

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

MAHATMA GANDHI AVENUE, DURGAPUR – 713209 (WEST BENGAL), INDIA

Department of Civil Engineering

Syllabus for PhD Admission Test (2024-25 onwards)

General Aptitude

- **Verbal Aptitude:** Basic English grammar: tenses, articles, adjectives, prepositions, conjunctions, verb-noun agreement, and other parts of speech. Basic vocabulary: words, idioms, and phrases in context, reading and comprehension, Narrative sequencing.
- **Quantitative Aptitude:** Data interpretation: data graphs (bar graphs, pie charts, and other graphs representing data), 2- and 3-dimensional plots, maps, and tables Numerical computation and estimation: ratios, percentages, powers, exponents and logarithms, permutations and combinations, and series Mensuration and geometry Elementary statistics and probability.
- **Analytical Aptitude:** Logic: deduction and induction, Analogy, Numerical relations, and reasoning.
- **Spatial Aptitude:** Transformation of shapes: translation, rotation, scaling, mirroring, assembling, and grouping Paper folding, cutting, and patterns in 2 and 3 dimensions

Engineering Mathematics

- Matrix algebra, Systems of linear equations, Eigen values and vectors.
- Functions of single variable, Limit, continuity and differentiability, Mean value theorems, local maxima and minima, Taylor series, Evaluation of definite and indefinite integrals with applications, Partial and Total derivatives, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals.
- First order (linear and non-linear) Ordinary Differential Equation and Fourier series.
- Sampling theorems, Conditional probability, Descriptive statistics – Mean, median, mode and standard deviation, Random Variables – Discrete and Continuous, Distribution.
- Error analysis, Linear and non-linear algebraic equations, Newton's and Lagrange polynomials, numerical differentiation, Integration by trapezoidal and Simpson's rule.

Engineering Mechanics & Solid Mechanics

- System of forces, free-body diagrams, equilibrium equations, Internal forces, friction and its applications, Centroid, Centre of mass and gravity, Moment of Inertia.
- Bending moment, shear force, Simple stress and strain, Simple bending theory, flexural and shear stresses, shear centre, Uniform torsion, Transformation of stress, thin-walled structures, buckling of column, combined and direct bending stresses, Principal Stress, Mohr Circle, Calculation of deflection, Redundancy of Structure.

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.
- Forces on immersed bodies, Flow measurement, Dimensional analysis and hydraulic similitude, Channel Hydraulics - Energy-depth relationships, specific energy, critical flow, hydraulic jump, uniform flow, gradually varied flow and profiles.

Building Materials & Geomatics

- Construction /building Materials: Structural Steel - Composition, material properties and behaviour, Concrete - Constituents, mix design, short-term and long-term properties
- Concrete Technology: Classification, sampling, properties, grading, tests of fine and coarse aggregates. Chemical composition, major compounds, hydration, properties, testing, fineness, consistency, setting time, soundness, strength, heat of hydration of cement.

- Water, admixture, workability, factors, measurement, segregation, bleeding and manufacture of concrete, Destructive and non-destructive test, shrinkage, creep, permeability, durability, attack of sulphates, efflorescence, Mix design
- Principles of surveying, Errors and their adjustment, Maps - scale, coordinate system, Distance and angle measurement - Levelling and trigonometric levelling, Traversing and triangulation survey, Total station, Horizontal and vertical curves.

Structural Engineering

Structural Analysis: Structural system, support condition and loads, Shear force, bending moment and torsion on determinate structures, calculation of slopes and deflections by various methods, Static and kinematic indeterminacy, Statically determinate and indeterminate structures by force/ energy methods; Method of superposition; Analysis of trusses, arches, beams, cables and frames; Displacement methods: Slope deflection and moment distribution methods; Influence lines; Stiffness and flexibility methods of structural analysis.

Design of Concrete Structures: Properties of concrete and reinforcing steel, Characteristic strengths, Stress strain curves, Shrinkage and creep phenomenon, I.S. specification, Design philosophies – working stress method and limit state method of design; Design of beams, slabs, columns, staircases, retaining wall, isolated & combined Footing; Bond and development length; Prestressed concrete beams, various I.S. specification, Serviceability, Limit states of deflection and cracking, Calculation of deflections

Design of Steel Structures: Properties of structural steel, I.S. rolled sections, I.S. specifications, Working stress and Limit state design concepts; Design of tension and compression members, beams, columns and beam- columns, column bases; Connections - simple and eccentric, beam-column connections, plate girders, gantry girders and trusses; Concept of plastic analysis - beams and frames.

Water Resources Engineering

- Hydrologic cycle, precipitation, evaporation, evapotranspiration, watershed, infiltration, unit hydrographs, hydrograph analysis, reservoir capacity, flood estimation and routing, surface run-off models, ground water hydrology - steady state well hydraulics and aquifers, Application of Darcy's Law.
- Stage, discharge & relations, interpretation of stream flow records. Factors affecting the run off, yield, flow duration & mass curve.
- Process, Capacity, Measurement, Estimation of Infiltration, and Run-off.
- Necessity, Advantages, Disadvantages, Types, Water distribution techniques, Quality of water, Duty, Delta, Base period, Indian crop seasons, Irrigation efficiencies, Soil–moisture–irrigation relationships, Estimating depth and frequency of irrigation.
- Capacities, losses, Design & construction of unlined, lined & stable channels, Sediment transport, Economics of canal lining, Cross drainage works.
- Causes, Control, Reclamation of saline and alkaline lands, Drainage; Definition of weirs, barrages & their classification, Layout of typical diversion head-works & its function; Reservoirs, Dam, Spillways and energy dissipaters, Flood Forecasting and routing.

Geotechnical Engineering

- **Soil Mechanics:** Origin of soils, soil structure and fabric; Three-phase system and phase relationships, index properties; Unified and Indian standard soil classification system; Permeability – one dimensional flow, Darcy's law; Seepage through soils – two-dimensional flow, flow nets, uplift pressure, piping; Principle of effective stress, capillarity, seepage force and quicksand condition; Compaction in laboratory and field conditions; One-dimensional consolidation, time rate of consolidation; Mohr's circle, stress paths, effective and total shear strength parameters, characteristics of clays and sand.
- **Foundation Engineering:** Sub-surface investigations – scope, 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, method of slices and Bishop's method; Stress distribution in soils – Boussinesq's and Westergaard's theories, pressure bulbs; Shallow foundations – Terzaghi's and Meyerhoff's bearing capacity theories, effect of water table; Combined footing and raft foundation; Contact

pressure; Settlement analysis in sands and clays; Deep foundations – types of piles, dynamic and static formulae, load capacity of piles in sands and clays, pile load test, negative skin friction.

Transportation Engineering

- **Transportation Infrastructure:** Highway alignment and engineering surveys; Geometric design of highways – cross-sectional elements, sight distances, horizontal and vertical alignments; Geometric design of railway track; Airport runway length, taxiway and exit taxiway design.
- **Highway Pavements:** Highway materials – desirable properties and quality control tests; Design of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible pavement using IRC: 37-2012; Design of rigid pavements using IRC: 58-2011; Distresses in concrete pavements.
- **Traffic Engineering:** Traffic studies on flow, speed, travel time – delay and O-D study, PCU, peak hour factor, parking study, accident study and analysis, statistical analysis of traffic data; Microscopic and macroscopic parameters of traffic flow, fundamental relationships; Control devices, signal design by Webster's method; Types of intersections and channelization; Highway capacity and level of service of rural highways and urban roads.
- **Port, harbour and airport Engineering**

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 and secondary treatment. Effluent discharge standards; Sludge 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).

Construction Planning and Management: Types of construction projects; Project planning and network analysis - PERT and CPM; Cost.

Sd/-

Chairperson, PhD Admission Committee