Biju Patnaik University of Technology, Orissa
Rourkela

Syllabus
of
M.Tech
in
CIVIL ENGINEERING
(Specialization: Geotechnical Engineering)

From 2014 -2015 Academic Session
# CIVIL ENGINEERING

## Syllabus and Course Structure for M.Tech in Geotechnical Engineering

<table>
<thead>
<tr>
<th>1&lt;sup&gt;st&lt;/sup&gt; Semester</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; Semester</th>
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<tbody>
<tr>
<td><strong>Theory (Compulsory)</strong></td>
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<tr>
<td><strong>Code</strong></td>
<td><strong>Subject</strong></td>
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<tr>
<td>GEPC 101</td>
<td>Advanced Geo-mechanics</td>
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<td>GEPC 102</td>
<td>Subsurface Exploration and Soil Testing</td>
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<td>GEPC 103</td>
<td>Ground Water and Flow Through Porous Media</td>
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<tr>
<td><strong>Professional Elective-I (any One)</strong></td>
<td><strong>Professional Elective-III (any One)</strong></td>
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<tr>
<td>GEPE 101</td>
<td>Rock Mechanics</td>
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<td>GEPE 102</td>
<td>Theory of Elasticity and Plasticity</td>
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<td>GEPE 103</td>
<td>Soil Stabilization by Admixtures</td>
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<td><strong>Professional Elective-IV (any One)</strong></td>
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<td>GEPE 104</td>
<td>Pavement Design</td>
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<td>GEPE 105</td>
<td>Soil Structure Interaction</td>
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<td>GEPE 106</td>
<td>Advance Construction Materials</td>
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<td>GEPE 207</td>
<td>Offshore Structures</td>
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<td>GEPE 208</td>
<td>Finite Elements in Geomechanics</td>
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<td>GEPE 209</td>
<td>Fundamentals of Soil Behaviour</td>
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## Practical/Sessionals

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<td><strong>Practical/Sessionals</strong></td>
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<tr>
<td>GEPR 101</td>
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<td>1 Disaster Management and Mitigation</td>
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<td>2 Non-conventional Energy</td>
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<td>Thesis Part - I</td>
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FIRST SEMESTER

1. Advanced Geomechanics (Cr = 04):


References:


2. Subsurface Exploration and Soil Testing (Cr = 04)

Problems and phases of foundation investigations: Geophysical sounding, drilling and accessible explorations. Sample requirements, sampling methods and equipment. Handling, preservation and transportation of samples. Sample preparation, laboratory tests, analysis of results and interpretation, importance of in-situ testing. Performing various in-situ tests. Precautions and interpretation, site evaluation and reporting, block vibration test.

References:

3. Ground Water and Flow Through Porous Media (Cr = 04)


References:
1. D.K.Todd, Groundwater Hydrology, John wiley and Sons

**Professional Electives - I (any ONE)**

4. **Rock Mechanics** (*Cr = 03*)

Rock: 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; Strength Behaviour: 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; Application of rock mechanics in Civil Engineering: Rock tunneling, Rock slope stability, bolting, blasting, grouting and rock foundation design.

**References**

4. V.S. Vutukuri and R D Lama, *Hand Book on Mechanical Properties*

5. **Theory of Elasticity & Plasticity** (*Cr = 03*)

Linear elasticity: stress, strain, constitutive relations, strain displacement relations, three dimensional stress and strain analysis, compatibility, stress and displacement functions.
Two dimensional problems in Cartesian and polar coordinates, description of an elasticity problem as a boundary value problem, bending of beams-cantilever and simply supported beam.

Torsion of rectangular bars including hollow sections, torsion of a circular and a rectangular section

Elements of plasticity, failure & yield criterion, Equations of plasticity, plastic stress-strain relations, flow rule, velocity field, slip lines and plastic flow, incremental plasticity.

References


(2) M.Kachanov, "Theory of Plasticity", MIR Publication.

(3) C.R.Calladine, "Plasticity for Engineers", Ellis Horwood, Chichester,U.K.,1985

6. Soil Stabilisation by Admixtures (Cr = 03)


References:


Professional Electives - II (any ONE)

7. Pavement Design (Cr = 03)
BASIC CONCEPTS

Pavements types - Historical developments - Approaches to pavement design - vehicle and traffic considerations - behaviour of road materials under repeated loading - Stresses and deflections in layered systems.

FLEXIBLE PAVEMENT

Factors affecting flexible pavements - material characterization for analytical pavement design - CBR and stabilometer tests - Resilient modulus - Fatigue subsystem - failure criteria for bituminous pavements - IRC design guidelines.

RIGID PAVEMENT


PAVEMENT EVALUATION AND REHABILITATION

Pavement evaluation and rehabilitation, condition and evaluation surveys causes and types of distress - in flexible and rigid pavements - PSI models - Serviceability index of rural roads - Overlay design, pavements maintenance management and construction.

STABILIZATION OF SOILS FOR ROAD CONSTRUCTIONS

The need for a stabilized soil - Design criteria and choice of stabilizers - Testing and field control - Stabilisation in India for rural roads - Use of Geosynthetics in road construction - Case studies.

References:


8. Soil Structure Interaction (Cr = 03)


References:
1. Foundation Design by Teng W.C (1969), Prentice Hall, NJ.
8. L.C. Reese, Single piles and pile groups under lateral loading, Taylor & Francis, 2000

9. Advance Construction Materials (Cr = 03)


References
2. 'Chemistry of cement and concrete', 3rd ed., 1970, Edward Arnold Proceedings of recent seminars etc. and journals
PRACTICALS/SESSIONALS

1. GEOTECHNICAL ENGINEERING LABORATORY (Cr = 02)

Modified Proctor Compaction Test; Permeability of fine grained soils; Direct Shear Test; Triaxial Shear Test (CU, CD, UU); C.B.R (Unsoaked & Soaked); Consolidation Test; Mechanical properties of geosynthetics / geogrid, Tensile strength of fibres.

2. COMPUTATIONAL LABORATORY (Cr = 02)

Computer programming in C++, Development of computer programs to solve problems related to Civil Engineering using matrix method.

3. TECHNICAL SEMINAR (Cr = 02)

20 min presentation by each student in presence of both B. Tech and M. Tech students and the teachers of the Deptt under the supervision of an external observer on the theories and practices they have learnt during course work. After presentation, there should be minimum 10 minutes question answer session.

SECOND SEMESTER

10. Advanced Foundation Engineering (Cr = 04)

INTRODUCTION


BEARING CAPACITY ESTIMATIONS

**SETTLEMENT EVALUATION**

Settlement analysis-immediate-consolidation settlement-stress path method of settlement evaluation-layered soil and rocks-construction period correction-evaluation from insitu tests - code recommendations.

**INTERACTIVE ANALYSIS AND DESIGN OF FOUNDATIONS**


**FOUNDATION FOR SPECIAL CONDITIONS**

Structural Design of shallow foundations - working stress method Introduction to special foundations - Foundation design in relation to ground movements - Foundation on recent refuse fills - Design of Foundation for seismic forces - Codal Recommendations.

**REFERENCES:**


11. Ground Improvement Techniques (Cr = 04)

Principles of ground improvement. Mechanical modification, properties of compacted soil, compaction control tests. Hydraulic modification, dewatering systems, filtration, drainage and seepage control with geosynthetics, preloading and vertical drains, Electri-kinetic dewatering, chemical modification. Modification by admixtures, stabilization using industrial wastes, grouting, modification by inclusion and confinement, soil reinforcement, flexible geosynthetic sheet reinforcement, anchorage. Reinforcement techniques, bearing capacity improvement, slope stability, retaining walls and pavements.

References


Professional Elective - III (any ONE)

12. Soil Dynamics and Geotechnical Earthquake Engineering (Cr = 03)

Soil Dynamics: Introduction: Soil mechanics and soil dynamics, problems of dynamic loading on soil structure. Theory of vibrations: Introduction, definitions, properties of simple harmonic motion, free vibrations of spring-mass system, Equations for free and forced vibrations with and without viscous damping. Dynamic Soil Properties: Introduction, measurement of dynamic soil properties (laboratory and field tests - Stress and strain controlled cyclic tri-
axial tests, seismic reflection and refraction test, seismic up-hole/down hole test, dilatometer and pressure meter tests, seismic cone penetration test, suspension logging test), stress-strain behaviour of cyclically loaded soils, strength of cyclically loaded soils.

Geotechnical Earthquake Engineering: Introduction, background, seismic hazards; ground shaking, structural hazards, liquefaction, landslides, lifeline hazards, tsunami hazards, mitigation of seismic hazards, significant historical earthquakes. Seismology and earthquakes: Internal structure of the earth, continental drift and plate tectonics, faults, elastic rebound theory, other sources of seismic activity location of earthquakes, size of earthquakes (intensity, magnitude and energy).

Seismic Liquefaction: Introduction, Flow liquefaction and cyclic mobility, liquefaction susceptibility (historical, geologic, and compositional). Initiation of liquefaction due to excess pore water pressure, effects of liquefaction (alteration of ground motion, development of sand boils, settlement and instability).

Bearing Capacity Analysis: Introduction, punching shear failure approach for cohesive and cohesion-less soils, Terzaghi’s method for both cohesion-less and cohesive soils.

Ground Improvement Techniques for Remediation of seismic hazards: introduction, densification techniques (Vibro-technique, dynamic compaction, blasting, grouting and mixing and drainage techniques).

References:


2. Soil Dynamics by Shamsher Prakash, McGraw-Hill Book Company


13. Optimization Methods and its Applications in Civil Engineering (Cr = 03)


References


14. Geo-environmental Engineering (Cr = 03)

Source, production and classification of wastes. Soil pollution processes, physical-chemical and biological interactions in soil, effects on geotechnical properties and case studies, waste disposal facilities such as landfills and impoundments, slurry walls, etc. Barrier systems - basic concepts, design and construction, stability, compatibility and performance. Transport in subsurface, reuse of waste materials. Contaminated site remediation.


PROFESSIONAL ELECTIVE- IV (any ONE)

15. Stability analysis of Slopes, Embankments and Dams (Cr = 03)

Landslide phenomenon: Types and causes of slope failures, Practical applications; Stability analysis of infinite slopes with or without water pressures; Stability analysis of finite and Infinite slopes: concept of factor of safety, pore pressure coefficients, Mass analysis, Wedge methods, friction circle method; Method of slices, Bishop's method, Janbu's method; Effect of seepage, submerged and sudden draw down conditions; Design of slopes in cutting, Embankments and Earth dams; Site Investigation: Reconnaissance, Preliminary and detailed investigation, Investigation for foundations; Advances in stability analysis of slopes.

References
1. L. W Abramson, T. S Lee, S Sharma and G M Boyce, Slope Stability and Stabilization Methods, Willey Interscience publications


3. T W. Lambe and R V Whitman, Soil Mechanics, John Wiley & sons


16. Reinforced Soil Structures (Cr = 03)

PRINCIPLES AND MECHANISMS OF SOIL REINFORCEMENT

Historical Background, Principles, Concepts and Mechanisms of reinforced earth.

REINFORCING MATERIALS AND THEIR PROPERTIES


DESIGN OF SOIL REINFORCEMENT

Reinforcing the soil-Geotextiles and Geogrids - Embankments and slopes - reinforced walls - bearing capacity - Road way reinforcement - slope stabilization.

DESIGN FOR SEPARATION, FILTRATION AND DRAINAGE

Geotextiles - requirement for design of separation - Filtration - General behaviour - filtration behind retaining wall, under drains, erosion control and silt fence - drainage design - Liners for liquid containment - Geomembrance and Geosynthetic clay liners.

DURABILITY OF REINFORCEMENT MATERIALS

REFERENCES:


17. Infrastructure Engineering & Transportation Planning (Cr = 03)

Module 1:
Quick response travel evaluation procedure, TSM actions: Traffic management techniques for improving vehicular flow, preferential treatment for high occupancy modes, demand management technique for reduced traffic demand, staggered hours, vehicle restrictions. Small area management: individual sites, residential neighbourhoods,

Module 2:
Introduction to transportation systems. Transportation innovations, social and economic impacts of transportation. Decision makers and their options, demand
modelling and prediction. Stated and Revealed Preference approaches; Modelling transportation technologies.

**Module 3:**
Analysis of network flows. Transportation networks. Network Theory, planning for pedestrians, parking planning. Travel demand management and telematics in travel planning, Design and drawing of grade intersections, Rotaries, interchanges (cloverleaf, trumpet), multilevel intersections; Onstreet parking facilities; Off-street parking facilities (parking lots and garages);

**Module 4:**
Layout for buses and trucks; Bridges and Fly-overs; Guard rails; Culverts; Retaining Sides; Mix wells; Foot bridges; River Spans; Tunnels and Underpasses;

**PROFESSIONAL ELECTIVES - V (any ONE)**

**18. Offshore Structures (Cr = 03)**
Design of offshore platforms: Introduction, fixed and floating platforms, case studies and general features-elements of hydrodynamics and wave theory-fluid structure interaction, Steel, concrete and hybrid platforms.


Behaviour under dynamic loading. Static and dynamic analysis of platforms and components.

Dynamic response in deterministic and indeterministic environment, codes of practice, analysis of fixed platform and semisubmersible related topics.

**19. Finite Elements in Geo-mechanics (Cr = 03)**
Basic concepts - Discretization of continuum, typical elements, the element characteristic matrix, element assembly and solution for unknowns - Applications.

Variational principles, variational formulation of boundary value problems, variational methods approximation such as Ritz and weighted residual (Galerkin)
methods, Applications.
Displacements based elements, finite elements for axial symmetry. One-
dimensional problems of stress, deformation and flow, assembly, convergence
requirements, Finite elements analysis of two-dimensional problems. The linear and
quadratic triangle, Natural coordinates.

Isoparametric formulation - Isoparametric bar element - plane bilinear
isoparametric element - refined elements - Numerical integration techniques.

Use of FEM to Problems in soils and rocks, Introduction to non-linearity.
Description and application to consolidation, seepage and soil - structure
interaction problems.

REFERENCES

3. Chadrupatla, R.T., and Belegundu. A.D, Introduction to Finite Elements in
5. Rajasekaran, S., Finite Element Analysis in Engg Design, Wheller Publishing,
6. Smith, I.M., Programming the Finite Element Method with Application to
7. Gupta, O.P. Finite and Boundary Element Methods in Engineering, Oxford &
1998.
perspective, Moral Dikker, Inc. 1998.

20. Fundamentals of Soil Behaviour (Cr = 03)
Origin of soils, identification of clay minerals, soil structure, soil classification, soil-water interactions in the environment, effective stress concepts, role of mineralogy in hydraulic conductivity, consolidation and shear strength of fine-grained soils, problematic soils.


PRACTICALS/SESSIONALS

IIInd Semester SESSIONAL

1. Geotechnical Engineering Design practice. (Cr = 04)

Standard Penetration test; Field vane shear test; Cone penetration tests; Plate load test (both field and laboratory); Pile load tests; Nondestructive testing of piles; Pressure meter test; Dilatometer Test, Static and Cyclic Triaxial Test, Geophysical Exploration; Field Visit.

2. Comprehensive Viva (Cr = 02)
3. Technical Seminar (Cr = 02)

3rd Semester

OPEN ELECTIVES (any ONE)

21. Disaster Management and Mitigation (Cr = 03)
22. Non-conventional Energy (Cr = 03)

23. Project Planning and Management (Cr = 03)

PRACTICALS/SESSIONALS
1. Thesis Part – I (0 - 0 - 3) Cr = 14

FOURTH SEMESTER
1. Thesis Part – II (0-0-6) Cr = 16
2. Technical Seminar (0-0-3) Cr = 02
3. VIVA (0-0-3) Cr = 02