PROPOSED SYLLABUS FOR POST GRADUATE PROGRAMME
M. Tech.
GEOTECHNICAL ENGINEERING
2012-2013
### Semester – I

<table>
<thead>
<tr>
<th>Sl. No</th>
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<td>1</td>
<td>PGT 111C</td>
<td>Geo-mechanics and Engineering</td>
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<td>2</td>
<td>PGT 122C</td>
<td>Soil Exploration and Field Testing</td>
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<td>Fundamentals of Soil Dynamics</td>
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<td>PGT 221C</td>
<td>Design of Earth Retaining Structures</td>
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### Semester – III

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### Semester – IV

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# LIST OF ELECTIVES

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<td>1</td>
<td>PGT 001E</td>
<td>Ground Improvement Techniques</td>
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<td>2</td>
<td>PGT 103E</td>
<td>Theory of Elasticity and Plasticity</td>
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<td>PGT 005E</td>
<td>Environmental Geo-Techniques</td>
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<td>Reinforced Earth Structures and Geosynthetics</td>
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<td>6</td>
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<td>Numerical Methods for Civil Engineers</td>
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<td>9</td>
<td>PGT 011E</td>
<td>Design of Machine Foundations</td>
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<td>Pile foundation Analysis and Design</td>
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<td>12</td>
<td>PGT114E</td>
<td>Geotechnical Earthquake Engineering</td>
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<td>Structural Design of Foundation</td>
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<td>Soil Structure Interaction</td>
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UNIT 1:

UNIT 2:

UNIT 3:

UNIT 4:

Reference Books:
SOIL EXPLORATION AND FIELD TESTING

Subject Code: PGT 122C
IA Marks: 50
No. of Lecture Hours: 52
Duration of Exam: 3 Hrs
Examination of Marks: 100
Assignment – hours/week: 02

UNIT 1:
Role of engineer in the systematic exploration of a site; Relevance of geology to civil engineering. Soil profiles of various regions.
Rock and soil types and their formation; Basics of structural geology; In-situ state of stress in soils and rocks; Engineering classification of intact and fissured rocks – RQD.

UNIT 2:
Geological exploration of an engineering site, Field reconnaissance, Applied geophysical surveys, Drilling and accessible explorations, Sampling methods and equipment’s, Factors considering in the selection of sampler, Factors affecting sample quality, sample disturbance, Spacing and Depth of boring, preservation and transportation of samples.

UNIT 3:
Importance of In-situ testing, performing various In-situ tests: standard penetration test, static and dynamic cone penetration tests, pressure meter test, plate load test and field vane shear test (VST), Ground water exploration, site evaluation and reporting.

UNIT 4:
Importance of photogrammetry and remote sensing in geological and geotechnical investigations. Photo interpretation–Basic elements in photo interpretation, Interpretation of rock forms and bed rocks.
Basic concepts of remote sensing, remote sensing system, energy interaction mechanism on ground, Earth’s emission, spectral response and spectral signature and spectra of rock and soils.

References Books:
1. Hvorslev M J., “Subsurface Exploration and Sampling of Soil for Civil Engineering Purposes”, Waterways Experiment station, Mississippi, 1949
FUNDAMENTALS OF SOIL DYNAMICS

Subject Code: PGT 123C  IA Marks: 50
No. of Lecture Hours: 52   Duration of Exam: 3 Hrs
Examination of Marks: 100   Assignment – hours/week: 02

UNIT 1:
Types of dynamic loads encountered in civil engineering. Occurrence of earthquakes, seismic waves generated by earthquakes and their properties. Types of surface waves and their uses in subsoil exploration, effect of depth below ground level on amplitudes of ground vibrations due to R waves.

Free and forced Vibration of single degree of freedom system with and without damping. Coulomb (friction) damping, viscous (proportional) damping, radiational (geometric) damping. Two degree of freedom systems with and without damping. Natural frequency and resonance and its effects.

UNIT 2:
Propagation of shear waves through layered media.
Dynamic stress-strain characteristics of cohesionless soils, cohesive soils and c-ϕ soils; Laboratory equipments for dynamic soil tests; In-situ measurements and field tests for evaluation of seismic wave velocity: SASW, MASW, cross bore hole, down hole, etc.

UNIT 3:
Liquefaction of soils: Occurrence of liquefaction and its significance in geotechnical engineering; examples of liquefaction under field conditions due to seismic vibrations; factors affecting liquefaction; liquefaction analysis; measures for reducing the damage to structures due to liquefaction.
Site characterization using seismic consideration, Numerical evaluation of wave amplification for 2 and 3 layer soils, determination of liquefaction potential of sites.

UNIT 4:
Vibration isolation and measures for vibration isolation.
Special topics in Geotechnical Engineering: Microzonation and base isolation.

Reference books:
5. Day, Handbook of Earthquake Geotechnical engineering
UNIT 1:
Importance of earth pressure structures in geotechnical engineering; Lateral earth pressures and earth pressure coefficients; Statically indeterminate nature of the earth pressure problem. Experimental studies on earth pressures under static and dynamic conditions; Shapes of rupture surfaces; Displacement dependent earth pressures. Classical theories of earth pressure proposed by Rankine and Coulomb; Earth pressure due to earth fill with irregular surface carrying concentrated, uniformly distributed loads by using Culmann’s construction; Passive earth pressures with curved rupture surfaces.

UNIT 2:
Factors affecting earth pressures: Angle of wall back, angle of wall friction, angle of shear resistance of the backfill, unit weight of the fill, angle of the plane backfill, shape of the back fill surface, level of water table in the backfill. Dynamic earth pressures, Monopole-Okabe method, influence of various factors effecting dynamic earth pressure; Distribution of dynamic earth pressures along back of retaining structure.

UNIT 3:
Static and dynamic at rest earth pressure, displacement dependence of at rest earth pressure, experimental studies for at rest earth pressures; Distribution of at rest earth pressures along back of retaining structure. Axi-symmetric earth pressures; Earth pressures on well foundations; Sinking resistance of well and its estimation; Curved retaining walls of road and railway embankments.

UNIT 4:

REFERENCES
CRITICAL STATE SOIL MECHANICS

Subject Code: PGT212C
IA Marks: 50
No. of Lecture Hours: 52
Duration of Exam: 3 Hrs
Examination of Marks: 100
Assignment – hours/week: 02

UNIT 1:
Stress and strain in a continuum, elasticity and plasticity in soils, principle of effective stress and its significance, increment of stress and strain in soils. Principle stresses and principle planes, Mohar circle of total and effective stress, Normal and shear strain. invariants of stresses, Stress paths, Representation of stress paths in different spaces, invariants of strain and strain paths.

UNIT 2:
Pore pressure potential, seepage velocity, hydraulic gradient, Darcy’s law, critical hydraulic gradient in two dimensional seepage and flownets. Compression and consolidation, isotropic compression test, isotropic compression of clay, idealization of isotropic compression of clay, possible state of isotropic compression, isotropic compression of sand.

UNIT 3:
Introduction to critical state concept, Families of undrained and drained shear tests, the critical state lines, drained and undrained planes. Roscoe surface, Roscoe surface as state boundary surface. Drained test for O.C soils. Hvorslev’s surface, critical straight lines for O.C soils and complete state boundary surface.

UNIT 4:
Elastic and plastic deformation, calculation of elastic strain, essentials plasticity theory, Cam- clay and Granta-gravel model. Mohar coulomb failure criteria, general stress states, pore pressure parameters for undrained loading.

References:
FOUNDATION ENGINEERING

Subject Code: PGT 213C
No. of Lecture Hours: 52
Examination of Marks: 100
IA Marks: 50
Duration of Exam: 3 Hrs
Assignment – hours/week: 02

UNIT 1:

UNIT 2:
Shallow Foundations - Conventional structural design of continuous footings. Individual footings, combined footings and Rafts of various types.
Pile Foundations – Analysis and Conventional Design of pile foundations for vertical and lateral loads including design of pile cap.

UNIT 3:
Piers and Well Foundations: Analysis and design of pier and well foundations. Caissons and cofferdams.
Foundations on expansive soils, under reamed piles.
Introduction to the design of special foundations diaphragm for structures such as radar towers

UNIT 4:
Design of foundation for Chimneys and high rise buildings
Design of sheet piles

References Books
3. Leonards., “Foundation Engineering”.
5. Teng, Wayne. S. “Foundation Design”
10. Leonards., “Foundation Engineering”.
12. Teng, Wayne. S. “Foundation Design”
GROUND IMPROVEMENT TECHNIQUE

Subject Code: PGT 001E  IA Marks: 50
No. of Lecture Hours: 52  Duration of Exam: 3 Hrs
Examination of Marks: 100  Assignment – hours/week: 02

UNIT 1:
Principles and objectives of ground improvement; History of ground improvement developments. Classification of ground improvement techniques. Factors affecting ground improvement.
Mechanical modification method of ground improvement, Theory of compaction, moisture-density relationship, optimum moisture content and maximum dry density, Laboratory compaction test using Proctor’s mould and modified Proctor Mould, Factors affecting compaction and Engineering behavior of soils compacted with water content on dry side and on wet side of optimum moisture content.

UNIT 2:
Field compaction – Dead weight surcharge for compaction, Equipment for field compaction: smooth wheel rollers, pneumatic rollers, sheep foot rollers, grid rollers and power rammers. Role of vibrations in dynamic compaction, Dynamic Field Compaction Equipment: Impact type of compaction, Vibratory rollers, Vibratory pneumatic tyre Vibratory compressors for deep compaction, compaction piles, vibroflotation, compaction sand columns and sand piles, underground blasts. Specifications for field compaction.
Hyd. Modification: Preloading by lowering ground water table, Filters, Control of ground water seepage, Drains, Well point system, Vertical drains and Electromosis and its application in ground improvement.

UNIT 3:
Chemical Modification: Factors affecting chemical modification, Lime stabilization, Cement stabilization, Bitumen stabilization, Stabilization with calcium chloride, sodium chloride, lignin and other synthetic polymers, Aggrigants and dispersants, Methods of construction- mix in place method, traveling plant and stationary plant methods.
Grouting: Factors affecting grouting, Groutability, Grouting materials and their properties, Pressure grouting, Compaction grouting, Grouting procedures, Applications of grouting.

UNIT 4:
Applications of geosynthetics for ground improvement.
Miscellaneous: Rock cutting, anchoring, heating, soil nailing.

Reference Books:
THEORY OF ELASTICITY AND PLASTICITY

Subject Code: PGT103E
No. of Lecture Hours: 52
Examination of Marks: 100
IA Marks: 50
Duration of Exam: 3 Hrs
Assignment – hours/week: 02

UNIT 1:
Definition of stress components of stress at a point, Cartesian and polar co-ordinates,
Equilibrium equations, Transformation of stress, Principal stresses, invariants of stress,
hydrostatic and deviatomic stress.
Definition of strain, components of strain at a point, Cartesian and polar co-ordinates,
Equilibrium equations, transformation of strain, principal strain, invariant of strain, spherical
and deviatoric strains, maximum shear strain, compatibility equations.

UNIT 2:
Compatibility equations, stress strain relations, constitutive relations- plane stress and plane
strain. Problems in polar co-ordinates (2D)
Problems in rectangular coordinates (2D) – boundary conditions Airy’s stress function approach
to 2-D problems of elasticity, simple problems on bending of beams. Solution of axi-symmetric
problems, stress concentration due to the presence of a circular hole in plates.

UNIT 3:
3D problems: Elementary problems of elasticity in three dimensions, stretching of a prismatical
bar by its own weight, twist of circular shafts.
Torsion: torsion of non-circular sections

UNIT 4:
Theory of plasticity: Plastic stress – strain relations, Failure theories, Criterion of yielding,
Theories of plastic flow, Plastic deformation
Bending of prismatic beams, residual stresses, Plastic torsion.

References
3. Chenn W.P and Hendry D.J, “Plasticity for Structural Engineers”, Springer Verlag
   Delhi.
9. Venkataraman and Patel “Structural Mechanics with introduction to Elasticity and
   Plasticity” – Mcgraw Hill, 1990.
UNIT 1:
Introduction – Components of pavement structure, Importance of subgrade soil properties on pavement performance – Functions of subgrade. Subbase. Base course and wearing course – True approach of pavement design. Stresses in flexible pavements – Stresses in homogeneous mass and layered systems deflections, shear failures, equivalent wheel and axle loads. Elements in design of flexible pavements – Loading characteristics – Static, Impact and Repeated loads, Effects and tandem axles. Area of contact and type pressure- Modulus or CBR value of different layers – Equivalent single wheel load, Equivalent stress and equivalent deflection criteria, Equivalent wheel load factors – Climatic and environmental factors.

UNIT 2:

UNIT 3:

UNIT 4:

Reference Books:
1. Yoder E.J. and Witezok M.W., “Principles of pavement design” Wiley international.
3. Khanna and Justo
ENVIRONMENTAL GEO–TECHNIQUES

Subject Code: PGT005E
IA Marks: 50
No. of Lecture Hours: 52
Duration of Exam: 3 Hrs
Examination of Marks: 100
Assignment – hours/week: 02

UNIT 1:
Introduction to Environmental Geotechnology; Source, Production and Classification of Wastes; Soil Pollution Processes Physical-chemical and Biological Interaction in Soil, Effects on geotechnical Properties;

UNIT 2:
Disposal and Containment of Solid waste- Landfill design, Liner systems etc.; Surface Impoundments, Slurry Walls, etc.,

UNIT 3:
Barrier systems-Basic concepts, design and construction, stability, compatibility and performance; Contaminant Transport in subsurface, Monitoring subsurface contamination;

UNIT 4:
Soil Remediation Techniques- Stabilization/Solidification, Soil Washing, Bioremediation etc.; Additional Aspects-Beneficial Reuse of waste Materials.

Reference Books:
REINFORCED EARTH STRUCTURES AND GEOSYNTHETICS

Subject Code: PGT106E  IA Marks: 50
No. of Lecture Hours: 52  Duration of Exam: 3 Hrs
Examination of Marks: 100  Assignment – hours/week: 02

UNIT 1:
Historical background – Introduction to reinforced soil structures. Comparison with reinforced cement concrete structures,
Principles, concepts and mechanisms of reinforced earth

UNIT 2:
Materials used, properties, laboratory testing and constructional details, Metallic strips, Metallic grids, Geotextiles, gerogrids, geomembranes and geocomposites, their functions and design principles. Tests on geotextiles

UNIT 3:

UNIT 4:
Application of geosynthetics
Seismic performance of reinforced earth structures – displacement, case studies

Reference :

NUMERICAL METHODS FOR CIVIL ENGINEERS

Subject Code: PGT018E  IA Marks: 50
No. of Lecture Hours: 52  Duration of Exam: 3 Hrs
Examination of Marks: 100  Assignment – hours/week:02

UNIT 1:
Introduction: Historical development of Numerical techniques, role in investigations, research and design in the field of civil engineering.
Development of algorithm/flow charts for following methods for solution of linear Simultaneous equation: a) Gaussian elimination method b) Gauss-Jordan matrix inversion method c) Gauss-Siedel method d) Factorization method
Application of solution of linear system of equations to civil engineering problems: Construction planning, slope deflection method applied to beams, frames and truss analysis.

UNIT 2:
Application of root finding to civil engineering problems: Development of algorithm for Bisection method and Newton-Raphson method and its applications for solution of non linear algebraic and transcendental equations from problems in hydraulics, irrigation engineering, structural engineering and environmental engineering.
Application of numerical integration for solving simple beam problems: Development of algorithm for Trapezoidal rule and Simpson’s one third rule and its application for computation of area of BMD drawn for statically determinate beams.

UNIT 3:
New Marks method for computation of slopes and deflections in statically determinate beams.
Development of algorithm and application of solution of ordinary differential equation to civil engineering problems by Euler’s method and Runge Kutta 4th order method

UNIT 4:
Application of finite difference technique in structural mechanics:
  i. Introduction, expression of derivatives by finite difference: backward differences, forward differences and central differences.
  ii. Application of finite difference method for analysis of statically determinate indeterminate beams
Application of Finite difference technique in structural mechanics (Contd..): Buckling of columns and Beams on elastic foundation.

Reference Books:
UNIT 1:
Basic concepts of elasticity – kinematic and static variables, approximate methods of structural analysis: Rayleigh-Ritz method, finite difference method, finite element method. Principles of finite element method, advantages and disadvantages, finite element procedure. Discretization of structures: Finite elements used for one, two and three dimensional problems, element aspect ratio, mesh refinement versus higher order elements, numbering of nodes to minimize band width.

UNIT 2:
Displacement Model: Nodal displacement parameters, convergence criterion, compatibility requirements, geometric invariance, shape function, polynomial form of displacement function. Generalized and natural coordinates, Lagrangian interpolation function, shape functions for one, two and three dimensional elements.

UNIT 3:
Concept of Isoperimetric Elements: Internal nodes and higher order elements, serendipity and Lagrangian family of finite elements, sub parametric and super parametric elements, condensation of internal nodes, Jacobian transformation matrix, variation method and minimization of energy approach of element formulation (development of strain – displacement matrix and stiffness matrix) consistent load vector, numerical integration.

UNIT 4:
Application of finite element method for the analysis of one and two dimensional problems: Analysis of simple beams and plane trusses, application to plane stress, strain and axi-symmetric problems using CST and quadrilateral elements. Application to plates and shells – Choice of displacement function (C⁰, C¹, C² type), techniques for nonlinear analysis.

References
CONSTRUCTION MANAGEMENT

Subject Code: PGT010E  
No. of Lecture Hours: 52  
Examination of Marks: 100

IA Marks: 50  
Duration of Exam: 3 Hrs  
Assignment – hours/week: 02

UNIT 1:
Stages of construction - estimating, tendering, pricing and contracting, equipment planning and waiting line situations, inventory management.
Engineering economics and Economic feasibility – budget, break-even analysis, Balance sheets, cost benefit analysis, discounted cash flow, Life cycle costing, cost control optimization

UNIT 2:
Principles and practice of project management; work breakdown structures, critical path networks, PERT, resource charts, cost charts, S-curves,
Performance ratios Updating of plans - purpose, frequency and methods of updating, common causes of time and cost overruns and corrective measures.

UNIT 3:
Design tree and decision analysis, construction simulation and simulation models, Appraisal of public investment projects, techno-economics of projects project investment analysis and decisions.

UNIT 4:
Quality control - concept of quality, quality of constructed structure, use of manuals and checklists for quality control, role of inspection, basics of statistical quality control, ISO standards.
Safety and health on project sites - accidents; their causes and effects, costs of accidents, occupational health problems in construction, organizing for safety and health, ISO standards

References Books:

1. Varma, M., “ Construction planning and management through system techniques ; Metropolitan Book Company , New Delhi 1977
4. Payne AC, Chelsom JV And Reavill RP, Management for engineers John Wiley and Sons, 1996,
DESIGN OF MACHINE FOUNDATIONS

Subject Code: PGT 011E
No. of Lecture Hours: 52
Examination of Marks: 100
IA Marks : 50
Duration of exam: 3 Hrs
Assignment: Hrs/week: 02

UNIT 1:

UNIT 2:

UNIT 3:

UNIT 4:
Framed Foundations: Their advantages for high speed machines, permissible amplitudes, design principles. Design of TG foundations.

References:
PILE FOUNDATION ANALYSIS AND DESIGN

Subject Code: PGT023E  IA Marks: 50
No. of Lecture Hours: 52  Duration of Exam: 3 Hrs
Examination of Marks: 100  Assignment – hours/week: 02

UNIT 1:
Shallow v/s deep foundations; Pile classification based on their function, composition and method of installation.
Axial load carrying capacity of single pile by different methods: By use of Static bearing capacity equations, by using dynamic formulae and by using field test data (SPT & CPT values).

UNIT 2:
Pile load test (Monotonic loading and cyclic loading); Pile group: Group efficiency, Problems related to load on each pile; Pile group with vertical and inclined piles (Culman’s graphical method and Analytical method).

UNIT 3:
Laterally loaded vertical piles; Under reamed piles;
Structural design of piles; Pile cap design;

UNIT 4:
Negative skin friction; Influence of pile driving on adjacent structures; some common construction problems and suggested remedial measures in pile foundation.
Pile testing: Integrity of piles, corrosion resistance, and durability, damage protection to wooden and concrete piles.

Reference Books :

UNIT: 1
Introduction to Engineering seismology, plate tectonic, Earthquake magnitude.
Ground motion and Effect of local soil condition on Ground motion.

UNIT: 2
Dynamic behavior of soils. Analysis of seismic site response. Liquefaction phenomena and analysis of pore pressure development.

UNIT: 3
Laboratory and in-situ testing for seismic loading, Analysis and design of slopes, embankments, foundation and earth retaining structures for seismic loading.

UNIT: 4
Case histories. Mitigation techniques and computer-aided analysis.

Reference books:
4. Day, Handbook of Earthquake Geotechnical engineering
UNIT: 1

UNIT: 2
Introduction to RC Design - Codal provisions: A review and A few examples.
Shallow Foundations: Geotechnical and Structural Design of Individual footings, combined footings, Rafts, Ring foundations, etc. Detailing, Examples and Case Studies. Beams and Plates on Elastic Foundation;

UNIT: 3

UNIT: 4
Special Foundations: Towers, Chimneys, High-Rise Buildings, Power Plants, etc.
Earthquake Resistant Design of Foundations – A few Examples and Case Studies.
Usage of Softwares.

References
EARTH AND ROCKFILL DAMS

UNIT 1:
Introduction: Why earth and Earth-Rockfill dams? Homogeneous earth dams zoned earth, earth – rock fill dams. Typical embankment, dam sections
Site selection and exploration: Influence of topography and subsoil conditions on location and alignment of the dam. Foundation sub surface exploration and studies of embankment construction material.

UNIT 2:
Factors influencing design: Material available for embankment construction, character of foundation, climate, shape and size of the valley, river diversion, probable wave action time available for construction function of reservoir and earthquake activity.
Design details: Material, location and inclination of earth core and shell materials, embankment side slopes, free board and crest width. Filter zones, design provisions, draw down pore pressures. Berms, upstream and downstream slope protection. Internal drainage systems.

UNIT 3:
Morgenstern-price method, wedge method, zones of planes of weakness in foundation, stability during construction, full reservoir and drawdown, settlement and horizontal movements. Special design problems and details.

UNIT 4:
Earth dams on pervious soil foundation: Methods of foundation treatment, preventing under seepage with complete vertical barriers and grouting, Reducing under seepage with partial vertical cutoffs and horizontal upstream impervious blankets, controlling under seepage by regulation of leaks and relief wells.
Embankment construction: Equipments for excavating, hauling spreading, blending, compacting and separating over sized rocks and cobbles, construction procedures and quality control of impervious and semi pervious embankments sections, handing dry and wet materials. Construction procedures and quality control of pervious embankment sections, construction problems caused by fines, construction procedures of hard and soft rockfill embankments, field test on rockfill embankments, slope treatment and riprap.

Reference Books :

23
SOIL-STRUCTURE INTERACTION ANALYSIS

Subject Code: PGT 117E  IA Marks : 50
No. of Lecture Hours : 52  Duration of Exam: 3 Hrs
Examination of Marks : 100  Assignment – hours/week:02

UNIT 1:

UNIT 2:
Beams and plates on elastic foundation, Elastic and elasto-plastic analyses of footings and raft foundations. Interaction analysis of pavements. Static interaction analysis of structures founded on shallow and deep foundations.

UNIT 3:
Analysis of axially and laterally loaded single pile and pile groups, Pile-cap-pile-soil interaction, Behaviour of piled-raft foundations.

UNIT 4:
Dynamics of foundations: Foundation input motion, Foundation embedded in a layered half-space, Seismic soil-structure interaction analysis in time domain for buildings and bridges. Examples and Case studies.

References
GEOTECHNICAL ENGINEERING LABORATORY

Subject Code: PGT 104 S/L

1. Grain size analysis of soil: wet and dry analysis.
2. Determination of relative density.
3. Triaxial test: UU, CU and CD.
4. Determination of compression index and coefficient of consolidation.
5. Electrical Resistivity
6. Standard Penetration Test (SPT)
7. Static Cone Penetration test (SCPT).
8. Plate load test.
10. Geotechnical investigation report.

Reference books:
1. Lambe T.W.,- Wiley Eastern Ltd., Soil testing for engineers-New delhi

Laboratory Assessment:
1. Each laboratory subject is evaluated for 100 marks (50 CIE & 50 SEE)
2. Allocation of 50 marks for CIE
   - Performance & journal write up:
     Marks for each experiment =30/ No. of proposed experiment
   - One Practical test for 20marks. (5 write up, 10 conduction, calculation, results etc., 5 Viva-voce
3. Allocation of 50 for SEE.
   - 25 % write up, 50% conduction, calculation, results etc., 25% viva-voce.