Department of Civil Engineering
M TECH IN GEOTECHNICAL ENGINEERING AND UNDER GROUND STRUCTURES
Teaching Scheme (2011 onwards)

1. FIRST SEMESTER

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Course No.</th>
<th>Course Title</th>
<th>L</th>
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<td>1.</td>
<td>CE-610</td>
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2. SECOND SEMESTER

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<td>1.</td>
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3. THIRD SEMESTER

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4. FOURTH SEMESTER

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Sub Total: 20

Total: 70

PROGRAMME ELECTIVE COURSES

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<td>CE-713</td>
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Self Study Course: CE-799 Special Topics in Geotechnical Engineering and Underground Structures
## DETAILED SYLLABUS

### CE-610 Advanced Soil Mechanics 3+0+0

### 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;

CE-615  
**Machine Foundation**  
3+0+0


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


**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.


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, Liquefication 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*
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

CE-703 Construction Planning And Scheduling 3+0+0
Construction Planning: Objectives and functions, stages in construction, work breakdown structure, pretender 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.


Books
- Chitkara, K.K. “Construction Project Management, Planning scheduling and controlling,”
- Pilcher, R. “Project Cost Control in Construction”,

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.


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.


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 axisymmetric stress analysis. Thin and thick plates and shells. Semi-analytical formulations, Three dimensional elements and degenerated forms. Stiffer 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

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

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

CE-717  **Environmental Rock Engineering**  
3+0+0

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

**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.