Department of Civil Engineering

M TECH IN GEOTECHNICAL ENGINEERING AND UNDER GROUND STRUCTURES

Teaching Scheme (2011 onwards)

1. FIRST SEMESTER

S.No.	Course No.	Course Title	L	T	P	C
1.	CE-610	Advanced Soil Mechanics	3	0	0	3
	CE-611	Advanced Foundation Engineering	3	0	0	3
3.	CE-612	Soil Dynamics	3	0	0	3
4.		Programme Elective-1	3	0	0	3
5.		Programme Elective-2	3	0	0	3
6.	CE-613	Advanced Soil Mechanics Laboratory	0	0	3	2
Sub Total			15	0	2	17

2. SECOND SEMESTER

S.No.	Course No.	Course Title	L	T	P	C
1.	CE-614	Underground openings and geotechnical processes in rock engg.	3	0	0	3
2.	CE-615	Machine Foundation	3	0	0	3
3.	CE-616	Exploration and Field Tests	3	0	0	3
4.		Programme Elective-3	3	0	0	3
5.		Open Elective-1 (from other Dept)	3	0	0	3
6.	CE-617	Exploration and Field Tests laboratory	0	0	3	2
Sub Total			15	0	2	17

3. THIRD SEMESTER

S.No.	Course No.	Course Title	L	T	P	C
1.	CE-800	Seminar				2
2.	CE-801	Dissertation				12
3.	CE-799	Self Study Course				2
Sub Total						16

4. FOURTH SEMESTER

S.No.	Course No.	Course Title	L	T	P	C
1.	CE-801	Dissertation				20
Sub Total						20
Total						**70**

PROGRAMME ELECTIVE COURSES

	Course No	Course Title	L	T	P	C
Common for all stream	CE-701	Fuzzy logic, artificial intelligence and neural network	3	0	0	3
	CE-702	Optimization Methods	3	0	0	3
	CE-703	Construction planning and scheduling	3	0	0	3
	CE-704	GIS and its application in civil engineering	3	0	0	3
	CE-705	Finite Element Method	3	0	0	3
GEOTECHNICAL ENGINEERING	CE-713	Earth Pressure and Retaining Structures	3	0	0	3
	CE-714	Reinforced Soil Structures	3	0	0	3
	CE-715	Offshore Geotechnical Engineering	3	0	0	3
	CE-716	Geotechnical Processes in Rock Engineering	3	0	0	3
	CE-717	Environmental Rock Engineering	3	0	0	3
	CE-718	Soil-Structure Interaction Analysis	3	0	0	3

Self Study Course CE- 799 Special Topics in Geotechnical Engineering and Under Ground Structures

DETAILED SYLLABUS

CE-610 Advanced Soil Mechanics 3+0+0

Origin, nature and distribution of soils. Description of individual particle. Clay mineralogy, clay-water-electrolytes. Soil fabric and structure. Effective stress principle. Steady state flow in soils. Effect of flow on effective stress. Determination of coefficient of permeability. Consolidation, one, two, three and radial consolidation. Variation of effective stress during consolidation. Various consolidation tests and determination of parameters. Stress-path. Triaxial and direct shear tests. Shear behaviour of granular soils. Factors affecting shear beahviour. Determination of parameters. Shear behaviour of fine grained soils. Porepressure parameters. UU, CU, CD tests. Total and effective stress-strength parameters. Total and effective stress-paths. Water content contours. Factors affecting strength : stress history, rate of testing, structure and temperature. Anisotropy of strength, thixotropy, creep. Determination of in-situ undrained strength. Stress-strain characteristics of soils. Determination modulus values. Critical state model. Engineering Behaviour of soils of India : Black cotton soils, alluvial silts and sands, laterites, Collapsible and sensitive soils, aeolin deposits.

CE-611 Advanced Foundation Engineering 3+0+0

Foundation classification; Choice of foundations; Bearing capacity and settlement analysis of shallow foundations like footings and rafts, Deep foundations like piles, piers and Caissons; Foundations on expansive soils, laterites, fills and rock; Construction aspects of foundations; Shoring and underpinning; Groundwater lowering and drainage; Legal aspects of foundation engineering; Introduction to Limit State Design of reinforced concrete in foundations; Soil pressure for structural design; Conventional structural design of continuous footings, individual footings, combined footings and rafts of various types subjected to vertical and lateral loads and moments; Design of circular rafts; Soil structure interaction and 'flexible' approach to the design of foundations; Structural design of piles including pile caps, under-reamed piles, piers and caissons; Structural design of retaining walls, Codal provisions.

CE-612 Soil Dynamics 3+0+0

Fundamentals of vibrations: Response of SDOF systems, Free vibration, Experimental determination of natural frequency and damping, Response of system to exciting forces and ground motions ranging from simple pulse like excitation to harmonic and complex histories, Transmissibility, Vibration measuring instruments, Response of 2 DOF and Multi degree of freedom systems. Propagation of seismic waves in soil deposits - Attenuation of stress waves, Stress-strain behaviour of cyclically loaded soils, Strength of cyclically loaded soils, Dynamic soil properties - Laboratory and field testing techniques, Selection of design values. Dynamic stiffness of foundation - Circular rigid mat foundation on elastic half space excited vertically, laterally, torsion or rocking, Effective stiffness and damping of such systems, Modelling of soil medium by frequency dependent and frequency independent elements, Effect of soil material damping and shape, Earthquake load on footing, effect of horizontal load and moment, provision of relevant standards, dynamic analysis for vertical and horizontal loads., Effect of foundation embedment, Finite soil layer and depth to bedrock on system of rigid foundations, Dynamic stiffness of single pile and pile group. Liquefaction studies in triaxial shear and oscillatory simple shear, evaluation of liquefaction potential, liquefaction analysis from standard penetration test data, Studies on shake table and field test.

CE-613 Advanced Soil Mechanics Laboratory 0+0+3

Consolidation test, Direct Shear test, Vane shear test, Unconfined compression test, Unconsolidated undrained triaxial test, Consolidated drained triaxial test, Consolidated undrained triaxial test with pore water pressure measurement, Free swell index test, Swelling pressure test, Brazilian Test, Point Load test, UCS of rock core etc.

CE-614 Underground openings and geotechnical processes in rock engineering 3+0+0

Underground openings, size and shapes. support systems. analysis, Stresses and deformations around openings, Stresses and deformations around tunnels and galleries with composite lining due to internal pressure, Design based on analytical methods; Empirical methods based on RSR, RMR, Q systems; Design based on Rock support interaction analysis; Observational method- NATM, Convergence-confinement method;

Design based on Wedge failure and key block analysis. Stability of excavation face and Tunnel portals. Ground improvement techniques, assessment. Compaction of disintegrated and weathered rocks. Grouting, type of grouts, suspensions, solutions and resins, Groutability. Grouting techniques, materials, equipment, evaluation and quality control. Shotcrete, method and materials, factors. Fibre reinforced shotcrete. Ground anchors, principles of reinforcement, rock bolts, mechanism, mechanical, friction, grouted tensioned and untensioned bolts. Design of bolts. Installation. Equipment. Testing. Cable anchors. Flow through intact and fissured rocks. Dewatering techniques, classification, assessment of insitu permeability, filter criteria and design of wells.

CE-615 Machine Foundation 3+0+0

Introduction, general view of machine vibration, Basic principles of design of machine foundations, types of foundations, Degree of freedom of machine foundation, vertical sliding, rocking, yawing vibrations of a block, simultaneous, sliding and vertical vibrations of a block. Foundation analysis: static and dynamic analysis, Indian standard for design of foundations for reciprocating machines and impact type of machines. Analysis and design of concrete foundation, block foundations for reciprocating engines, Low speed rotary machines, Forge hammers and frame foundations for high speed rotary machineries, Vibration isolation and absorption techniques. Construction details.

CE-616 Exploration and Field Tests 3+0+0

Planning of investigation programmes, Information required for planning different stages of investigations. Geophysical methods: electrical resistivity, and seismic refraction methods. Methods of site investigations: Direct methods, semi-direct methods and indirect methods, Drilling methods. Boring in soils and rocks, methods of stabilizing the bore holes, measurement of water table, field record. Field tests: In-situ shear test, in-situ permeability test, SPT, DCPT, SCPT, in-situ vane shear test, pressure meter test, plate load test.

Codal provisions. Sampling techniques, Sampling disturbances, storage, labeling and transportation of samples, sampler design, influence on properties. Report writing. Safety measures.

Geotechnical Processes: Principles of compaction, Laboratory compaction, Engineering behaviour of compacted clays, field compaction techniques- static, vibratory, impact, Earth moving machinery, Compaction control. Shallow Stabilization with additives: Lime, flyash, cement and other chemicals and bitumen . Deep Stabilization: sand column, stone column, sand drains, prefabricated drains, electro-osmosis,lime column. soil-lime column.

Grouting: Permeation, compaction and jet. Vibro-floatation, dynamic compaction, thermal, freezing. Dewatering systems.

Rock drilling: Percussion, rotary drilling, drill bits. Core samplers, Core boxes. Logging, stratigraphic profile, scan line survey, oriented cores, classification. Planning of laboratory tests, report. Stresses in rocks, gravity, tectonics, residual, thermal and induced stresses. Stress anisotropy and stress ratio. Stress relief and compensation techniques, USBM, door stopper Tests, flat jack, hydrofrac, strain rossette and dilatometers. Deformability, plate load, pressure tunnel and bore hole tests. Strength tests, insitu compression, tension and direct shear tests. Pull out tests. Borehole extensometers, piezometers, embedment gauges, inclinometers, Slope indicators, packer tests for insitu permeability, Codal provisions.

CE-617 Exploration and Field Tests Laboratory 0+0+3

Undisturbed and representative sampling, Auguring, Drilling of bore hole, Earth pressure measurement, DCPT, SCPT, SPT, Plate load test, in-situ vane shear test, pressure meter test, Pile load test, Block vibration tests, Liquefaction potential tests.

PROGRAMME ELECTIVES

CE-701 Fuzzy Logic, Artificial Intelligence and Neural Network 3+0+0

Introduction- Classification of artificial intelligence-expert systems-artificial neural networks-basic concepts-uses in functional approximation and optimization-applications in the design and analysis, building construction.

Fuzzy logic-basic concepts-problem formulation using fuzzy logic-applications

Texts/References

1.D.E. Rumelhart, J.L. McClelland, Parallel distributed processing Vol 1, M I T Press England 1986.
2. Fuzzy logic implementation and applications, M.J. patyra, Mlynek, Wiley Teubner 1996.

CE-702 Optimization Methods 3+0+0

Basics of engineering analysis and design, Need for optimal design, formulation of optimal design problems, basic difficulties associated with solution of optimal problems, Classical optimization methods, Necessary and sufficient optimality criteria for unconstrained and constrained problems, Kuhn-Tucker conditions, Global optimality and convex analysis, Linear optimal problems, Simplex method, Introduction to Karmarkar's algorithm. Numerical methods for nonlinear unconstrained and constrained problems, sensitivity analysis, Linear post optimal analysis, sensitivity analysis of discrete and distributed systems. Introduction to variational methods of sensitivity analysis., shape sensitivity, Introduction to integer programming, dynamic programming, stochastic programming and geometric programming, Introduction to genetic algorithm and simulated annealing.

Text/References

1. Kalyanmov Deb, Optimization for engineering design: Algorithms and examples, PHI Pvt Ltd, 1998.
2. J.S. Arora. Introduction to optimum design, McGraw Hill International editions 1989.
3. R.T. Hafta and Z. Gurdal, Elements of structural optimization, third revised and expanded edition. Kluwer academic publishers 1996.

CE-703 Construction Planning And Scheduling 3+0+0

Construction Planning: Objectives and functions, stages in construction, work breakdown structure, pre-tender stage planning, contract stage planning, methods of scheduling, bar charts, limitations of bar charts, milestone charts, preparation of material, equipment, labour, and finance schedule.

Critical Path Method (CPM): Network techniques, element of a network, rules for developing networks, development logics, numbering events, time computations, activity floats, network updating. Resources profile, resources smoothing and resources leveling. Cost versus time, direct cost, indirect cost, total project cost, optimum duration, contracting network for cost optimization.

Programme Evaluation and Review Technique (PERT): Probability concept in network, optimistic time, pessimistic time, most likely time, variance, standard deviation, slack, central limit theorem, Probability of achieving completion time.

Precedence Diagram Method (PDM): Precedence networks fundamentals, advantages, logic and precedence networks applications, PDM versus CPM.

Line of Balancing (LOB) technique in the construction scheduling: Line of balance methods of scheduling repetitive construction.

Books

- Chitkara, K.K. "Construction Project Management, Planning scheduling and controlling."
- Moder J.J. Philips, C.R. and Davis, E.W. "Project Management with CPM and PERT, and precedence diagramming"
- Pilcher, R. "Project Cost Control in Construction",
- Brien J.J. CPM in "Construction Management", Mc. Graw Hill

CE-704 GIS And Its Application In Civil Engineering 3+0+0

1. **Basics of remote sensing:** Introduction to Remote Sensing, data acquisition and processing, sensor systems, Electromagnetic Radiation (EMR) and its characteristics, Radiation principles, prosperities of solar radiant energy, atmospheric windows. Interaction in the atmosphere, nature of atmospheric interaction, atmospheric effects of visible, near infra-red thermal and microwave wavelengths, interaction at ground surface, interaction with soils and rocks, effects of soil moisture, organic matter, particles, size and texture, interaction with vegetation, spectral characteristics of individual leaf, vegetation canopies, effect of leaf pigments, radiation geometry.

2. **Introduction with GIS:** Def. of GIS, Difference between GIS and CAD worlds, utility of GIS, various GIS packages and their salient features, essential components of a GIS, scanners and digitizers.
3. **Map projection and coordinate systems:** Introduction, geographic Grid, Map projection, Coordinate systems.
4. **Vector data models and Analysis:** vector data and its representation, topological data structure, non-topological vector data structure, TIN, Region, vector data editing and analysis.
5. **Raster data models and Analysis:** acquiring and handling of raster data storage, function of raster based GIS data analysis.
6. **Engineering applications of GIS:** applications of GIS in civil engineering.

Books

- Remote Sensing and Image Interpretation : T.M. Lillensand and R.W. Keifer
- Principles of Remote Sensing : P.J. Curren
- Concept and Techniques of Geographical Information systems : C.P. Lo and albert K.W.Yeung
- Introduction to Geographical Information systems : Kang-tsung Chang
- Geographical Information systems- A Management Perspective : Stan Aromoff

CE-705 Finite element analysis 3+0+0

Principles of discretization, element stiffness and mass formulation based on direct, variational and weighted residual techniques and displacements approach, Shape functions and numerical integrations, convergence, Displacement formulation for rectangular, triangular and isoparametric elements for two dimensional and axisymetric stress analysis. Thin and thick plates and shells. Semi-analytical formulations, Three dimensional elements and degenerated forms. Stiffner elements and modifications such as use of different coordinate systems, use of non-conforming modes and penalty functions. FEM in incompressible and compressible fluid, applications of FEM in thermal problems.

Texts/ References

1.O.C. Zienkiewicz and R.L. Taylor, Finite element methods, Vol I & Vol II, McGraw Hill, 1989, 1992.
2.K. J. Bathe, Finite element procedures, PHI Ltd 1996.
3. R.D. Cook, D.S. Malkus and M.E. Plesha, Concepts and applications of finite element analysis, Third edition, John Wiley and Sons, 1989.

CE-713 Earth Pressure and Retaining Structures 3+0+0

Earth Pressure: Types – at rest, active, passive; Rankine's theory; Backfill features – soil type, surface inclination, loads on surface, soil layers, water level; Coulomb's theory; Effects due to wall friction and wall inclination; Graphical methods; Earthquake effects. Rigid Retaining Structures: Types; Empirical methods; Stability analysis. Flexible Retaining Structures: Types; Material; Cantilever sheet piles; Anchored bulkheads – free earth method, fixed earth method, moment reduction factors, anchorage. Braced Excavation: Types; Construction methods; Pressure distribution in sands and clays; Stability – bottom heave, seepage, ground deformation. Laterally Loaded Piles: Short and long piles; Free head and fixed head piles; Lateral load capacity of single piles; Lateral deflection; Elastic analysis; Group effect; Lateral load test; Codal provisions. Underground Structures in Soils: Pipes; Conduits; Trenchless technology; Tunnelling techniques – cut-and-cover method, shield tunnelling.

CE-714 Reinforced Soil Structures 3+0+0

Types and functions; Materials and manufacturing processes; Testing and evaluations; Principles of soil reinforcement; Design and construction of geosynthetic reinforced soil retaining structures – walls and slopes; BS-8006 Codal provisions; Bearing capacity improvement; embankments on soft soils; Indian experiences. Geosynthetics in Pavements: Geosynthetics in roads and railways; separations, drainage and filtering in road pavements and railway tracks; overlay design and construction; AASHTO and other relevant guidelines; trench drains. Geosynthetics in Environmental Control: Liners for ponds and canals; covers and liners for landfills – material aspects and stability considerations; Landslides – occurrences and methods of mitigation; Erosion – causes and techniques for control.

CE-715 Offshore Geotechnical Engineering 3+0+0

Submarine soils: Origin, nature and distribution. Terrigenic and pelagic soils. Submarine soils of India. Engineering behaviour of submarine soils: underconsolidated soils, calcareous soils, cemented soils, corals. Offshore site investigations: sampling and sampling disturbance, insitu testing, wireline technology. Offshore pile foundations for jacket type structures. Foundations of gravity structures. Foundations for jack-up rigs. Anchors and breakout forces; anchor systems for floating structures. Stability of submarine slopes. Installation and stability of submarine pipelines.

CE-716 Geotechnical Processes in Rock Engineering 3+0+0

Ground improvement techniques, assessment. Compaction of disintegrated and weathered rocks. Grouting, type of grouts, suspensions, solutions and resins, Rheological models. Viscous and viscoplastic flows. Spherical and radial flows. Groutability. Grouting techniques, materials, equipment, specifications, evaluation and quality control. Case histories, Shotcrete, method and materials, factors. Fibre reinforced shotcrete. Ground anchors, principles of reinforcement, rock bolts, mechanism, mechanical, friction, grouted tensioned and untensioned bolts. Design of bolts. Installation. Equipment. Testing. Cable anchors. Dewatering techniques, classification, assessment of insitu permeability, filter criteria and design of wells, Codal provisions.

CE-717 Environmental Rock Engineering 3+0+0

Hazardous Earth processes. Temperature, pressure and water related problems, Stress relaxation, high ground stresses, rock bursts, subsidence. Karst formations. Landslides and rock falls, slopes stabilization, mitigation, Case studies. Earthquakes, tectonic stresses, creep, ground motions, damage, prediction. Volcanic activity and hazard. Tsunamis. Case studies. Waste disposal, Radioactive and hazardous wastes, repositories, location and design, Waste container, barriers, rock structure, embedment, buffers and seals. Performance assessment, quality control and monitoring. Case histories.

CE-718 Soil-Structure Interaction Analysis 3+0+0

Introduction: Analysis of foundations and flexible retaining structures by conventional method- isolated and combined footings, mats, pile caps, eccentrically loaded foundations, transmission tower foundations, sheet pile walls. Soil-structure interaction : Subgrade reaction method; Beam and plate theories; Analysis of footings, mats, pile caps, laterally loaded piles, sheet pile walls, water front structures. Elastic half-space method: Closed form solutions, charts and FEM- footings, mats, reinforced foundations and embankments. Evaluation of relevant material parameters. Use of appropriate software packages.

Self Study Course

CE- 799 Special Topics in Geotechnical Engineering and Under Ground Structures

A course which will vary from year to year to study new and exciting developments in the broad spectrum of Geotechnical Engineering and Under Ground Structures. The course will also focus on new offshoots of Geotechnical Engineering and Under Ground Structures.