

## **MCQ test for screening of non-GATE non-NET PhD applicants to appear in Interview along with GATE qualified candidates**

(a) 25 MCQs of 2 marks each will be set from **research methodology**,

(b) 25 MCQs from structural Engineering including Concrete & Steel structures and 25 MCQ from Soil mechanics & foundation engineering, transportation engineering and Construction Management etc. (i.e.50 questions) of 2 marks will be set from the core subjects.

(c) Students will answer all questions for research methodology and 25 questions from the rest 50 MCQs. Only first 25 answered questions will be considered if candidates answer extra questions.

Qualifying marks for interview: 50 for general and 40 for reserved candidates. There may be negative marking for wrong answers as specified by the Authority.

### **1. Syllabus for Research Methodology**

1. Meaning of research, dissertation, thesis, Term paper, journal paper, concept notes.
2. Research hypothesis, need & justification, Novelty of Research.
3. Characteristics and components of Research, Need based /specific problem solving (state / national)
4. Topics identification, learning, formulating and analyzing the problem with existing problem/project/extension work of respective department / division / interdepartmental efforts.
5. Search Procedures for statement and formulation of research problem.

Literature survey, web search, textual reading, search engine application, online data search , use of internet, personal communication, bound journal/paid journal/ E-journals, institution repository, gateway, cross-ref, Scopus, Science Direct, Advanced search tools. Institution Library consultation/ borrow

6. Application of proposed research / Fundamental Research/ Experiment base Numerical/ Computation.
7. Computation work, language, programming, software tools, to be used. Spread sheet, features and functions, data storage, generating charts, graphs tables- use of latest's software tools, features of statistical tools/ features.
8. Application of theoretical and system modeling for respective area of problems.
9. Statistical tools with data mining. Probability and sampling distribution, ANOVA test, SSPS Package, correlations, Test of Hypothesis, Student test, error analysis, mean square error , Box analysis, normalization of data series, Linear programming, Dynamic Programming , Fuzzy logic problem.
10. Optimization analysis:-

Use of Factors, ANN, ANOVA (BOTH WAYS), SIGNAL TO NOISE RATIO, Orthogonal arrays, replication,

Data validation with predicted values,

11. Aims & objective of research.

Area of Research- Formulation of research objectives based on Literature survey, critical review, Gaps exist in present knowledge domains in the field of research.

Scope analysis

12. Research Methodology: - Study population, parameters estimation and consideration, sampling- field / industrial real life, monitoring, Experimental investigation, Literature /Proceedings/ journal search, etc.

Plan for data collection, and analyzing , Plan For data processing and recording , Ethical presentation 13.

Experimental Work: - Analytical methods/ Protocols, Standard methods national and international codes, flowchart for Experimental procedures, Fabrication details of experimental devices and instruments to be used, experimental Set up, pilot plant if any to be required. Replications, Quality control, Quality Assurance procedures, Standardization of instruments to be used.

14. Work plan: - Major components and outline of the different phases of research investigation, use of flow chart, time frame summary of proposal.

15, Use of mathematical tools: - Numerical analysis, Finite element and difference , differential equation solving tools, use of tensor and vector calculus, etc., design of experiment.

16. Presentation tools: - Power point tool, creating and customizing presentation.

17. Thesis writings: - Draft thesis, paper communication and publications, conference attendance presentation proceedings, Plagiarism checking ( use of Urkund, Biblio, Tertitin) and citation. Major contribution, outcome of the research, patent possibilities.

## 2. Syllabus for Structural Engineering

Bending moment and Shear force for determinate and indeterminate structures, Bending stress, Shear stress, Shear flow and shear centre, Torsion of circular shafts, Analysis of two and Three hinged Arch

Strain energy principle: Castiglino's theorems, Deflection analysis of beams, frames and trusses, Slope and deflection analysis of beams. Influence line analysis for determinate beams, trusses and three hinged arches.

Buckling load: Euler's theory, Rankine's theory, empirical formulae, Column under eccentric load, Beam–Column. Buckling analysis by energy principle, Unsymmetrical bending, Slope-Deflection method and Moment distribution method. Beams and Portal frame problems. Two hinged and fixed Arches. Beams Curved in plan. Approximate analysis of Multi bay Multistoried Portal frames: Cantilever method, Portal method.

Stiffness and flexibility methods: Matrix methods of structural analysis. Analysis of Suspension bridges, Influence linediagram for Three-hinged and Two-hinged stiffening girders. Influence line diagram for indeterminate structures: Muller-Breslau principle. Plastic analysis of Structures: Beams and Portal frames. Model analysis and applications.

## **Concrete Technology**

Cement-manufacturing process. Physical and Chemical properties. Different types of cement and their uses. Codes of practices, Testing of cement: Physical and Chemical tests. Tests on fresh and hardened concrete. Chemical admixtures and Plasticizers. Durability of concrete. Mix design approaches. High Performance Concrete, Ready Mixed Concrete. Fibre Reinforced Concrete. Shotcrete . Pumped concrete. Fly ash concrete. Self -Compacting concrete. Polymer concrete,etc. Grouting and grouting materials.

## **Concrete Design**

Properties of concrete. Codes of practices. Working stress and limit state design of reinforced concrete structures: Single and Doubly reinforced rectangular, T, L, sections etc. against bending moment, shearforces and Torsion.

Bond stress: Development length and Lap length. Design of One-way and Two-way Slabs. Staircase. Continuous beams. Axially loading columns. RCC members under combined bending and axial load. Isolated footing.

Design of Multistoried RCC buildings considering wind and seismic forces. IS code and specification, Combined and Strip footing. Raft foundation. Pile foundations. Retaining walls. Underground water tanks. Overhead water tank. RCC Culverts and bridges: IRC loading, design of deck slab and girder. Design of Prestressed concrete structures

## **Steel Design**

Design of Riveted, Bolted and Welded joints and connections. Working stress and limit state design of Tension and Compression members, Beams and Plated beams, Roof trusses, Purlins, Columns, Base connection and foundations. Compound columns with lacingand battens. Design of Steel structures using tubular, rectangular and square section. Gantry girders and Gantry columns including base and foundation. Steel Portal frames. Pressed steel water tanks rectangular and circular tanks. Steel Towers

## **Dynamic Analysis**

Free and force vibration analysis, Damped and Undamped vibration analysis of Single and Multiple degree of freedom systems: Beams and Portal frames. Plate vibration. Vibration control. Machine foundation. Random vibration.

## **Finite element method**

Matrix Algebra – methods for matrix inversion and solution of simultaneous equations – band and sparse matrix techniques-stiffness and flexibility matrices of structural elements – various co-ordinate system and their transformation and synthesis-matrix formulation of force and displacement methods – member approach.Finite element concept in Engineering Analysis – Displacement model shape functions and element properties. Analysisof plane stress/strain – axi-symmetricstress analysis. Weighted residual methods and variational formulation of Finite Element Analysis. Isoparametric element –Potential flow and heat transfer in 2-Dimension – Numerical integration.

## **Theory of Elasticity and Elastic Stability**

2 and 3-dimensional stress tensors, equations of equilibrium and compatibility, plane stress and plane strain problems, stress functions, constitutive relationship. Equations in Cartesian and Polar coordinates systems, bending of beams and plates, torsion of shafts, Introduction to bifurcation of equilibrium, beam-column, plates under axial compression, Finite element formulation of geometrically non-linear problem.

## **3. Syllabus for Soil Mechanics & Foundation Engineering**

Formation and types of soil, Weight and volume relationships; consistency limits, particle size distribution; identification and classification of soil; soil structure and clay mineralogy. Soil water suction and capillary rise, effective and pore water pressure. Permeability and ground water flow–Darcy's law, factors affecting permeability; laboratory and field determination of permeability, permeability of stratified deposits. Seepage pressure; quick condition; Laplace's equation; construction and use of flow nets, piping and heaving. Compaction of soil– compaction phenomena, laboratory compaction test and field compaction control. Compressibility and consolidation of soil–Terzaghi's theory of one-dimensional consolidation; consolidation test and evaluation of consolidation parameters. Three dimensional consolidation; Numerical solution, uniform and layered deposits. Sand drains – theory and applications.

Shear strength of soil, Mohr-Coulomb theory, Determination of shear strength from laboratory and field tests. Stress path and its application.

Stability of earth slopes, finite and infinite slopes, stability analysis by Swedish method of slices; stability number; tension cracks. Stability of Dams under steady seepage and rapid drawdown conditions. Lateral earth pressure; earth pressure at rest, active and passive conditions; Rankine and coulomb's theory; Earth pressure on retaining walls. Bearing capacity of soil; modes of failure; bearing capacity theories; factors affecting bearing capacity. Subsurface exploration, methods of boring and sampling; different types of samplers; ground water observations.

Stress distribution in homogeneous, non-homogeneous, layered and anisotropic deposits; Effect of nonlinearity

Design of shallow foundation with settlement analysis in Sand and Clay,

Principles of ground improvement; Mechanical densification; Drop hammer and compaction pile; Compaction of cohesive soils, pre-loading and vertical drains, stone columns and granular piles; Admixture stabilization; Grouting; Geotextile application.

Pile foundations – vertical and lateral loads; Settlement of Piles; Negative skin friction of piles; Uplift capacity of piles and anchors; Foundations on expansive soils; Well foundations; Machine foundations.

Cantilever sheet pile wall; Anchored bulk head, Free and fixed earth support methods, types of sheet piles and construction aspects; cellular coffer dams, design procedures, interlock, piling rise and overturning; Braced excavation, types, earth pressure, effect of wall rigidity and sequence of construction, Design of wall and wall supports; tunnels and shafts, pressure distribution, design of tunnel lining, methods of tunnelling, ground loss.

## 4. Syllabus for Transportation Engineering

### **Highway Engineering:**

Traffic studies:

Speed, volume, delay and capacity of highways; Origin and destination studies; parking studies; accident surveys; Traffic forecasting; Traffic flow characteristics; Capacity and Level of service at basic freeway segments and highway intersections; Traffic Controls and signals

Theory of traffic flow including shock waves, bottlenecks and weaving; Queuing theory and its application; Management of signalised and unsignalised intersections

Trip Generation, Distribution, Modal split and Traffic Assignment; Land use transport models; Transportation economics; urban transportation management

Geometric design of highway:

Cross Sectional elements, Curves: Horizontal and Vertical, Intersection Geometry, conflicts and Grade separation, Road drainage; Illumination

Pavement and Its Design:

Types; Components; Wheel loads; Stresses in flexible pavements – Two layer system; Flexible pavement design – Burmister Method, IRC Method, AASHTO methods and mechanistic approach; Stresses in rigid pavements; Rigid Pavement Design by Westergaard, and IRC method.

Pavement Material and Construction:

Highway Materials and Testing under static and repetitive loading; Construction of flexible pavement.

Pavement evaluation, maintenance and management:

Pavement failures; quality control and Assessment; Overlay design of flexible and rigid pavement, condition monitoring of pavements

### **Railway Engineering:**

Elements of permanent way; Tractive resistance's; gradients and grade compensation on curves; cant; transition curves; vertical curves; Stresses in railway tracks; Points and crossings; Signalling and interlocking, Maintenance of railway track.

### **Airport Engineering:**

Planning and layout; runway and taxiway; grading and drainage; Design of Pavement

## 5. Syllabus for Construction Management

Construction as an industry, Basic concepts of management. Planning Organizing, controlling & Motivating. Different schools of management. Introduction to behavioral science, communication skills, leadership Applied psychology, project Formulation techno-economic study, multidisciplinary approach, budget allotment, Facets of construction Management-General M, personnel M, contract M, contract Labour M, Material M., organizational structure-work Flow and information flow. Two-party and three-party models. In-house and offloading.

Construction Infrastructure: Power, water, Access, Housing security, storage, plant, Maintenance, communication, Welfare. Enabling Works; personally; progress control; safety and Quality control. Planning and Scheduling Gantt chart, Milestone chart, PERT and CPM. Squared networks. Monitoring and updating. control on material consumption. Use of computer packages. Material procurement storage and accountancy. Labour management. Basic concepts in law, related to construction Laws; contract Labour (R&A), Act and rules, payment of wages Act, Minimum Wages Act, workman's compensation Act, Interstate Labour Act, Trade Union Act, Industrial Disputes Act.

Planning and Scheduling CPM and PERT Squared networks, Monitoring and updating. control on material consumption. Use of computer packages, Material procurement storage and accountancy. Contracts objective of contracting parties: Reconciliation of aims. Conflicts and problems, Standard form contracts, Type of contracts, their peculiarities and applications to repair job; Tendering process; Storing of materials with identifiable batch lot, documentation of incoming certificates, in-house checking and documentation of input materials, semi processed materials, finished materials. Quality assurance plan, Items of work. Method of measurement and documentation, Pricing rules of taking off, Principles of abstracting, Bill of quantities, Analysis of rate, Overhead and profit, Determination of unit rate, Specification of work.