MCQ test for screening of non-GATE 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 each of the remaining 6subjects (i.e., 150 questions) of 2 marks each be set from remaining core subjects.

(c) Students will answer all questions for research methodology and 25 questions from the rest 150 MCQs. We take only first 25 answered questions if candidates answer extra questions.

Qualifying marks for interview: 50 for general and 40 for reserved candidates. There will 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 hypo thesis, need and 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, knowledge on statistical 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 and 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

Structural Analysis

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.

Theory of plate bending: Navier's solution, Levy's solution. Plate buckling problems.

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.

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.

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.

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 stabilisation; 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 Environmental Engineering

Section A :- Air pollution and control

Criteria and non criteria air pollutants, effect of air pollution, measurement of air pollutants (PM_{10}, PM_5 , $PM_{2.5}$, NO_X , SO_2), Air quality Index (AQI), Standards and limits, Air pollution monitoring, Source apportioning model, receptor model, plume dispersion model, plume

pattern and atmospheric stability, stack monitoring, Box model, Canyon modeling, Calline model, Sreet dispersion one dimensional highway model, fundamental of air pollution control devices (SPM Control only), Green House effect, Acid rain, Global Warming, Ozone layer depletion, Emission standard.

Section B :- Water Supply & Treatment

Water Demand, Water sources- surface and ground water, quality of drinking water, Water Quality Index (WQI), Delphi Techniques , Bacteriological examination of water, Water distribution system and network analysis, Balancing reservoir,

Water treatment methods- Various unit operations, Flow diagram, settling analysis, High rate settling theory, Colloid dispersion double layer ionic theory, Coagulation and Flocculation, Jar test, Filtration process, Adsorption process, disinfection Break point chlorination, softening process, Drinking water quality standard, Fluoride and arsenic remediation techniques.

Section C: - Solid Waste Management

Classification of Solid Waste, Characteristics, Sampling and analysis, Integrated Solid waste Management Practice, Collection Methods, (Manual and contain) transfer station, processing and disposal methods, Incineration and pyrolysis, landfill, leachate estimation, HELP model, energy content evaluation, landfill liner system and design, route selection and optimization, composting and vermiculture , aerobic and anaerobic digestion of solid waste, waste to energy, Hazardous and biomedical waste and their management, Solid waste Management Rules.

Section D: - Wastewater Engineering

Waste water characteristics, BOD, COD and their determination, Strom drainage system, rational methods, sanitary sewer and combine sewer design, basic microbiology and kinetics of bacteriological growth.

Primary treatment of sewage- Screen , Grit chamber, oil & grease removal, primary clarifier, chemical sedimentation, pH Control.

Secondary Treatment- Biological treatment of wastewater, Suspended growth and fixed film reactor system, Activate sludge process, Trickling filter, Bio filter, Aerated lagoon, extended aeration process, stabilization pond, hybrid bioreactor, SBR, Anaerobic digester.

Tertiary Treatment- Advanced oxidation, Electro coagulation, Adsorption, Reverse Osmosis, Reuse and treated wastewater.

Mathematical Modeling of Wastewater treatment system-ASPM I , Atkinson, hybrid, material balance, Rittman, McCarty, Davis , Isotherm, Reaction Order, Break through column (BDST), etc

Sludge handling and treatment, heavy metal removal process, chemical oxidation, equalization, neutralization.

Section E: - Environmental Management

Rudiments of EIA, Scoping criteria and analysis, EIA methodology, Matrix , Leopold, Tally methods, short term and long term (Rapid and final EIA), EMP, Rules and regulations, category of EIA on industrial basis, Pollution control requirements.

---Noise pollution, sound pressure level, units, standards, Noise meter, Noise pollution control.

--- Ecology & Environment-Aquatic ecosystem , ecosystem, components population ecology, Solar energy and its importance, productivity, food chain, Trophic level, Ecological pyramid, bio geochemical cycles

- Plant Physiological Stress, POD, NRA, oxidative stress, phytoremediation, Plant Enzymes features.
- Environmental Monitoring system- sustainable development
- Green Technology, carbon credit, green building concept.

5. Syllabus for Water Resources Engineering

1) Hydrological Cycle:- Rainfall runoff measurement technique devices, Aquifer, Aquifer Parameters, Darcy's Law, Steady & Unsteady State Well Hydraulics, Ground Water Flow, Salt water intrusions Stream flow measurement technique , Infiltration Indices , ϕ and W Index, Hydrograph analysis, Unit hydrograph, S and Instantaneous hydrograph , Synthetic hydrograph, Flood estimation, Abstraction of precipitation, flood routing.

2) Statistical; hydrology----Rainfall Analysis, RI R period , uncertainties, R Index, Mean Value Problem, Monte Carlo Simulation, Parameter Estimation, Moment Method, Likelihood Method,Goodness of fit Kolanogoror test,λ^2 analysis , Anderson test

3) Hydrologic simulation model. Watershed model- HEC, HSPF (Standard Package Further),SWM,MIKE.Watershed classifications. Simulation model, forecasting models Deterministic, Stochastic, Mccuran model.Multi objective modeling, Optimization model.Use of Fuzzy Logic for Optimisation.

4) Water Resource Engineering :-Hydroelectric power plant, Dam hydrology, Diversion work, Weirs and barrage, Spur, Scour depth, lined and unlined canals , canal irrigation system, hydraulic structures, apron, falls, hydraulic jumps, siphon, aqueduct. Concepts of Isovels, Draugt and flood management , Remote sensing and GIS, GPS applications, River training and Bank protection, Gates and Valves for flow control, spillways and energy dissipaters, Stage –Discharge curve.

6. Syllabus for Remote Sensing & GIS
Energy sources, energy interaction in the atmosphere, data acquisition and interpretation, types of scanning and sensing system, History of Indian Remote Sensing,Types of data, Visual Image interpretation, Concept of GPS and its application, Digital Image Analysis - rectification and restoration, Image enhancement, manipulation techniques, Image classification, Post classification Smoothing, classification accuracy assessment, Principles of GIS, Application of Remote Sensing and GIS in different projects.

7. Syllabus for Transportation Engineering

Mathematics:
Fundamentals of Statistics:
Collection and graphical representation of data; Measures of central tendency and measures of dispersion; Correlation and regression; Linear regression, Introduction to non-linear regression; Sampling theory; Hypothesis testing; Confidence interval; Probable errors;Analysis of variance
Theories of Probability:

Random experiments and events; Classification of probability; Laws of probability;Definition and postulates of probability; Field of probability; Mutually exclusive events; Bayes' Theorem; Independence; Bernoulli trial; Conditional probability distribution; Binomial, Normal and Poisson distributions;
Optimisation Technique:
Calculus of several variables; Implicit function theorem; Nature of singular points; Necessary and sufficient conditions for optimization; Elements of calculus of variation; Constrained Optimisation; Lagrange multipliers; Gradient method; Dynamic programming

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 splitand Traffic Assignment; Landuse 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

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