Department of Civil Engineering

Syllabus for PhD entrance test

Structural Engineering

Mechanics of materials:

Stress-Strain behaviour for uniaxial loading, Generalized Hooke's law, Elastic constants for isotropic materials, Notion of equilibrium, Free body diagrams, Deformation of axial members, statically determinate and indeterminate problems, Truss structures – Stiffness methods. Definition of stress, Different states of stress – uniaxial, biaxial, plane stress, Transformation of plane stress, Principal stresses and maximum shear stresses, Mohr's circle. Definition of strain – shear and normal strains. Shear force and bending moment diagrams. Bending stresses: Beam bending equation and bending stresses in beams Shear stresses: Torsion: Torsional moment diagrams, Torsion formula for circular cross-sections, Maximum normal and shear stresses,

Structural Analysis

Concept of determinate and indeterminate structures – Moment-curvature relation – Slope and deflection of beams by successive integration – Principle of superposition – Moment area method – Conjugate beam method – Introduction to energy methods: Strain energy and complementary energy - Castigliano's theorems and its application to statically determinate beam – Moving loads and influence line diagrams: Indeterminate structures – force methods: Determination of static and kinematic indeterminacy in beams, rigid jointed frames and trusses – Method of consistent displacements and its application– Indeterminate structures-Displacement method and Introduction to Matrix method of analysis: Introduction to displacement method of analysis – Slope deflection method for beams and rigid-jointed frames – Moment distribution method for beams and rigid-jointed plane frames.

Concrete Technology

Cement & Hydration Production, composition, and properties, cement chemistry, bogue's compounds, hydration process, types of cements, special cements. Aggregates: Mineralogy, properties, tests and standards, Alkali silica reaction Admixtures: Water reducers, air entrainers, set controllers, specialty admixtures - structure properties, and effects on concrete

properties, Mix design Basic principles; IS method; new approaches based on rheology and particle packing, batching of ingredients, mixing, transport, and placement, Consolidation, finishing, and curing of concrete. Concrete production, Fresh & Hardened properties Fresh concrete: workability tests on concrete, setting times of fresh concrete, segregation and bleeding. Hardened properties of concrete:

Design of Reinforced Concrete Structures

Concepts of RC. Design – Working Stress Method – Limit State method – Material Stress-Strain Curves – Safety factors – Characteristic values. Stress Block parameters – IS 456 – 2000. Beams: Limit state analysis and design of singly reinforced, doubly reinforced, T and L beam sections. Limit state analysis and design of section for shear and torsion – the concept of bond, anchorage and development length, I.S. code provisions. Design and detailing of the cantilever, simply supported and continuous beams. Design and detailing of one-way slabs, Two-way slabs, and continuous slabs Using IS Coefficients, Design and detailing of Compression members (Columns) and simple footings.

Design of Steel Structures

Mechanical properties of steel, cold working and strain hardening; Philosophy, concept and methods of design of steel structures. Bolted/Riveted Connections: Simple Connections: Lap and butt joints, hanger joints, beam-column and beam-beam connections. Welded Connections: Design of tension members: Design of compression members: Effective length factors and degree of restraints; Trusses and columns – Built-up Compression members. Design of laterally supported beams:

Transportation Engineering

Transportation Engineering Syllabus for PhD entrance test

Introduction to transportation modes – classification of roads - road patterns - planning surveys - saturation system – Highway planning in India – Highway alignment – requirements for an ideal alignment - factors controlling alignment – Highway economics

Highway Geometric design - cross-section elements – camber - sight distance - design of horizontal alignment – super-elevation - transition curves – widening of pavement – setback distance - curve resistance - vertical alignment – grade compensation

Traffic characteristics - Road user and vehicular characteristics - traffic studies and surveys – speed studies, volume studies, parking studies, accident studies – traffic signs and markings - Signal design by Webster's method - Types of intersections - Highway capacity

Material requirement for pavements – soil, aggregates, bitumen – properties - material testing and specification – Marshall's mix design – pavement construction and maintenance

Highway pavement design - Design factors - design of flexible pavement: CBR method – stresses in rigid pavements - design of rigid pavements: IRC method – joints in rigid pavements

Urban Transportation Planning – Travel Demand Modelling: Four stages – Trip generation, distribution, modal split, and trip assignment

Basic AI and ML – Definitions - Supervised, un-supervised, reinforcement learning techniques – Fundamental ML algorithms – Transportation applications

Geotechnical Engineering

Geotechnical Engineering: Index and engineering properties of soil, compaction and consolidation- shear strength of soils-Site Investigations: Need – Methods of soil exploration – Standard penetration test, cone penetration test, Plate load test – Shallow Foundations: Types-Choice of Foundation-Location of Depth-Safe bearing capacity-Terzaghi -Allowable settlement of structures- contact pressure-immediate settlements- Pile Foundations: Classification of piles– selection of Pile-Load carrying capacity of piles based on static pile formulae in different soils.

Ground improvement techniques: Problematic Soil and Improvement Techniques: Role of ground improvement in foundation engineering – methods of ground improvement –Selection

of suitable ground improvement techniques based on soil conditions. Mechanical modification: Shallow compaction and deep compaction- Chemical stabilization

Geosynthetic Reinforcements: Manufacturing of geosynthetics- Types and functions of reinforcements: Metal strips, Geo textiles, geogrid, geocell. Reinforced earth wall – Mechanism – simple design – applications of reinforced earth wall.

Construction Planning and Management

1. **Construction Project Management-** Project life cycle, Work Breakdown Structure (WBS), Planning and scheduling, CPM and PERT, Resource allocation, Cost estimation and budgeting, Project monitoring and control, Earned Value Management (EVM), Quality management, Safety management.
2. **Contract Management-** Types of construction contracts, EPC, PPP, BOT, DB, DBB contracts, Tendering and procurement systems, Contract administration, Arbitration and dispute resolution, Liquidated damages, Performance guarantees.
3. **Construction Risk Management-** Risk identification, Risk assessment frameworks, Qualitative and quantitative risk analysis, Risk allocation, Risk mitigation strategies, Risk registers, Financial risk, Sensitivity analysis, Decision-making under uncertainty.
4. **Lean Construction-** Principles of lean thinking, Lean production systems, Waste identification and elimination, Value Stream Mapping (VSM), Last Planner System (LPS), Pull planning, Just-in-Time (JIT), 5S methodology.
5. **Digital Construction & Emerging Technologies-** Building Information Modeling (BIM), Digital Twin concepts, Automation and robotics, Industry 4.0 and Construction 4.0, Smart construction systems, Data-driven decision making