DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Syllabus for Ph.D. Admission–Session: Aut-2021

I. (Geotechnical Engineering)

A. Core Area (50% Weightage)

Soil Mechanics; Soil and its formation, processes and agencies involved in formation, types of soils, three phase soil model, index properties and classification of soils. Flow through soils, Laplace equation for steady flow. Effective stress concept and pore pressure, Compaction of soils and its field application; stress distribution under loaded plates; Clay Mineralogy, Basic structural units, Isomorphic substitution, base exchange capacity, inter automatic and inter molecular bonds, different clay minerals; Engineering properties of clay minerals, permeability, swelling & shrinkage and stress – strain characteristics of soil and consolidation theory; review of conventional shear stress factors affecting shear strength of soils – pore pressure in soils – pore pressure measurements in triaxial test and field measurements – total and effective shear stress parameters, stress path, total stress path and effective stress path – Horslave shear parameters – shear strength , thixotropy and liquefaction of soils.; Compressibility of Soils**:** Concept of Stress, Principal Stress and Strain, Stress – Strain relations, plane Stress, Plane Strain, Mohr's diagram.;Settlement and consolidations: ultimate Settlements (Consolidation Test), Time rate of Consolidation, Effect of Layers and changes in parameters on the rate of consolidations.;

Shallow and Deep Foundations**;** Soil Investigations: Factors affecting site investigation, Planning sub soil exploration programme, Methods of soil exploration, Spacing and depth of borings, Location of borrow areas, bore log,; Types of Shallow Foundations: Strip pad, Combined, Raft Foundations; Bearing Capacity: Terzaghi's factors, Accuracy of Terzaghi's factors, Effect of footing shape, Net bearing capacity, General formulae, Soil layers of finite depths, Non uniform soils, Strength increasing with depth, Footings on slopes, Layered soils.; Settlement: Limits of settlement, Settlement computation, theory of elasticity, 1-D Conditions, 3-D problems,; Rate of settlement, Settlement of footings on sand, determination of BC based on

settlement and bearing criteria.; Raft Foundations: Strip raft, Circular raft, rectangular raft, foundation – soil materialization – Beams & Plates on EI Found.; Foundation – Soil Structure Interaction: Idealized soil behavior – Foundation behavior, Interface behavior, Analytical techniques, Scope of soil – Foundation interaction analysis.; Beams on Elastic Foundations: Winkler and Modified Winkler Models ;Theory of sub grade reaction, Applications of solution of beams on elastic foundations for footings and rafts, Finite Difference Method.;

Deep Foundations: Criteria for Design, types of Piles, Pile Load Capacity, Group Effects ; Design charts and equations for single pile, pile group settlement, pile load testing, Butter Piles, Negative Skin friction, Settlements and deformation prediction, Lock – Socketed Piles.; Well Foundations: Shapes of wells and component parts, Depth of well foundation and bearing capacity, Forces acting on a well foundation, Analysis of well foundation, well curb, cutting edge, staining and bottom plug, Well sinking.;

Earth Pressure and Retaining Structures; Earth Pressure Theories and Retaining Walls: conventional retaining wall, Gravity and Cantilever walls, shut pile walls Cantilever & Anchored)..; Strutted excavations: Stability of slopes to open excavations, Support of excavations, Structural Design of Supports to excavation, Over all stability, inward yielding and settlement of ground surrounding excavation.; Reinforced Earth Walls: Concepts – Designs

***B- Allied Areas-------(25% Weightage)*:**

***Surveying*;** principles of surveying, types of surveying; Leveling and trignometrical leveling; Theodolite surveying; Tacheometry, Geodetic surveying, areas and volume, curves,

Strucrural Engineering: Analysis of stress and strain, flexural and torsional load analysis, determinate and indeterminate structures, bending and shear stresses, compound stresses, slopes and deflections, columns.

***Fluid mechanics and Hydraulics*:** Basic fluid flow concepts, fluid statics, fluid kinematics and dynamics, pressurized flow, water hammer, laminar and turbulent flow; open channel hydraulics, irrigation engineering; water quality and waste treatment.

C.GeneralAptitude & Mathematics(25%Weightage)

i) General Aptitude

ii) Mathematics

The calculus of the Finite Difference : Differences, Differences Formulae, Difference table, Operator E, Properties of the operator E and Δ, Leibnitz rule – Interpolation with equal intervals, unequal intervals, Central difference interpretation formulae.; Numerical Differentiation and Integration and Inverse Interpolation; Numerical solution of ordinary difference equations of the first and second order; Simultaneous linear algebraic equations – methods of solution using the inverse of the matrix, method of successive elimination.; Iterative method – gauss Siedel method, Relaxation methods;

Introduction to Finite Element Analysis various steps in solving a problem by finite Element Method (displacement approach). Two dimensional method elements.; Formulation of the finite element method using (i) Principle of virtual work (ii) Minimization of total potential energy of a system, Discrete Element Method.

II. (Engineering Geosciences and Rock Engineering)

A. Core Area (50% Weightage)

1. Engineering Seismology (Earthquake Engineering) Engineering Seismology, Seismology and Seismic Exploration (Definitions). Introduction to Seismic Hazard and Earthquake Phenomenon. Global seismicity - Analysis of earthquake focal mechanisms. Seismotectonics and Seismic Zoning of India. Microzonation. Mechanism of Faulting. Earthquake Prediction. Site Response to Earthquakes: Local geology and soil conditions. Site investigations and soil tests. Dynamic design criteria for a given site. Earthquake Monitoring and Seismic Instrumentation. The Seismograph – Principles of Seismometer. Location of the epicenter of an earthquake. Earthquake size and intensity. Energy released in an earthquake. Earthquake: Risk and Preparedness. Earthquake: Social Consequences; Codes and Public Policy.

2. Engineering Geology:

Physical Geology; geology and its relevance to civil engineering, geological work of wind, rivers, glaciers and seas. Petrology; formation of rocks, types/field classification, weathering of rocks, origin of soils. Structural Geology; folds, faults, joints, unconformities. Engineering Geology; geological considerations in tunnels, dams, bridges, building sites; landslides; Earthquakes; basic definitions, types and causes, distribution in the world, seismic zones.

3. Materials:

Stones; their engineering properties; bricks, classification and strength requirements; tiles and their uses. Timber; properties, defects, seasoning, decay and prevention. Lime; types, properties and tests.

4. Rock Mechanics:

Introduction to rock mechanics and rock engineering. Terminology, Rock Classification Systems. Physical and Mechanical Properties of Rocks. Laboratory Testing. Rock masses: strength, deformability, failure criteria.

Foundations and slope stability: foundations on discontinuous rock, slope instability basic mechanisms. Rock reinforcement and rock support: underlying principles, similarities and differences. Rock Bolting.

5. Tunnelling Technology:

Introduction to tunnelling: Fundamental definitions, tunnelling art and engineering, historical development, Classification of tunnels. Geological aspects of tunnelling: Geological investigation, evaluation and appreciation, importance of geological knowledge, aim of geological investigation, principal elements of exploration programme, Influence of geological conditions on design and construction of tunnels. Methods of Tunnelling in soft and hard rock. Lining of tunnels. Tunnel supports.

***B- Allied Areas-------(25% Weightage)*:**

***Surveying*;** principles of surveying, types of surveying; Leveling and trignometrical leveling; Theodolite surveying; Tacheometry, Geodetic surveying, areas and volume, curves,

Soil Mechanics: Origin of soils, soil classification, three-phase system, fundamental definitions, permeability and seepage effective stress principle, consolidation , compaction, shear strength

***Water Resources Engg.*:** Hydrologic cycle, rainfall, evaporation, infiltration, stage discharge relationships, unit hydrographs, flood estimation, reservoir capacity, reservoir and channel routing. Well hydraulics.

C. General Aptitude & Mathematics ---------(25% Weightage)

i) General Aptitude

ii) Mathematics

The calculus of the Finite Difference : Differences, Differences Formulae, Difference table, Operator E, Properties of the operator E and Δ, Leibnitz rule – Interpolation with equal intervals, unequal intervals, Central difference interpretation formulae.; Numerical Differentiation and Integration and Inverse Interpolation; Numerical solution of ordinary difference equations of the first and second order; Simultaneous linear algebraic equations – methods of solution using the inverse of the matrix, method of successive elimination.; Iterative method – gauss Siedel method, Relaxation methods;

III. Structural Engineering:

A. *Core Area (*Structural Analysis and Design of Structures) *(50% Weightage)*

Evaluation of internal forces in determinate, indeterminate, structures and space trusses using classical methods. Approximate analysis of 2-D frames, Influence lines and travelling loads, plastic analysis of beams and frames. Cables and suspension bridges. The Matrix Displacement Approach. Stiffness Matrix of a Bar Element, Beam Element. Matrix Displacement Analysis of Planar Rigid-Jointed Frames.

One Dimensional Finite Elements. Stiffness Matrix for the basic Bar & Beam Element.

Finite Element analysis of Two Dimensional Planar Bodies.

Analysis of stress and strain, stress-strain relationship. Plane stress and plain strain. 2-dimensional problems in Cartesian co-ordinates for simple problems. Energy methods: Principles of virtual work- energy theorem.

Free and Forced vibration analysis of SDOFS and MDOFS. Orthogonality relationships of principal modes, Earthquake forces, nature and magnitude, pseudo-static method of approximate evaluation of earthquake forces. Seismicity, Earthquake Motion and Response, Response Spectra, Philosophy of Capacity Design. Concepts of seismic design: Earthquake resistant design of R.C.C Structures; provisions of IS:1893. Earthquake resistant construction of R.C.C. Elements: Detailing aspects and IS:13920; Earthquake resistant design of Brick Masonry Structures and IS:4326.

Aggregates: Classification, Properties, Grading, Methods of combining aggregates, specified grading, Testing of aggregates. Cement: Chemical composition, Hydration of cement, structure of hydrated cement, special cements, water chemical admixtures. Concrete: Properties of fresh concrete, Hardened concrete, Strength, Elastic properties, Creep and Shrinkage, Variability of concrete strength. Mix Design: Principles of concrete mix design, Methods of concrete mix design, Testing of concrete. Special Concretes: Light weight concrete, Fibre reinforced concrete, Polymer concrete, Super plasticized concrete, Properties and applications.

Philosophies of working stress, ultimate load and limit state method of design, Analysis and design of structures in flexure/ torsion by limit state method. Codal provisions with reference to IS: 456-2000. Design of columns, slabs, staircases; design of isolated and combined footings. Design of Slender Columns, Deep Beams, Plain & ReinforcedConcrete Walls, Corbels and Flat Slabs. Design of cantilever and counter-forte type RCC retaining walls.

Working stress and plastic method concepts of steel design; riveted, bolted and welded connections. Design of steel, tension members, compression members including built up members. Design of steel flexural members, beams, build up sections and plate girders, steel roof truss. Design of Slender Columns, Corbels & Edge (Spandrel) Beams.

Pre-stressing systems and end anchorages, losses of pre-stress. Analysis and design of members for flexure, shear, bond and bearings. Cable layouts. Design of Pre-stressed Bridges.

Design of road bridges: single and multi lane bridges as per IRC Class-A, Class-AA and 70R. Grillage Analogy. Design of Abutments, Piers and their foundations. Design of Bearings.

Construction planning-Construction facilities, Schedules, Layout of Plant utilities, Construction methods: Excavation and handling of Earth and Rock; Production and handling of Aggregates and Concrete , cooling of concrete in dams. Construction control and management-CPM/PERT, Human Factors, Organization.

Network techniques, construction planning, excavation, form works, cofferdams, construction equipments, control on construction, Construction management, industrial development, financing of civil engineering works, engineering economics of projects, organization of civil engineering works, accounting , money banking an trade.

***B- Allied Areas-------(25% Weightage)*:**

Geo-Technical and Transportation Engineering:Introduction to soil hydraulics, soilcompressibility, effective stress, stress distribution, shear strength, bearing capacity, clay mineralogy stability of slopes, bearing capacity of foundations , earth pressure, soil stabilization, soil investigation, Dynamic behavior of soils and its impact on foundation design, stability of

slopes, Flow through anisotropic soil and flow nets. Design of filters, soil stabilization, soil exploration.

Railway bridges, docks and harbors, alignment, geometric design, pavement, design, Traffic engineering, Highway materials and construction, hill roads, airport geometrics, airport pavement design, airport drainage.

Fluid mechanics and Hydraulics:Basic fluid flow concepts, fluid statics, fluidkinematics and dynamics, pressurized flow, water hammer, laminar and turbulent flow; open channel hydraulics, irrigation engineering; water quality and waste treatment.

Surveying:principles of surveying, types of surveying; Leveling and trignometricalleveling; Theodolite surveying; Tacheometry, Geodetic surveying, areas and volume, curves.

C. General Aptitude & Mathematics ---------(25% Weightage)

i)General Aptitude

ii) Mathematics

Matrices, statistics and probability, complex variables, Numerical Differentiation and Integration and Inverse Interpolation. Numerical solution of ordinary differential equations of the first and second order. Simultaneous linear algebraic equations – methods of solution using numerical methods: the inverse of the matrix, method of Successive Elimination; Iterative method – Gauss Siedel method, Relaxation methods; Eigen value/vector problems.

The calculus of the Finite Difference: differences, Differences Formulae, Difference table, Operator E, Properties of the operator E and Δ, Leibnitz rule – Interpolation with equal intervals, unequal intervals, Central difference interpretation formulae.

IV. TRANSPORTATION ENGINEERING AND PLANNING (TE&P)

A. Core Area (Weightage = 50%)

Transportation Planning Process & Surveys: transportation study area, zoning & surveys, transportation planning process- inventory, model building.

Travel Demand Estimation: basic planning stages-trip generation, trip distribution, modal split and route assignment, various techniques of demand estimation and analysis.

Landuse-Transportation Models: Location models - opportunity models, accessibility models.

Traffic Engineering & Studies: traffic elements, characteristics-vehicle, road user and road; traffic studies-speed & delay, traffic volume, O & D, parking and accidents, sample size, study methodology, data collection & presentation.

Traffic Analysis: Speed, volume, parking & accident data analysis, statistical approach, traffic maneuvers, different intersections, conflict points, traffic stream characteristics- relationship between speed, flow and density, fundamental equation of traffic flow, level of service & capacity analysis, traffic forecasting.

Traffic Design: Channelisation of islands for different traffic situations, design of rotaries & at-grade intersections, grade separated intersections, their warrants; facilities for pedestrian & bicycle ways.

Traffic Control Devices: Traffic signs, markings and signals; principles of signal design, Webster's method, signal coordination.

Traffic Regulation & Management: Speed, vehicle, parking, enforcement regulations, mixed traffic regulation, management techniques-one-way, tidal flow, turning restrictions etc., road safety measures.

Highway Geometric Design: Alignment Issues, Cross section elements, sight distance characteristics, horizontal and vertical alignment, hill roads

Pavement Mix Analysis: Bituminous mix design – Marshall stability approach, concrete mix design for roads.

Pavement Basics: Types & comparison, vehicular loading pattern, loading pattern on airport pavement, factors affecting design and performance of pavements, airport pavement, environmental impact on pavements, sub grade requirements

Design of Flexible Pavements: Analytical approach, flexible pavement layers, ESWL, repetitions of load, techniques of design methods, wheel load analysis, traffic analysis, stress distribution in subgrade soil, Burmister's theories, group index method, CBR approach, IRC guidelines, CRV method, triaxial & McLeod method, present practices.

Design of Concrete Pavements: Westergaard's approach, temperature & frictional stresses, design of expansion & longitudinal joints, design of dowel & tie bars, IRC guidelines, present design practices.

B. Allied Areas (Weightage = 25%)

Nature of soils, engineering soil behaviour, gradation, porosity, void ratio, atterberg limits, classification, compaction characteristics, consolidation, shear strength, UC etc. Subgrade properties, soil stabilization, strengthening, stress distribution, active and passive pressures, stability of earth slopes and soil investigation.

Highway Drainage: Importance, principles of surface drainage, roadside drains- cross-section; design, drains for hill roads, subsurface drains, capillary cut-off treatment.

Cross Drainage Works: Importance of cross drainage, causeways, culverts & bridges- types; estimation of design discharge, fixation of waterway, foundation depth and spans. Classification of bridges, Selection of bridge sites, Bridge alignment, Sub-surface investigations, Bridge Hydrology, Flood discharge, waterways, scour depth, depth of foundation, standards of loadings, types of loads, impact effect, wind loads, seismic focers, buoyancy, earth pressure, loadings on various bridges, traffic requirements, types of

low cost bridges, Settlements, Allowable soil pressures, types of foundatiuons, foundation failures, foundation setting, cofferdams, superstrcuture elements, Bridge flooring.

C. General Aptitude & Mathematics -----(25% Weightage)

(i). General Aptitude

a. Numerical aptitude

b. Ability to read graphs & tables

c. Data interpretation

(II). Mathematics

Statistics & Probability Base: Various probability distributions & their applications, parameter estimation, hypothesis testing, random variables, method of maximum likelihood.

Linear & Multi-linear Regression and Correlation Analysis: Estimation and analysis of simple regression models, correlation coefficients, analysis of correlation coefficients.

Basics of numerical methods and optimization.

V. (Water Resources Engineering)

A. Core Area (50% Weightage)

Fluid Mechanics and Hydraulics: Properties of fluids, principal of conservation of mass, momentum, energy and corresponding equations, potential flow, applications of momentum and Bernoulli's equation, laminar and turbulent flow, flow in pipes, pipe networks. Concept of boundary layer and its growth. Uniform flow, vertical flow and gradually varied flow in channels, specific energy concept, hydraulic jump. Forces on immersed bodies flow measurements in channels, tanks and pipes. Dimensional analysis and hydraulic modeling Kinematics of flow, velocity triangles and specific speed of pumps and turbines.

Hydrology:- Hydrologic cycle, rainfall, evaporation, infiltration, stage discharge relationships, unit hydrographs, flood estimation, reservoir capacity, reservoir and channel routing. Well hydraulics.

Irrigation : Duty , delta, estimation of evapo- transpration. Crop water requirements. Design of: lined and unlined canals, water ways, head works, gravity dams and spillways. Design of weirs on permeable foundation. Types of irrigation system, irrigation methods. Water logging and drainage, sodic soils.

Water Quality: Quality standards, basic unit processes an operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water. Sewage and sewerage treatment, quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, sludge disposal, effluent discharge standards, Domestic wastewater treatment, quantity of characteristics of domestic waste water , primary and secondary treatment. Unit operations and unit processes of domestic waste water sludge disposal.

Air pollution; Types of pollutants, their sources and impact, air pollution meteorology, air pollution control, air quality standards and limits.

Municipal solid wastage: Characteristics, generation , collection and transportation of solid wastes, engineered systems of solid waste management (reuse/recycle, energy recovery, treatment and disposal.

***B- Allied Areas-------(25% Weightage)*:**

***Surveying*;** principles of surveying, types of surveying; Leveling and trignometrical leveling; Theodolite surveying; Tacheometry, Geodetic surveying, areas and volume, curves,

Strucrural Engineering: Analysis of stress and strain, flexural and torsional load analysis, determinate and indeterminate structures, bending and shear stresses, compound stresses, slopes and deflections, columns.

***Soil Mechanics*:** Origin of soils, soil classification, three-phase system, fundamental definitions, permeability and seepage effective stress principle, consolidation , compaction, shear strength

C. General Aptitude & Mathematics ------(25% Weightage)

i) General Aptitude

ii) Mathematics

Basic concepts of Statistics & Probability: Probability - Random variables – Moments - Standard distributions – Two dimensional random variables Principle of least squares – Regression – Correlation (Multiple and Partial), hypothesis testing, The calculus of the Finite Difference : Differences, Differences Formulae, Difference table, Operator E, Properties of the operator E and Δ, Leibnitz rule – Interpolation with equal intervals, unequal intervals, Central difference interpretation formulae.; Numerical Differentiation and Integration and Inverse Interpolation; Numerical solution of ordinary difference equations of the first and second order; Simultaneous linear algebraic equations.