DEPARTMENT OF CIVIL ENGINEERING

ALIGARH MUSLIM UNIVERSITY, ALIGARH

SYLLABUS OF GEOTECHNICAL ENGINEERING FOR PHD ENTRANCE TEST 2018-19

SECTION - A
Multiple Choice Questions

Part I - Multiple Choice Questions on Research Methodology **(40 marks)**

Writing Skill: Tenses, parts of speech, clauses, subject- verb agreement, Idioms and phrases, reading comprehension, word-meaning, synonyms-antonyms, hyponyms,

Logical and Analytical Reasoning.

Programming Skills: Data types, assignments, conditional statement, branching and looping, input and output statements.

Mathematics and Statistics: Algebra, Ordinary Differential Equation (ODE), Numerical Analysis, Real and Complex Analysis, Vector Analysis, Measure of Central Tendency, Probability Distribution Function.

Part II - Multiple Choice Questions from Syllabus of Civil Engineering. **(20 marks)**

SECTION - B Subjective Questions **(20 Marks)**

Soil Engineering: Different types of soils and their geotechnical properties, Behavior of different soils under moisture and loading conditions, Determination of geotechnical properties through field tests. In-situ tests, selection of suitable in-situ test, Instruments and their applications, Interpretation and analysis of results. Sampling methods and equipment for laboratory experiments, handling, preservation and transportation of samples, sample preparation, laboratory tests for site characterization. Concepts and importance of site characterization, methods of site characterization based on types of projects, comparison of lab and in-situ test results.

Foundation Design-I: Foundation failures (general, shear, punching, large settlements), Bearing Capacity equations, bearing capacity factors, factor of safety, bearing capacity of foundation: on layered soil, on or near slope, with eccentric loading, with inclined loading, with uplift forces, bearing capacity correlations with field tests (SPT, CPT, DCPT, etc.), Bearing capacity from building codes. Foundation design based on settlement criteria, stresses induced on soil mass due to foundations, settlement computations (Immediate, Primary settlement), layered soils, structures on fills, tolerable settlements, differential settlement, Building code recommendations. Types of shallow footing, factors affecting foundation design, design of spread footings for different loadings conditions (concentric, eccentric, shear, moment), design of rectangular and combined footings. Different types of piles, design methodology for piles, calculation of pile capacity, stresses in pile, analysis of pile group, pile load test, settlement of pile group, concept of negative skin friction, piles subjected to lateral loads.

Design of Earth Retaining Structures: Fundamental relationships between the lateral pressures and the strain with a back fill. Rankine and Coulomb theories, Active, passive and pressure at rest ; Backfill with broken surface, wall with broken back, concentrated surcharge above the back fill, earth pressure due to uniform surcharge, earth pressure of stratified backfills, saturated and partially saturated backfill. Passive earth pressure in engineering practice. Assumption and conditions, point of application of passive earth pressures. Types, material, method of construction, nature of forces acting, comparison of different earth pressure theories and application in retaining wall, stability analysis and design aspects, application of theory of elasticity in analysis of earth pressure distribution. Types, materials used in construction, free earth system, fixed earth system, selection of soil parameters, analysis and design of cantilever and anchored sheet pile walls, dead man and continuous anchor, diaphragm and bored pile walls. Earth pressure against bracings in cuts, heave of the bottom of cut in soft clays; reinforced earth retaining structures, design of earth embankments and slopes; arching and open cuts, recent advances in Earth retaining structures.

Advanced Ground Improvement Techniques: Compaction piles, dynamic compaction, vibro-floatation technique, controlled blasting for compaction. Principle of accelerated consolidation for clays, vertical drains, method of preloading, design of PVDs with vacuum-preloading systems, Electro-kinetic dewatering, design and construction methods. Cement

stabilization and cement columns, Lime stabilization and lime columns. Stabilization using bitumen and emulsions, Stabilization using industrial wastes Construction techniques and applications. Soil nailing, rock anchoring, micro-piles, design methods, construction techniques, case studies of ground improvement projects.

Rock Engineering: Formation of rocks, Physical properties, Classification of rocks and rock masses, Static Elastic constants of rock ; Rock Testing: Laboratory and Field tests ; Discontinuities in Rock Masses: Discontinuity orientation, Effect of discontinuities on strength of rock ; Compression, Tension and Shear, Stress-Strain relationships, Rheological behavior; Strength/ Failure Criterion: Coulomb, Mohr, Griffith theory of brittle strength and other strength criteria. Stresses in rock near underground openings; Rock tunneling, rock slope stability, bolting, blasting, grouting and rock foundation design. Instrumentation in tunnels, Rock support and reinforcement

Foundation Design-II: Analysis and design of tension piles, laterally loaded piles, partially embedded piles and poles. **S**tructural design of: piles, laterally loaded piles, pile groups, pile cap analysis, pile – raft system basic interactive analysis. Drilled Piers: Application, construction practices, Capacity analysis and settlement, practical considerations and design; Cellular Cofferdams: Types and applications, stability analysis, bearing capacity, settlement, and practical consideration and design. Expansive soils, collapsible soils, frosty conditions.

Geo-synthetic and Reinforced Soil-Structure: Historical Development – Types of Geosynthetics – Geotextiles – Geogrids- Geonets – Geomembranes – Geocomposites – Functions – Reinforcement – Separation – Filtration – Drainage – Barrier Functions. Manufacturing Methods of – Polyamide – Polyster – Polyethylene – Polypropylene – Poly Vinyl Chloride – Woven – Monofilament – Multifilament – Slit Filament – Non-Woven – Mechanically bonded- Chemically bonded – Thermally bonded. Physical properties : Mass per unit area – Thickness – Specific gravity; Hydraulic properties :Apparent open size – Permittivity – Transmissivity. Mechanical Properties : Uniaxial Tensile Strength – Burst and Puncture Strength – Soil Geosynthetic friction tests; Durability : Abrasion resistance – Ultraviolet resistance. Use of geosynthetics for filtration and drainage – Use of geosynthetics in roads – Use of renforced soil in Retaining walls – Improvement of bearing capacity – Geosynthetics in land fills.

Soil Dynamics: Elastic response of continua, wave equation, response of non-plastic and plastic soils under cyclic loading; stress- strain models(elastic, visco-elastic, nonlinear elastic, plasticity), introduction to liquefaction. Vibration of elementary systems; Degrees of freedom (SDOF and MDOF systems); equation of motion for SDOF system, types of vibrations, Earthquake excitation, Un-damped and damped free vibrations, torsional vibration, critical damping, decay of motion, un-damped and damped forced vibration, constant force and rotating mass oscillators, dynamic magnification factor, transmissibility ratio, non-harmonic, arbitrary, impact and other types of forced vibrations, Duhamel's integral, vibration isolation, vibration measuring instruments. Stresses in soil element, determination of dynamic soil properties, field tests, laboratory tests, stress-strain behavior of cyclically loaded soils, estimation of shear modulus, damping ratio ,linear, equivalent-linear and non-linear models, ranges and applications of dynamic soil tests, cyclic plate load test, liquefaction, Screening and estimation of liquefaction, simplified procedure for liquefaction estimation, factor of safety, cyclic stress ratio, cyclic resistance ratio, correlations with SPT, CPT, SASW test values. Dynamic earth pressures, force and displacement based analysis, pseudo-static and pseudo-dynamic analysis, guidelines of design codes, dynamic analyses of various geotechnical structures like retaining wall, soil slope, railway subgrade and ballast using MSD model.

Advanced Techniques in Geotechnical Engineering: Shell foundations, special construction problems, pile driving and well sinking, pre-stressed ground anchors, diaphragm walls, bored pile walls, soil nailing, gabions, crib wall, retaining walls with relieving shelves, piled raft foundation, granular pile anchor in swelling soils, cantilever footing, Simplex pile, under reamed pile construction, half bulb, V-piles. Drainage of soil and dewatering of foundations, controlled yielding technique for reduction of lateral earth pressure, Vibro-compaction, Soilcrete, Soilfrac (Soil fracturing), static installation of piles – Pipe/Box jacking, vacuum consolidation, dynamic compaction, cathodic protection of marine foundations, role of drilling mud in geotechnical engineering, Terramesh for slope stabilization. Dynamic pile testing, Centrifugal testing of geotechnical models, Pressure meter testing, The flat dilatometer test, Piezocone test, Osterberg cell, Advances in geotechnical testing and monitoring. Geotechnical modern case studies. Basic rules for personal safety, Public safety and safety tips for workplace with special reference to electrical and fire safety, Safety of workers, machine and environment during various field operations of foundation excavations, pile driving, tunneling, quarrying and material handling, Environmental issues in geotechnical engineering, sources and type of ground, water and air contamination, Protection of environment from harmful effects of different construction activities, Utilization and contamination of large volume wastes.

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