UNIVERSITY OF CALICUT

(Abstract)


GENERAL AND ACADEMIC BRANCH – IV – ‘E’ SECTION


     2.  U.O. No. GA1V/E1/1894/03 (Sub file) dated 13-12-2010.
     3.  Minutes of the meeting of the Board of Studies in Engineering (PG) held on 25/03/2011 (item No. 1)
     4.  Orders of Vice-Chancellor in the file of even number dated 08.04.2011.

ORDER

As per paper read first above, University has granted affiliation for starting M.Tech Course in Geo-Technical Engineering in Civil Engineering department at IES College of Engineering, Chittilappilly, Thrissur for the year 2010-2011.

Vide paper read 2nd above, an expert committee was constituted for the preparation of the syllabus for the M.Tech Course in Geo-Technical Engineering with the following members.

a)  Prof. K. O. Varghese, Assistant Professor, Department of Civil Engineering, Government College of Engineering, R.V. Puram, Thrissur (Convener).

b)  Dr. P. Vijayan, Assistant Professor, Department of Civil Engineering, Government College of Engineering, R.V. Puram, Thrissur.

c)  Prof. Anil Kumar. P. S., Assistant Professor, Department of Civil Engineering, Government College of Engineering, R.V. Puram, Thrissur.

d)  Dr. Kouzer. K. M., Lecturer, Department of Civil Engineering, Government Engineering College, West Hill, Kozhikode.

As per paper read 3rd above, the meeting of Board of Studies in Engineering (PG) held on 25.03.2011 vide item No.1, unanimously resolved to recommend the approval of the syllabus of the M.Tech course in Geo-Technical Engineering.
Considering the urgency of the matter, the Vice-Chancellor has accorded sanction to implement the scheme and syllabus of the M.Tech course in Geo-Technical Engineering, subject to ratification by Academic Council, vide paper read 4th above.

Sanction is therefore accorded for implementing the scheme and syllabus of the M.Tech course in Geo-Technical Engineering with effect from 2010-2011 admission.

Orders are issued accordingly. The syllabus is available in University website.

Sd/-

DEPUTY REGISTRAR (G&A-IV)
For REGISTRAR

To
The Principal,
IES College of Engineering,
Chittilappilly, Thrissur.

Copy to:
System Administrator (with a request to upload in the University website urgently)
PS to VC /PA to Registrar/PA to CE/Ex Sn/EG/
Chairman, Board of Studies in Engineering (UG)/ (PG)/
Dean, Faculty of Engineering/ SF/FC

Forwarded/By Order

Sd/-

SECTION OFFICER
UNIVERSITY OF CALICUT

PROPOSED SCHEME AND SYLLABUS

of

M. TECH.

in

GEOTECHNICAL ENGINEERING

(CIVIL ENGINEERING)
# Scheme and Syllabus for M. Tech. Programme in Geotechnical Engineering

## Semester I

<table>
<thead>
<tr>
<th>SI no</th>
<th>Course code</th>
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**ELECTIVE I**

- CEG10 105A  Applied Soil Mechanics
- CEG10 105B  Ground Improvement
- CEG10 105C  Pavement Design

L-Lecture  T-Tutorial  P-Practical  ESE-End Semester Examination

ICA-Internal Continuous Evaluation
**Semester II**

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**ELECTIVE II**

- CEG10 204A Highway Subgrade and Foundation Analysis
- CEG10 204B Modern Techniques in Geotechnical Engineering
- CEG10 204C Ground Water Hydrology

**ELECTIVE III**

- CEG10 205A Environmental Geotechnical Engineering
- CEG10 205B Reinforced Earth and Geotextiles
- CEG10 205C Stability Analysis of Slopes and Embankments
### Semester III

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</table>

**NB:** The student has to undertake departmental work assigned by HOD

**ELECTIVE IV**

- CEG10 301A Forensic Geotechnical Engineering
- CEG10 301B Soil Exploration and Field Testing
- CEG10 301C Modelling, Simulation and Computer Applications

**ELECTIVE V**

- CEG10 302A Earthquake Geotechnical Engineering
- CEG10 302B Shell Foundations
- CEG10 302C Remote Sensing and GIS
## Semester IV

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NB: The student has to undertake departmental work assigned by HOD

EC - Evaluation Committee; EE - External Examiner; VV - Viva Voce
SEMESTER I
CORE SUBJECTS
CEG10 101 ADVANCED ENGINEERING MATHEMATICS

Credits: 4

Hours per week: Lecture-3 and Tutorial-1

Objective: To familiarize students in the field of differential equations and wave equations to solve boundary value problems associated with engineering application and to expose the students to various probability distribution techniques to enable them apply statistics in various areas of geotechnical engineering like sampling, analysis, modeling etc.

MODULE 1

Four standard forms of non-linear partial differential equations, linear homogeneous partial differential equations with constant coefficients, one dimensional wave equation, D’Alembert’s solution of one dimensional wave equation, derivation by the method of separation of variables – problems, Laplace equation in Cartesian, cylindrical and spherical coordinates.

MODULE II

Discrete Fourier Transform (DFT) - definition and examples of DFT, Properties of DFT, Inverse of DFT, Cyclical convolution and convolution for DFT, Parseval’s theorem for DFT. Fast Fourier Transform (FFT): Definition and examples of FFT.

MODULE III

Probability distributions - Probability & random variables. Discrete and Continuous distributions: Binomial distribution, Poisson distribution, Geometric distribution, uniform distribution, normal distribution, gamma distribution, exponential distribution and Weibull distribution.

MODULE IV

Moments, moment generating function, sampling distributions, sampling distributions of standard means, chi-square distribution, student’s t-distribution, F-distribution, Point and Interval estimation, Testing of hypothesis, Bivariate distributions Independence, Correlation and Regression.
References:


Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question Pattern

Two questions of 20 mark each from each module and Answer any 5 questions by choosing at least one question from each module.

<table>
<thead>
<tr>
<th>Module 1</th>
<th>Module 2</th>
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Objective: To make students understand soil structure, stress-strain characteristics of soils, the mechanism of failure, the factors that affect the shear strength and the various test procedures to determine the shear strength. Also to impart knowledge about three dimensional consolidation, secondary consolidation and basics of rheological models.

MODULE I

Soil structures, types of bonds, important clay minerals, atomic structure, Base exchange capacity, Clay – water interaction, Lambe’s compaction theory, Field Compaction methods, Structural and engineering properties of compacted soils

MODULE II

Elastic theories – stress- strain relationship, principal stresses and strains, Mohr diagram, Stresses due to distributed line loads, concentrated force, Boussinesque’s and Westergaard’s solutions, isobar diagram, influence diagram, Newmark’s chart, Introduction to constitutive relationships of soils- Mohr-Coulomb model, Duncan and Chang model, Cam clay model, Drucker and Prager Model

MODULE III

Mohr-coulomb equation, Modified Mohr-coulomb equation, Testing of soils- Direct shear, Triaxial, UCC, Shear strength parameters of saturated cohesionless and cohesive soils. Pore pressure coefficient, concept of stress path. Critical state – Critical state line, Roscoe surface, Behaviour of over consolidated samples, Hvorslev surface

MODULE IV

Three dimensional consolidation, sand drains, secondary consolidation, Rheology – Introduction to basic rheological models - Kelvin and Maxwell models, Stability analysis of slopes – Swedish slip circle method, Friction circle method, Bishop method of stability analysis, Taylor stability number, Stability chart

References:


**Internal continuous assessment: 100 marks**

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**End semester Examination: 100 marks**

**Question Pattern**

Two questions of 20 mark each from each module and Answer any 5 questions by choosing at least one question from each module.

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<th>Module 1</th>
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<td>Question 4 : 20 marks</td>
<td>Question 6 : 20 marks</td>
<td>Question 8 : 20 marks</td>
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</tbody>
</table>
CEG10 103  FINITE ELEMENT METHOD FOR GEOMECHANICS

Credits: 4

Hours per week: Lecture-3 and Tutorial-1

Objective: To make students appreciate the basic concepts, principles and other formulations in finite element method and its application in geotechnical engineering.

MODULE I

Introduction – the finite element method – historical development – advantages, basic equations of elasticity – strain-displacement relations – theory of stress and deformation, general procedure of finite element analysis, displacement approach, concept of nodes and elements – aspect ratio
Energy principles - stationary principles, Principle of stationary potential energy-Potential energy of an elastic body - Rayleigh-Ritz Method - Finite element form of Rayleigh-Ritz method
Co-ordinate systems – global, local and natural co-ordinates – co ordinate transformation.
Shape functions – Lagrangian and Hermition interpolation for one and two dimensional elements - shape functions for C^0 and C^1 elements - convergence criteria – conforming and non-conforming elements - patch test

MODULE II

Formulation of stiffness matrix – bar element - beam element - plane stress and plane strain problems - triangular elements, Accuracy and mesh locking aspects in plane stress and plane strain analyses – properties of stiffness matrix - consistent element nodal load vector and boundary conditions
Storage schemes- conservation of computer storage - different methods, node numbering to exploit matrix sparsity

MODULE III

Plate bending elements- Kirchoff theory – Rectangular plate elements – refined quadrilateral element – shear deformation in plates - Mindlin’s theory –plate 4 and plate 8 elements- shear locking problems - selective and reduced integration – spurious modes
Shell elements – thin and thick shell - introduction to flat plate and curved elements
FEA in structural dynamics – dynamic equation for single degree of freedom system – Introduction to formulation of mass and damping matrices – lumped mass and consistent mass
MODULE IV

Soil-structure interaction – introduction to contact modelling- interface elements-stress, strain and stiffness matrices of interface elements- application of interface elements. Modelling of unbounded media and singularities - infinite elements – singularities in one and two dimensions

References:


Internal continuous assessment: 100 marks

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End semester Examination: 100 marks

Question Pattern

Two questions of 20 mark each from each module and Answer any 5 questions by choosing at least one question from each module.
Objective: To make the students understand engineering properties of rock, classification of rocks, laboratory testing of rocks, failure criteria, tunneling in rocks and various techniques to improve the insitu strength of rocks.

MODULE I

Introduction-Geological formation of rocks, Structural Geology, Classification of rocks, Defects in rock, Physical mechanical properties of rocks, Exploration techniques – RQD and RMR, Laboratory tests for shear strength, tensile strength, flexural strength, elastic constants, Field tests – test for deformability, shear tests and strength tests

MODULE II

Engineering classification of Rock mass, Stress-strain behaviour, Failure criteria for rock masses - Yield criteria for failure theories: maximum stress theories, maximum elastic strain theories etc, and Griffith’s theory of fracture initiation, stresses around open flaw and equation defining fracture

MODULE III

Tunnelling in rocks - different phases and methods of tunnelling, Instrumentation in tunnels, Rock freezing, Rock fall, Improvement techniques for rock – Grouting, Rock bolting

MODULE IV

Rock reinforcement - Mechanism, types of reinforcement, steps involved in installation, Foundations on rock, Rock blasting- explosives, Selection criteria for explosives, steps involved in blasting

References:


Internal continuous assessment: 100 marks

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End semester Examination: 100 marks

Question Pattern

Two questions of 20 mark each from each module and Answer any 5 questions by choosing at least one question from each module.

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CEG10 105: ELECTIVE I

CEG10 105A APPLIED SOIL MECHANICS

Credits: 4

Hours per week: Lecture-3 and Tutorial-1

Objective: To build the students’ knowledge in the engineering behaviour of soils such as arching, soil pressure on conduits and silos. Also to gain knowledge in geotechnical design of different types of earth retaining structures.

MODULE I

Arching in soils, prerequisites and features of arching, Theory of arching in soils. Application of arching in tunnels through c-soils, \( \phi \) -soils and c- \( \phi \) soils.
Soil pressures on conduits- Loads on ditch, negative and positive projecting conduits. Bedding conditions for conduits and types of conduits, Pressures in silos, Janssen’s theory for pressures in silos

MODULE II

Earth pressures and types of retaining structures, Stability analysis of RCC cantilever retaining walls.
Sheet piles and Anchored bulkheads-stability analysis of cantilever sheet pile, analysis of anchored bulkheads with free and fixed earth support, Anchorages for bulkheads – design of continuous and individual anchors, anchor plates. Position of anchor walls.

MODULE III

Open cuts-general and local states of plastic equilibrium, Terzaghi’s general wedge theory for earth pressures in cuts, Analysis of Earth pressures in cuts in c-soils, \( \phi \) -soils and c- \( \phi \) soils. Design of bracings of shallow and deep cuts. Heave at bottom of c-soils, \( \phi \) -soils and c- \( \phi \) soils.

MODULE IV

Types of Cofferdams, Types of cellular cofferdams- circular and diaphragm, analysis of cellular cofferdam under no submergence and partial submergence conditions. Diaphragm walls, Bored pile walls and prestressed ground anchors Design aspects of non-conventional retaining systems - Gabion wall, mechanically stabilised earth walls, soil nailing and shotcreting.

References:


**Internal continuous assessment: 100 marks**

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**End semester Examination: 100 marks**

**Question Pattern**

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</table>
Objective: To enable students to identify problematic soils and their associated issues, propose suitable remedial techniques and design.

MODULE I

Introduction - The need for engineered ground improvement in Geotechnical Engineering, Traditional objectives and classification of Ground modification techniques, Mechanical Modification- Methods of compaction, Shallow compaction techniques, Deep Compaction, Dynamic compaction, Vibro compaction, compaction control tests

MODULE II

Hydraulic Modification-Ground water lowering by well points, deep wells, Vertical Drains and Preloading: Method of providing vertical drainage, preloading without vertical drains, vacuum preloading, electrokinetic dewatering – basic concepts, electrosmosis, practical aspects of electrosmosis.

MODULE III

Anchors: Introduction-Components-Design of Anchors

MODULE IV

Thermal methods: Stabilisation by heating, Soil Freezing, Area of Application, Cooling by Liquid Nitrogen/by Brine, Advantages & Disadvantages.
Expansive Soil: Identification of Expansive Soil-Problems Associated With Expansive Soil-Introduction to CNS (Cohesive Non Swelling) Layer-Treatment by Chemical Additives, Prewetting, Soil Replacement with Compaction Control, Moisture Control, Surcharge Loading, Thermal Methods
**References:**

1. Mosely, M.P. “Ground Improvement”, Blackie Academic and Professional.
3. US Army Corps of Engineers “Guidelines on Ground improvement for Structures and Facilities”.
4. FHWA manuals

**Internal continuous assessment: 100 marks**

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students right at the beginning of the semester by the teacher.

**End semester Examination: 100 marks**

**Question Pattern**

Two questions of 20 mark each from each module and Answer any 5 questions by choosing at least one question from each module.

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</table>
Objective: To train students in assessment of aspects influencing pavement behaviour and to train them in analysis, design of rigid and flexible pavements for different serviceability conditions.

MODULE I

Introduction: Historical developments in pavement engineering, Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airport pavements.
Reliability concepts as applicable for flexible and rigid pavement – Statistical concepts, Probabilistic methods- Methods based on ESAL and different Axle Load.

MODULE II

Stresses and strains in flexible pavements: Stresses and strains in an infinite elastic half space – use of Boussinesq's equations - Burmister's two layer and three layer theories; Wheel load stresses, various factors in traffic wheel loads; Equivalent single wheel load of multiple wheels. Repeated loads and EWL factors;

MODULE III

Flexible pavement design methods for highways and airports: Empirical, semi-empirical and theoretical approaches; Development, principle, design steps of the different pavement design methods including AASHTO, Asphalt Institute, Shell Methods. IRC method of pavement design. Use of software for stress analysis

MODULE IV

Stresses in rigid pavements: Types of stresses and causes; Introduction to Westergaard's equations for calculation of stresses in rigid pavement due to the influence of traffic and temperature; Considerations in rigid pavement analysis, EWL; wheel load stresses, warping stresses, frictional stresses, combined stresses.
Rigid pavement design: Design of cement concrete pavement for highways and runways; Design of joints, reinforcements, tie bars, dowel bars. IRC method of design

References:

1. Yoder and Witczak “Principles of Pavement Design “John Wiley and sons


Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question Pattern

Two questions of 20 mark each from each module and Answer any 5 questions by choosing at least one question from each module.

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CEG10 106(P): SEMINAR

Credits: 2

Objective: To train the students to address to a group of people and to present technical topics in a well organised manner to the audience. It is also intended for improvement of communication skills of students, to make them confident in expressing their views with clarity and to make them capable of taking part in debates. This will help create self esteem and confidence that are essential for engineers.

Individual students are required to choose a topic of their interest from the field of geotechnical engineering preferably from outside the M.Tech syllabus and give a seminar on that topic for about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in geotechnical engineering) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his/her seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Internal continuous assessment: 100 marks
Objective: To train students in laboratory and field-testing methods to determine index, engineering and chemical properties of soils.

LIST OF EXPERIMENTS

1) Atterberg’s Limits
2) Consolidation test – Compression Index.
3) Swell Test
4) Direct Shear Test
5) Vane Shear Test
6) Triaxial Test
7) Tests on Geosynthetic Materials-Tensile Test, Interface Friction
8) UCC Test on Rock
9) Field Density – Rubber Balloon, Wax Coating.
10) Relative Density Test.
11) Block Vibration Test.
12) Study of Standard Penetration Test.
13) Study of Sampling Devices.
14) Study of Plate Load Test.
15) Total Soluble Solids, Calcium Carbonate Test.
16) Total Sulphate Content, Organic Content Test.
17) pH, Cation Exchange Capacity, Conductivity.

Internal continuous assessment: 100 marks
Objective: To familiarize students with different types of foundations, analysis and geotechnical design of shallow foundations, pile foundations, caissons and well foundations. Also to acquaint students with foundations provided in various soil conditions, flexible analysis and soil-structure interaction models.

MODULE I

Foundation classification; Selection of foundations; Geotechnical design parameters- Bearing capacity – Methods by Terzaghi, Meyerhoff, Hansen and IS Code, settlement, Proportioning of Foundations for equal settlement, loads for design, depth of foundation, concepts of net and gross loads. Analysis of shallow foundations in clay and sand - individual and combined footings, and rafts - floating and partially compensated.

MODULE II

Classification of pile foundations – Selection of pile foundations - friction piles, end bearing piles, laterally loaded piles, Load carrying capacity of individual piles - static formula, IS Method, dynamic formula, Pile load test – pull out test, lateral load test, initial load test, routine load test and cyclic load test, negative skin friction, pile groups, Settlement analysis of individual and group of piles. Piers in clay and sand.

MODULE III

Caissons and well foundations – design aspects of caissons, open caissons, pneumatic caissons, floating caissons, well foundations, monoliths, design and construction aspects of well foundations. Foundations on expansive soils, analysis of under reamed piles. Precautions to be taken while constructing foundations on laterites, fills and rock.

MODULE IV
Soil structure interaction and ‘flexible’ approach to the design of foundations, Contact Pressure – from theory of Elasticity and Sub grade reaction, Experimental Determination of Sub grade Modulus. Introduction to Soil-structure interaction models - Winkler, Pasternak, Hetenyi and Filonenko-Borodich.

**References:**


**Internal continuous assessment: 100 marks**

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students right at the beginning of the semester by the teacher.
End semester Examination: 100 marks

Question Pattern

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Objective: *To expertise students in structural design of shallow foundations, piles, well foundations, and retaining walls with the theoretical knowledge in limit state design and steel design of sheet pile walls*

**MODULE I**

Introduction to Limit State Design of reinforced concrete in foundations; Soil pressure for structural design, Conventional structural design of continuous footings, individual footings – rectangular and circular, combined footings – rectangular, trapezoidal and strap.

**MODULE II**

Raft Foundations – Structural Design of rectangular and circular rafts and mats using conventional method of analysis, Analysis and design of rafts and mats incorporating soil structure interaction using any FEM software.

**MODULE III**

Structural design of piles including pile caps, under-reamed piles, Structural Design of pier, Well Foundation – Types, Structural Design of Well Foundations.

**MODULE IV**

Structural design of retaining walls-Reinforced Concrete Cantilever retaining wall, Counterfort retaining wall, Flexible retaining Structures –Sheet Pile Wall, Anchored Bulk Heads.

**References:**


**Internal continuous assessment: 100 marks**

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students right at the beginning of the semester by the teacher.

**End semester Examination: 100 marks**

**Question Pattern**

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Objective: To enhance Students’ knowledge in dynamic loading, theory of vibrations, dynamic soil properties, dynamic earth pressure, dynamic bearing capacity, vibration isolation, liquefaction of soils and to train the students in machine foundation design.

MODULE I

Introduction: Comparison of Soil mechanics and Soil Dynamics, Nature of Dynamic loads, Stress conditions on soil element under earthquake loading, seismic force for pseudo static analysis as per IS Code


MODULE II


MODULE III


MODULE IV


References:


Internal continuous assessment: 100 marks

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End semester Examination: 100 marks

Question Pattern

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Objective: To gain thorough knowledge about subgrade soil properties on pavement performance, effect of water in soils, functions and design of subsoil drainage system, various tests for strength evaluation of subgrade soils.

MODULE I


MODULE II

Effect of water in soils - swelling/shrinkage, Soil Moisture movement - ground water, Gravitational water, held water and its classification, water held by capillarity and surface tension, soil suction, factors governing soil suction, Stress in Soils, Cohesion and plasticity in soil, Theories of elastic and plastic behaviour of soils.

MODULE III

Drainage - General principles, Functions and design of subsoil drainage system. Frost action in soil - Frost susceptible soils, Air and soil temperature, Heat flow through soils. Depth of frost penetration, Effects of particle size, water table and pavement thickness on frost heave, loss of strength during frost melting.

MODULE IV

Strength Evaluation of subgrade soils, Laboratory tests - Direct shear test, UCC test, CBR test, Triaxial test, Field tests-Co-efficient of subgrade reaction, Field CBR, North Dakota Cone test. Compaction of Soils - Field and Laboratory methods and equipment – Field Compaction control.

References:


**Internal continuous assessment: 100 marks**

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be a minimum of two tests per subject. The assessment details are to be announced to students right at the beginning of the semester by the teacher.

**End semester Examination: 100 marks**

**Question Pattern**

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Objective: To provide a comprehensive treatise on foundations for various structures like water tanks, chimneys, towers, industrial structures, ground storage tanks etc., impart knowledge in modern instrumentation methods and also thermal, electromagnetic identification techniques of soil.

MODULE I

Foundations for water tanks, silos, Chimneys, Cooling towers, Telecommunication towers, Transmission line towers, Guyed structures, Screw piles and other special foundations.

MODULE II

Foundations for industrial structures, Ground storage tanks, underground power houses, and offshore structures. Foundations in high and low temperature conditions.

MODULE III

Instrumentation in soil engineering, strain gauges- resistance and inductance type, Instrumentation for load measurements, pore water pressure measurements, earth pressure measurements.

MODULE IV


References:


**Internal continuous assessment: 100 marks**

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students right at the beginning of the semester by the teacher.

**End semester Examination: 100 marks**

**Question Pattern**

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Objective: To make the knowledge base of the student in Hydrology stronger and broader so that they can handle the design and analysis of the environmental systems with confidence.

MODULE I

Introduction: Definition of groundwater, role of groundwater in a hydrological cycle, Groundwater bearing formations, Classification of aquifers, Rock properties affecting ground water vertical distribution- porosity, permeability, hydraulic conductivity, transmissivity, Specific retention, Specific yield and storage coefficient, Water-yielding Properties, Stratiography, Darcy's law, Integral transforms and mathematical functions - Laplace equation, potential flow lines, flow net, Anisotropy and heterogeneity, Groundwater exploration techniques

MODULE II

Groundwater and well hydraulics: steady unidirectional flow, steady radial flow in to a well in confined and unconfined aquifers, steady flow with uniform discharge, Effect of boundaries, Unsteady radial flow in to a well in confined and unconfined aquifer-Dupuit-Forchheimer assumptions, pumping test analysis -non equilibrium equation for pumping tests, Thies method of solution, Cooper Jacob method, Chow’s methods of solution, Wells : Different types of wells, Construction of wells, Characteristics of well losses.

MODULE III


MODULE IV


References:


**Internal continuous assessment: 100 marks**

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**End semester Examination: 100 marks**

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CEG10 205: ELECTIVE III

CEG10 205A ENVIRONMENTAL GEOTECHNICAL ENGINEERING

Credits: 4

Hours per week: Lecture-3 and Tutorial-1

Objective: To make the students aware about Environmental Geotechnics, landfill engineering, and contaminant transport.

MODULE I

Introduction to Environmental Geotechniques-Environmental cycles and their interaction-Soil water environment interaction relating to geotechnical problems-Effect of pollution on soil water behaviour- Sources, production and classification of wastes, chemical reactions in subsurface.

MODULE II

Fly ash characterisation process and utilisation, Landfill engineering - Criteria for selection of sites for waste disposal facilities-parameters controlling the selection of wastes disposal sites - current practices for waste disposal, Liners – types and design - Passive containment systems-Leachate contamination - applications of geomembrane, Land fill gases and their properties, Landfill Gas monitoring systems.

MODULE III

Contaminant Transport phenomena in saturated and partially saturated porous media, contaminant migration and contaminant hydrology, Contaminant site remediation Bearing capacity of compacted fills - foundation for waste fill ground, Case studies of foundation failures by ground contamination.

MODULE IV


References:


**Internal continuous assessment: 100 marks**

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students right at the beginning of the semester by the teacher.

**End semester Examination: 100 marks**

**Question Pattern**

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Objective: To introduce the concepts of geosynthetics and reinforced soil, design and construction of Geotextiles and application of geosynthetics in pavements and environmental control.

MODULE I

Introduction to Geosynthetics - Types – Geotextiles - polymer type geotextiles - woven and non-woven geotextiles, geogrids, geonets, geo membranes and geocomposites, functions and mechanisms in reinforcement, filtration, drainage, liquid barrier, multiple functions - Materials and manufacturing processes - Mechanical, endurance, hydraulic and degradation properties - Testing and evaluation.

MODULE II

Principles of soil reinforcement - load transfer mechanism and strength development - Design and construction of geosynthetic reinforced soil retaining structures - walls and slopes, Codal provisions, Soil Bearing capacity improvement using reinforcing elements.
Gabions - Design and construction of gabions walls - gabion faced reinforced soil retaining structures.

MODULE III

Geosynthetics in pavements- Advantages and disadvantages of placing geosynthetics in surfacing, base, sub base and sub grade layers, Embankments on soft soils, Geosynthetics in roads and railways, separators, drainage and filtering in road pavements, railway tracks, overlay design and constructions, trench drains

MODULE IV

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, control and construction techniques.

References:


**Internal continuous assessment: 100 marks**

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students right at the beginning of the semester by the teacher.

**End semester Examination: 100 marks**

**Question Pattern**

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Objective: To provide students with an understanding of landslide phenomenon, analysis of slope stability, embankments and to familiarise them with practical aspects of failures through case studies.

MODULE I

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.

MODULE II

Pore pressure coefficients, Mass analysis, Limit Equilibrium method, Wedge methods, friction circle method; Method of slices, IS Method, Bishop’s method, Jambu’s method.

MODULE III


MODULE IV

Site Investigation of slopes, Reconnaissance, Preliminary and detailed investigation, Investigation for foundations; Advances in stability analysis of slopes, Case studies Failure and damages, Nature and importance of failures in embankment and foundation - Piping, Differential settlement, Foundation slides, Earthquake damage, creep and anisotropic effects, Reservoir wave action, Dispersive piping.

References:


**Internal continuous assessment: 100 marks**

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students right at the beginning of the semester by the teacher.

**End semester Examination: 100 marks**

**Question Pattern**

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CEG10 206 (P): SEMINAR

Credits: 2

Hours per week 2

Objective: To train the students to address to a group of people and to present technical topics in a well organised manner to the audience. It is also intended for improvement of communication skills of students, to make them confident in expressing their views with clarity and to make them capable of taking part in debates. This will help create self esteem and confidence that are essential for engineers.

Individual students are required to choose a topic of their interest from the field of geotechnical engineering, preferably from outside the M.Tech syllabus and give a seminar on that topic for about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in geotechnical engineering) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his/her seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Internal continuous assessment: 100 marks
Objective: To train students in the modeling and analysis of various geotechnical problems using softwares currently being used in the industry. Students will also become familiar with the approach for linear, non-linear finite element analysis and contact modelling of soil-structure interaction analysis using the programs GEO5, Plaxis and academic FEA bundles of MSC Software Corporation.

LIST OF EXPERIMENTS

1) Analysis of beams on Winkler medium.
2) Analysis of beams on elastic foundation.
3) Analysis of footings on elastic and elasto-plastic mediums.
4) Analysis of rafts on elastic and elasto-plastic mediums.
5) Analysis of piles on elastic and elasto-plastic mediums.
6) Seepage analysis of embankments / dams.
7) Stability analysis of slopes.
8) Analysis of piles using contact modeling.
9) Analysis of retaining structures using contact modeling.
10) Analysis of reinforced earth structures.
Objective: To introduce the concepts of project reconnaissance, forensic geotechnical and foundation engineering.

MODULE I

Project reconnaissance and characterization of the distress, including document search such as plans, codes, and other technical specifications followed in the original design.
Diagnostic tests – Analysis of field data – selection of laboratory tests based on actual field parameters to evaluate the behaviour of soil/ground.

MODULE II

Scope and extent of application of Forensic Engineering techniques in geotechnical and foundation failure investigations, settlement of structures, expansive soils, lateral movement, other geotechnical and foundation problems, groundwater and moisture problems.

MODULE III

Back analysis: Selection of theoretical model - methods of analysis, Instrumentation and Monitoring
Development of the most probable failure hypothesis - cross-check with original design.

MODULE IV

Performing reliability checks, Legal issues involving jurisprudence system, insurance, repairs, reducing potential liability, responsibility of geotechnical engineers and contractors.

References:


5. Engineering, Ground Improvement and Geosynthetics for Human Security and Environmental Preservation, Asian Institute of Technology (AIT), Bangkok, Thailand, 6-7 December 2007.


**Internal continuous assessment: 100 marks**

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**End semester Examination: 100 marks**

**Question pattern**

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Objective: To familiarize the students with principles of exploration, geophysical methods, modern methods of drilling, sampling, offshore investigation and instrumentation.

MODULE I

Principles of exploration - geophysical methods – electrical method, seismic method, and sounding methods. Field tests - penetration tests, procedures and methods, data interpretation, field vane shear, In-situ shear and bore hole shear test, pressure meter test, utility, correction and data interpretation, plate load test–monotonic and cyclic; field permeability test.

MODULE II

Modern methods of boring and drilling, exploration techniques, non-displacement and displacement methods, drilling in difficult subsoil conditions, stabilization of boreholes, bore logs.

MODULE III

Soil Sampling - disturbed and undisturbed soil sampling, advanced sampling techniques, offshore sampling, types of samplers, design criteria for samplers, preservation and handling of samples.

MODULE IV


References:


8. Roy E. Hunt “Geotechnical Engineering Investigation handbook” CRC Press


**Internal continuous assessment: 100 marks**

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students right at the beginning of the semester by the teacher.

**End semester Examination: 100 marks**

**Question Pattern**

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Objective: To make the students understand systems and models, validation of simulation and probability distributions.

MODULE I


MODULE II


MODULE III

Validation Simulation: Random variables: Basic concepts, Probability density and distribution functions, Expectation and standard deviation of discrete and continuous random variables and their functions, Covariance and correlation.

MODULE IV

Commonly used theoretical Probability distributions (uniform, normal, binomial, Poisson's and negative exponential), Fitting distributions to raw data, Kolmogrov-Smirnov's tests of the goodness of fit, central limit theorem, various algorithms for generation of Random numbers. Queueing theory: Elements, Deterministic queues, Applications Monte Carlo simulation: Basic concepts, Generation of synthetic observations. Statistical interpretation of the output, Evaluation of definite integrals, Role in Civil Engineering, Examples.
Lab Work - Each student/a group of students shall conduct computer aided modelling and simulation studies on a civil engineering system of his/their interest.

References:


Internal continuous assessment: 100 marks

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End semester Examination: 100 marks

Question Pattern

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Objective: To enable the students understand the basics of earthquake seismology and related aspects, ground response analysis, liquefaction and seismic slope stability analysis.

MODULE I

Earthquake seismology - Causes of earthquake, Continual drift and plate tectonics, Earthquake fault sources, Seismic waves, Elastic rebound theory, Quantification of earthquake, Intensity and magnitudes, Earthquake source models.

Earthquake ground motion - Seismograph, Characteristics of ground motion, Effect of local site conditions on ground motions, Design earthquake, Design spectra, Development of site specification and code based design.

MODULE II

Ground response analysis - One dimensional ground response analysis, Linear approaches, Equivalent linear approximation of non-linear approaches. Use of any software for analysis of structures under earthquake loading.

MODULE III

Liquefaction and lateral spreading - Liquefaction related phenomena, liquefaction susceptibility - historical, geological, compositional and state criteria. Evaluation of liquefaction by cyclic stress and cyclic strain approaches, lateral deformation and spreading, criteria for mapping liquefaction hazard zones. Seismic design of foundations - Seismic design requirements for foundation, Seismic bearing capacity, Seismic settlement, Design loads.

MODULE IV

Seismic slope stability analysis - Internal stability and weakening instability, seismic design of retaining walls - design consideration, dynamic response of retaining walls, seismic displacement of retaining walls.

References:

5. Seco E Pinto, “Seismic behaviour of ground and Geotechnical structures”, A.A.Balkener, Rotterdam

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question Pattern

Two questions of 20 mark each from each module and Answer any 5 questions by choosing at least one question from each module.

<table>
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<tr>
<th>Module 1</th>
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Objective: To provide knowledge in basic geometrical aspects in shell foundations, geotechnical design, membrane and bending analysis, ultimate strength analysis, structural design and construction of shell foundation and make aware about the latest trends in this area.

MODULE I

Shells in Foundations: -Geometrical Aspects—shell as a structural form, structural efficiency of shells, Classification of shells, shells in structural foundations, Different types of shells used in foundations, Use of shell foundations

Geotechnical Design of Shell Foundations and Soil-Structure Interaction—Introduction, the two phases of foundation design, geotechnical design of shell foundations, Geotechnical design of a hypar shell footing in clay and sand, soil structure interaction models, contact pressures under shell foundations.

MODULE II

Membrane Analysis of Foundation Shells-Introduction, General system of loads on foundations, Real and pseudo stress resultants, membrane stresses in foundation shells- hyperbolic paraboloid, Introduction to conical shells, Elliptic paraboloidal shell.

Bending Analysis of Foundation Shells-Introduction, Approximate solution (Vreendenburgh’s analysis), Rigorous solutions, Numerical solutions, bending analysis of hyperbolic paraboloidal umbrella footing, Gioncu’s analysis, Experimental investigations, Finite element technique.

MODULE III

Ultimate Strength Analysis of Foundation Shells – Introduction, Ultimate strength of hyperbolic paraboloidal Individual footings, Failure hypothesis, Derivation of an expression for the ultimate strength of a square hypar footing based on ‘diagonal failure mechanism’, Limitations, Simplified expression for the internal work by the shell, Influence of contact pressure distribution on ultimate strength, Derivation of an expression for the ultimate strength of the hypar footing for “ridge failure”, Test results, Model Tests.

MODULE IV

Structural design of shell foundation – Introduction, limit state design of shell foundations, design of hyperbolic paraboloidal shell foundations, critical sections,
structural efficiency of shells in foundations, comparative cost analysis of shell foundations.

Construction of Shell Foundations – Introduction, In-situ construction, Precast construction, Installation, Remote compaction of the core soil below the precast shell footings, Industrial production, Case histories, other uses of shells in substructure


References:


Internal continuous assessment: 100 marks

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End semester Examination: 100 marks

Question Pattern

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Objective: To provide a comprehensive treatise on Remote Sensing and the Geographic Information System.

MODULE I

Remote sensing - Fundamentals: Definition - Scope - types and chronological development – ideal and real remote sensing system. Comparison of conventional survey, aerial remote sensing and satellite remote sensing - advantages and limitation of satellite remote sensing.


MODULE II

Remote Sensors: Electro-optical sensor systems - LANSAT, SPOT, IRS and IKONS sensors - scanning and orbiting mechanisms - resolution: spatial, spectral, radiometric and temporal resolution of the satellites. Multi concepts in remote sensing Other resources satellite programs of the world - need for geostationary satellite programs - sensor characteristics - meteorological, ocean monitoring and telecommunication satellites.

MODULE III

GIS and spatial data: Definition - maps and spatial information - components of GIS - people and GIS, Geographic data presentation - maps – mapping process – coordinate systems – transformations – map projections – geo referencing - data acquisition, spatial and attributes data modeling and management - spatial entities Geographic Data Representation, Storage, Quality and Standards: Storage - Digital representation of data, Data structures and database management systems – Raster data representation – Vector data representation – Concepts and definitions of data quality – Components of data quality – Assessment of data quality

MODULE IV

Spatial autocorrelation – Quadrant counts and nearest neighbour analysis – Network analysis – Surface modeling – DTM.

GIS Applications: (in one of the following areas using any GIS Software)

Applications of GIS in Environment monitoring, Land information, Geotechnical engineering

References:


Internal continuous assessment: 100 marks

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End semester Examination: 100 marks

Question pattern

Two questions of 20 mark each from each module and Answer any 5 questions by choosing at least one question from each module.

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CEG10 303 (P): INDUSTRIAL TRAINING

Credits: 1

Hours per week -30 (during the period of training)

The students have to undergo an industrial training of minimum two weeks in an industry during the break after semester II and the training shall be completed within 15 calendar days from the start of semester III. The students shall submit a report of the training undergone and present the contents of the report before the evaluation committee for the End Semester Examination. Evaluation committee will award the marks for the End Semester Examination in industrial training based on training quality, contents of the report and presentation.

End semester examination: Marks 50
Objective: To improve the professional competency and research aptitude by touching the areas which are not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

The project work can be a design project/experimental project and or computer simulation project on any of the topics in GEOTECHNICAL ENGINEERING or related topics. The project work is allotted individually on different topics. As far as possible the students shall be encouraged to do their project work in the parent institute itself. If found essential, they may be permitted to do their project outside the parent institute subject to the conditions in clause 10 of M.Tech regulations. Department will constitute an Evaluation Committee to review the project work. The student is required to undertake the Master Research Project (Phase 1) during the third semester and the same is continued in the 4th semester (Phase 2). Phase 1 consists of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review assesses the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members.

Internal Continuous Assessment:

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<tr>
<td>Second review</td>
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Total: 300 marks
SEMESTER IV

CEG10 401 (P): MASTERS RESEARCH PROJECT PHASE 2

Credits: 12

Hours per week: 30

Objective: To improve the professional competency and research aptitude by touching the areas which are not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Master Research Project Phase 2 is a continuation of project phase 1 started in the third semester. Towards the end of the semester there would be a pre submission presentation before the evaluation committee to assess the quality and quantum of the work done. This would be a pre qualifying exercise for the students for getting approval by the departmental committee for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conference. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external.

Internal Continuous Assessment:

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End Semester Examination:

Project Evaluation by external examiner: 150 marks

Viva Voce by external / internal examiner: 150 marks (75 each)

Total: 600 marks