

- **Soil Type and Structure**: Gradation and Particle Size Distribution, Consistency Limits.
- **Water in Soil**: Capillary and Structural, Effective Stress, Pore Water Pressure, Permeability Concept, Field and Laboratory Determination of Permeability, Seepage Pressure, Quick Sand Conditions.
- **Shear Strength Determination**: Mohr-Coulomb Concept.
- **Compaction of Soil**: Laboratory and Field Tests.
- **Compressibility and Consolidation**: Concept, Consolidation Theory, Consolidation Settlement Analysis.
- **Earth Pressure Theory**: Analysis for Retaining Walls, Application for Sheet Piles and Braced Excavation.
- **Bearing Capacity of Soil**: Approaches for Analysis, Field Tests, Settlement Analysis, Stability of Slopes.
- **Subsurface Exploration of Soils**: Methods.

Foundation:

- **Types and Selection Criteria**: Design Criteria for Foundations.
- **Analysis of Distribution of Stress for Footings and Piles**: Pile Group Action, Pile Load Test.
- **Ground Improvement Techniques**.

Paper II

1. Construction Technology, Equipment, Planning, and Management

1.1 Construction Technology

Engineering Materials:

- Physical properties of construction materials with respect to their use in construction.
- Stones, bricks, and tiles; lime, cement, different types of mortars, and concrete.
- Specific use of ferrocement, fibre-reinforced concrete, high-strength concrete, and timber.
- Properties, defects, and common preservation treatments of timber.
- Use and selection of materials for specific applications such as low-cost housing, mass housing, and high-rise buildings.

Construction:

- Principles of masonry using brick, stone, and blocks.
- Construction detailing and strength characteristics.
- Types of plastering, pointing, flooring, roofing, and other construction features.
- Common repairs in buildings.
- Functional planning principles for residential and specific-use buildings.
- Building code provisions.
- Principles of detailed and approximate estimating, specification writing, and rate analysis.
- Principles of valuation of real property.
- Machinery for earthwork, concreting, and their specific uses.
- Factors affecting selection of equipment and operating costs.

1.2 Construction Planning and Management

- Construction activities, schedules, and organization for the construction industry.
- Quality assurance principles in construction.
- Use of network analysis (CPM and PERT) for construction monitoring, cost optimization, and resource allocation.
- Basic principles of economic analysis and methods.
- Project profitability, basic principles of financial planning, and toll fixation criteria.

2. Surveying and Transportation Engineering

2.1 Surveying

- Common methods and instruments for distance and angle measurement for civil engineering work.
- Use in plane table, traverse survey, levelling, triangulation, contouring, and topographical mapping.
- Basic principles of photogrammetry and remote sensing.

2.2 Railways Engineering

- Permanent way components, types, and their functions.
- Functions and design constituents of turnouts and crossings.
- Necessity of geometric design of track.
- Design of stations and yards.

2.3 Highway Engineering

- Principles of highway alignments, classification, and geometrical design elements for roads.
- Pavement structure for flexible and rigid pavements, design principles, and methodology.
- Typical construction methods and materials standards for stabilized soil, WBM, bituminous works, and CC roads.
- Surface and sub-surface drainage arrangements for roads and culvert structures.
- Pavement distresses and strengthening by overlays.
- Traffic surveys, their application in traffic planning, and typical design features for intersections, signal designs, and standard traffic signs and markings.

3. Hydrology, Water Resources, and Engineering

3.1 Hydrology

- Hydrological cycle, precipitation, evaporation, transpiration, infiltration, overland flow, hydrograph, flood frequency analyses, flood routing through reservoirs, and channel flow routing (Muskingam method).

3.2 Ground Water Flow

- Specific yield, storage coefficient, coefficient of permeability, confined and unconfined aquifers, aquifers, aquitards, and radial flow into a well under confined and unconfined conditions.

3.3 Water Resources Engineering

- Ground and surface water resources, single and multipurpose projects, storage capacity of reservoirs, reservoir losses, and reservoir sedimentation.

3.4 Irrigation Engineering

- Water requirements of crops: consumptive use, duty, and delta, irrigation methods, and their efficiencies.
- Canal distribution systems, canal capacity, canal losses, alignment of canals, efficient section designs, lined canals, and regime theory.
- Water logging, its causes, and control methods.
- Canal structures: design of head regulators, canal falls, aqueducts, metering flumes, and canal outlets.
- Diversion headwork: principles and design of weirs on permeable and impermeable foundations, Khoslaâ??s theory, and energy dissipation.

- Storage works: Types of dams, design, and principles of rigid gravity stability analysis.
- Spillways: types and energy dissipation.
- River training: objectives and methods of river training.

4. Environmental Engineering

4.1 Water Supply

- Predicting demand for water, impurities in water, and their significance.
- Physical, chemical, and bacteriological analysis, waterborne diseases, and standards for potable water.

4.2 Intake of Water

- Water treatment: Principles of coagulation, flocculation, and sedimentation.
- Slow, rapid, pressure filters, chlorination, softening, removal of taste, odor, and salinity.

4.3 Sewerage Systems

- Domestic and industrial wastes, sewerage systems, separate and combined systems, and flow through sewers.
- Design of sewers.

4.4 Sewage Characterization

- BOD, COD, solids, dissolved oxygen, nitrogen, and TOC.
- Standards for disposal in normal water courses and on land.

4.5 Sewage Treatment

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

4.6 Solid Waste

- Collection and disposal of solid waste in rural and urban contexts.
- Management of long-term ill effects.

5. Environmental Pollution

- Sustainable development, radioactive wastes and disposal, environmental impact assessment for thermal power plants, mines, river valley projects.
- Air pollution and pollution control acts.