SCHEME AND SYLLABUS
OF
M.Tech Programme in
Civil Engineering
( 2013 Scheme )

with specialisation in
GEOTECHNICAL ENGINEERING

University of Kerala
Thiruvananthapuram
M.Tech PROGRAMME - CIVIL ENGINEERING – GEOTECHNICAL ENGINEERING
CURRICULUM AND SCHEME OF EXAMINATIONS
### SEMESTER I

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Name of Subject</th>
<th>Credits</th>
<th>Hrs / week</th>
<th>End Sem Exam hours</th>
<th>Marks</th>
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Marks

| CGC 2001 | Soil Dynamics and Machine Foundations    | 3 | 3 | 3 | 40 | 60 | 100 | |
| CGC 2002 | Special Foundations and Design of Foundations | 3 | 3 | 3 | 40 | 60 | 100 | Do |
| *       | Stream Elective I                        | 3 | 3 | 3 | 40 | 60 | 100 | Do |
| *       | Stream Elective II                       | 3 | 3 | 3 | 40 | 60 | 100 | Do |
| *       | Department Elective                      | 3 | 3 | 3 | 40 | 60 | 100 | Do |

Remarks

<p>| CGC 2001 | Soil Dynamics and Machine Foundations    | 3 | 3 | 3 | 40 | 60 | 100 | Of the 40 marks of internal assessment 25 marks for test and 15 marks for assignment. End sem exam is conducted by the University |
| CGC 2002 | Special Foundations and Design of Foundations | 3 | 3 | 3 | 40 | 60 | 100 | Do |
| *       | Stream Elective I                        | 3 | 3 | 3 | 40 | 60 | 100 | Do |
| *       | Stream Elective II                       | 3 | 3 | 3 | 40 | 60 | 100 | Do |
| *       | Department Elective                      | 3 | 3 | 3 | 40 | 60 | 100 | Do |</p>
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*Students can select a subject from the subject listed under stream/department electives as advised by the course coordinator.

**Stream electives - SE I**
CGE2001-Finite Element Analysis in Geotechnical Engineering
CGE2002-Rock Mechanics and Tunnel Engineering
CGE2003-Earth Dam Engineering

**Stream electives – SE II**
CGE2004-Ground Modification Techniques
CGE2005-Pavement Engineering
CGE2006-Earthquake Geotechnical Engineering
<table>
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<th>Code No.</th>
<th>Name of Subject</th>
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<th>Hrs/week</th>
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*Students can select a subject from the subjects listed under stream electives as advised by the course coordinator.  
**Students can select a subject from the subjects listed under interdisciplinary electives as advised by the course coordinator.

**Stream electives- SE III**
- CGE3001-Applied Numerical Methods and Optimisation
- CGE 3002-Environmental Geotechnique
- CGE3003-Soil Structure Interaction

**Stream electives- SE IV**
- CGE3004- Reinforced Soil and Geosynthetics
- CGE3005-Critical State Soil Mechanics
- CGE3006-Behaviour and Testing of Unsaturated Soils
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List of Department Electives

1. CSD 2001 Design of Bridges
2. CHD 2001 Project Planning in Water Resources
3. CRD 2001 Geoinformatics in Civil Engineering
   (Students of Geoinformatics specialization are not allowed to choose CRD 2001 subject as the contents are dealt with in detail in the core papers)
4. CGD2001-Geoenvironment and landfill
6. CTD 2002 Regional Transportation Planning
7. CED 2001 Ecological Engineering
8. CED 2002 Air Pollution Control and Monitoring
9. CED 2003 Environmental Impact Assessment and Risk Analysis

List of Interdisciplinary Electives

1. CSI 3001 Finite Element Analysis
2. CSI 3002 Mechanics Of Composites
3. CHI 3001 Fuzzy Sets And Systems In Engineering
4. CRI 3001 Geoinformatics For Infrastructure Development
5. CGI 3001 Geotechnical Engineering For Infrastructure Projects
6. CTI 3001 Fundamentals Of Reliability Engineering
7. CEI 3001 philosophy Of Technology
8. CEI 3002 Environmental Management
9. CEI 3003 Environment And Pollution
CMA 1001    Applied Mathematics

Structure of the Course
Lecture : 3hrs/week    Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives
• To understand the concepts of Calculus and probability
• To make the students familiar with the concepts of special functions

Learning Outcomes
• Students can solve their engineering problems using various probability techniques and differential calculus
• Students can apply integral transforms in various engineering problems

Module I
Special functions: Beta and Gamma functions, relation between Beta and Gamma functions, Bessel function, Recurrence formulae, Generating function and orthogonality of Bessel function.

Module II
Calculus of variation: Formation and solution of Euler’s equation, Isoperimetric problems, Problems with several dependent variables. Functions involving higher order derivatives.
Integral equations: Conversion of a linear differential equation to an integral equation and vice versa. Solution of integral equations by (i) Laplace transforms method (ii) Successive approximation method.

Module III

References

Structure of the Question Paper
For the End Semester Exam, there will be three questions from each module out of which two questions are to be answered by the students.
CGC 1001  
Fundamentals of Soil Behaviour

Structure of the Course

Lecture : 3 hrs/ Week  
Credits : 3  
Internal Continuous Assessment : 40 Marks  
End Semester Examination : 60 Marks

Course Objectives

• Detailed knowledge of the clay minerals.  
• Detailed knowledge of the strength and deformation behaviour of soil  
• Information on advancements in the above areas.

Learning Outcomes

• Ability to understand clay minerals and their identification.  
• Understand the strength and deformation aspects of soil.  
• Understand the more recent developments in the understanding of soil behaviour.

Module I


Module II


Module III


References


Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions from each module are to be answered by the students.
CGC 1002                    Theoretical Geomechanics

Structure of the Course
 Lecture : 3 hrs/ Week       Credits : 3
 Internal Continuous Assessment : 40 Marks
 End Semester Examination    : 60 Marks

Course Objectives
• To know the necessary mathematical concepts and terminology to define geotechnical problems
• To grasp the essence of modelling in geotechnical research and design
• To equip students with the skills entailed in the application of the principles Geomechanics to
  the solution of commonly encountered problems in geotechnical engineering

Learning Outcomes
• At the end of the course, the student will be able to
  the solution of a variety of geotechnical engineering problems.

Module I
Soil deformation under applied stress. Concept of stress and strain, Equilibrium equation of
compatibility. Stress-strain relations, principal stresses and strains. Octahedral stresses and strains.
Special matrices- spherical stresses and strains – Deviator stresses and strains, plane stress and plain
strain, Mohrs diagram.

Module II
Rheological properties of material- Rheological equation of state, models – Winkler, shear
models, Rheological models, stress-deformation behaviour of soil subject to loading, solution of
problems of linearly elastic solids, Deformation of Rheological constants – pore pressure developed
in soil by applied stresses. Stresses and displacement in soil, Basic solutions of Boussinesq and
Westerguaard line force (two dimensional cases). Distributed Line Loads (two dimensional),
Concentrated force (three dimensional), Distributed loads at the surface of semi-infinite mass (three
dimensional).

Module III
Stress conditions at failure, Tresca, Von Misess, Mohr – coulomb failure conditions. Failure
loci in deviatoric plane and principal stress space, Influence of intermediate principal stress on
failure. Testing of strength of soil - Direct shear, triaxial and hollow cylinder tests, Strength of
saturated clays, Hvorselev’s parameters, Strength of granular soils.

References

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each
module out of which two questions are to be answered by the students.
CGC 1003 Earth Pressure and Retaining Structures

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

• Should impart in-depth knowledge about the mechanism of development of earth pressure.
• Should impart knowledge about the analysis and design of earth retaining structures.
• Should help the students to take proper engineering decisions in practical situations.

Learning Outcomes

• Capability to analyse and design retaining structures.
• Capability to select the right retaining system for the right situation.
• Capability to design excavations.

Module I
Stress conditions in a soil mass- Earth pressure theories- Methods of evaluation of earth pressure on retaining walls- Effect of point loads surcharge. Use of charts for earth pressure calculation- Retaining walls under dynamic loading conditions.

Module II
Retaining structures- Types- Analysis of cantilevered and anchored sheet pile walls in granular & cohesive soils- Fixed and free earth support method. Types and design requirements of different anchorages- Deadman and Tie-back anchors.

Module III

References

2. Braja M Das- Principles of Foundation Engineering, Global Engineering, USA.

Structure of the Question paper
For the End Semester Examination, there will be three questions from each module out of which two questions are to be answered by the students.
Geotechnical Investigation for Infrastructure Projects

Structure of the Course
   Lecture : 3 hrs/ Week    Credits : 3
   Internal Continuous Assessment : 40 Marks
   End Semester Examination    : 60 Marks

Course Objectives

• Should impart in-depth knowledge about the various methods of geotechnical investigation and the field tests to be conducted in different situations.
• Should give the students a clear idea about how a geotechnical investigation programme is to be planned and executed.
• Should help the students to take proper engineering decisions in practical situations.

Learning Outcomes

• The students understand the procedure, applicability and limitations of various methods of geotechnical investigation as well as the field tests to be conducted.
• The students get confidence in effectively managing and executing geotechnical investigation programmes.
• Ability of the students in making proper engineering judgements and in taking appropriate decisions related to geotechnical investigations is greatly improved.

Module I

Module II
   Sampling – Disturbed and undisturbed soil sampling – representative samples - Methods to minimise sample disturbance –importance of area ratio, inside clearance, outside clearance, recovery ratio, ball check valve - Types of samplers – split spoon sampler, piston sampler, thin walled sampler etc. – Preservation and handling of samples – Piston extruder. Field Tests – Standard Penetration Test – Precautions for obtaining reliable results – Corrections, interpretation of results and correlations

Module III
   Dynamic and static cone penetration tests – procedure and correlations - Pressure meter test – Field vane shear test - Plate load test – Pile load tests – Static and Cyclic loading – lateral load test – Field permeability test - Determination of pore pressure and Observations of Ground Water Table - Piezometer –Determination of vertical and horizontal displacements - Settlement gauge and Inclinometer.

References

Structure of the Question paper
For the End Semester Examination, there will be three questions from each module out of which two questions are to be answered by the students.
CGC 1005  Advanced Foundation Engineering

Structure of the Course

Lecture : 3 hrs/ Week  Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

• To determine the bearing capacity of soil and the probable settlement and also to select the type of depth of foundation for a project.
• To import empirical knowledge of soil behaviour required by the geotechnical engineer for the design of foundation and other soil related structures.

Learning Outcomes

• A comprehensive and well defined knowledge on bearing capacity theories is expected. Also an exposure on grey areas like the design of laterally loaded piles and sheet piles will be obtained.
• Students are trained how to design the foundations of a particular project depending upon the properties of soil and type of projects.
• The students become competent enough to give general guidelines to the society and the problems or challenge related to geotechnical engineering.

Module I

Shallow foundations- Soil Design of foundations-Loads for design-Methods of estimating bearing capacity- Terzaghi’s, Meyerhof’s, Hansen’s, Vesic’s and I.S code equations-Comparison of various methods for estimation of bearing capacity – Effect of water table, eccentricity, and inclination of loading on Bearing Capacity – Footings on layered soils - Correlation of bearing capacity from penetration test data.

Module II


Module III


References :

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions from each module are to be answered by the students.
Structure of the Course

Practical: 2 hrs/ week    Credits : 1
Internal Continuous Assessment : 100 Marks

Course Objectives

• To make the students aware of laboratory soil testing.

Learning Outcomes

• Practice on soil testing and analysis

Atterberg’s Limits, Sieve Analysis, Hydrometer Analysis, Wet Sieve Analysis, Permeability test, Compaction Test, C.B.R test, Consolidation test, Different types of shear tests, Triaxial tests with pore pressure measurements with GDS, swell test, Volumetric shrinkage, Relative Density Test.
CGC 1102  Seminar

Structure of the Course

Practical: 2 hrs/ Week               Credits : 1
Internal Continuous Assessment: 100 Marks

Course Objectives

The student has to present a seminar in one of the current topics in the stream of specialization. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject, present the seminar and submit seminar report at the end of the semester.
CGC2001 Soil Dynamics and Machine Foundations

Structure of the Course

Lecture: 3 hrs/ Week  Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination: 60 Marks

Course Objectives

- Understanding the fundamental concepts of theory of vibration
- Measurement of dynamic soil properties
- Understanding methods of analysis of machine foundations
- Design of Machine foundations
- Understanding the nature of wave propagation through soil
- Vibration isolation techniques

Learning Outcomes

- At the end of the course, the student will be able to assess the dynamic properties of soil and various design parameters required for the design of machine foundation as well as design of foundation for various types of machines.

Module I

Fundamentals of theory of vibrations-simple harmonic motion, Response of SDOF system-Vibration analysis procedure- Free and forced vibration with and without damping. Formulation of mathematical model of different vibration modes- Parameters for mathematical models-Transmissibility- Experimental and field determination of strength and deformation characteristics of soils under dynamic loads.

Module II

Types of machine foundations- Special considerations for design of machine foundation-Vibration analysis of block foundation for different modes of vibration. Method of analysis of machine foundations- Linear elastic weightless spring and elastic half space theory approach. Design criteria of machine foundation as per IS codes. Design of Block Foundation for reciprocating engine and low speed machines.

Module III


References


Structure of the Question paper

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
CGC 2002

Special Foundations and Design of Foundations

Structure of the Course

Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

• Should familiarise the students with the soil design and structural design of foundations and retaining walls.
• Should help the students to build a basic knowledge of the types of special foundations used in various situations.

Learning Outcomes

• The students understand the various aspects related to the soil design and structural design of foundations and retaining walls.
• The course would give confidence to the students when dealing with practical situations requiring special foundations.

Module I

Depth of footings- Bearing capacity and settlement of isolated footings - Bearing capacity and settlement of raft foundations – Soil design and structural design of isolated footings - Soil design and structural design of combined footings.

Module II

Bearing capacity of piles, Static analysis - Bearing capacity and settlement of Pile Groups - Soil design of pile group - Lateral load capacity of piles –Well foundation- Terzaghi’s analysis for determination of safe lateral load on well foundation - Bearing capacity of well foundations. 
Structural design of pile cap.

Module III

Retaining wall- stability against overturning and sliding - Stress variation at the base - Structural design of cantilever retaining wall.Introduction to foundation for special structures such as Water tanks, Silos, Chimneys, Transmission line towers, Industrial structures, Ground storage tanks, Underground structures, and Coastal and Offshore structures. Foundations on special soils such as expansive soils.

References


**Structure of the Question paper**

For the End Semester Examination, there will be two questions from each module out of which one question is to be answered by the students.
Structure of the Course
Lecture: 2 hrs/ Week          Credits: 2
Internal Continuous Assessment: 40 Marks
End Semester Examination: 60 Marks

Course Objective:
To formulate a viable research question
To distinguish probabilistic from deterministic explanations
To analyze the benefits and drawbacks of different methodologies
To understand how to prepare and execute a feasible research project

Outcome
Students are exposed to the research concepts in terms of identifying the research problem, collecting relevant data pertaining to the problem, to carry out the research and writing research papers/thesis/dissertation.

Module 1
Introduction to Research Methodology - Objectives and types of research: Motivation towards research - Research methods vs. Methodology. Type of research: Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, and Conceptual vs. Empirical.
Research Formulation - Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem. Literature review: Primary and secondary sources - reviews, treatise, monographs, patents. Web as a source: searching the web. Critical literature review - Identifying gap areas from literature review - Development of working hypothesis.

Module 2

Module 3
Reporting and thesis writing - Structure and components of scientific reports - Types of report - Technical reports and thesis - Significance - Different steps in the preparation, Layout, structure and Language of typical reports, Illustrations and tables, Bibliography, referencing and footnotes. Presentation; Oral presentation - Planning - Preparation - Practice - Making presentation - Use of audio-visual aids - Importance of effective communication.

Application of results of research outcome: Environmental impacts - Professional ethics - Ethical issues - Ethical committees. Commercialization of the work - Copy right - royalty - Intellectual property rights and patent law - Trade Related aspects of Intellectual Property Rights - Reproduction of published material - Plagiarism - Citation and acknowledgement - Reproducibility and accountability.
References:
1. C.R Kothari, Research Methodology, Sultan Chand & Sons, New Delhi, 1990
CGC 2101     Experimental Geotechniques II

Structure of the Course
Practical: 2 hrs/ Week                Credits : 1
Internal Continuous Assessment: 100 Marks

Course Objectives
• To make the students aware of laboratory soil and geosynthetic testing,

Learning Outcomes
• Practice on soil and geosynthetics testing

Plate load test- Physical properties of Geotextiles like thickness, weight, opening size-wide width tensile test and trapezoidal tear test using UTM for Geotextiles-cone drop test-CBR push through test, FEM Analysis of simple Geotechnical Problems using PLAXIS Software
Structure of the Course
Lecture: 2 hrs/ Week  
Credits: 2
Internal Continuous Assessment: 100 Marks

Course Objectives
Student is expected to start the preliminary background studies towards the thesis by conducting literature survey in the relevant field. He/she should broadly identify the area of thesis work, familiarize with the design and simulation tools required for the thesis work and plan the experimental platform, if any, required for thesis work. The student should submit a detailed report of these activities at the end of the semester.
CGC 2103  Seminar

Structure of the Course
Practical: 2 hrs/ Week  Credits : 2
Internal Continuous Assessment: 100 Marks

Course Objectives
The student has to present a seminar in one of the current topics in the stream of specialization. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject, present the seminar and submit seminar report at the end of the semester.
Structure of the Course

Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives

• The ability to judge the situations and apply the logical aspects of the method
• Should be able to apply the numerical formulation for analysing geotechnical systems
• The ability to apply the concepts for solving multi task applications

Learning Outcomes

• Understand various theories involved in finite element method
• Understand capabilities of various models used to simulate the soil media
• Understand the features of methods of analysis and apply them in real life applications

Module I

Introduction to FEM; Theoretical considerations - Equilibrium, Compatibility, Constitutive behaviour; Geometric idealisation - Plane stress, Plane strain, Axisymmetry; Simple methods of analysis: Limit equilibrium, Stress field solution, Limit analysis; Numerical analysis: Beam spring approach, Full numerical analysis.

Module II

Steps in FEM – Discretisation; Displacement models - 1D and 2D only – Formulation of stiffness matrix: truss, beam, triangular and quadrilateral elements only – Overall equilibrium equation – Numerical Integration – Storage schemes – Calculation of stresses and strains.

Module III


References


Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions from each module are to be answered by the students.
CGE 2002  
**Rock Mechanics and Tunnel Engineering**

**Structure of the Course**

- **Lecture**: 3 hrs/Week  
- **Credits**: 3  
- **Internal Continuous Assessment**: 40 Marks  
- **End Semester Examination**: 60 Marks  

**Course Objectives**

- 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 insitu strength of rocks.

**Learning Outcomes**

- Understand the behaviour & characteristics of rocks.  
- To reduce the complexity involved in numerical computations in rock mechanics

**Module I**

- Classification and index properties of rocks, Rock strength and failure criteria, initial stress in rocks, influence of joints and their orientation in distribution of stress- deformability of rocks. Laboratory and in situ tests for various physical and mechanical properties. Insitu stress, Various methods of stress measurement.

**Module II**


**Module III**

- Tunnel Engineering: Necessity, planning of tunnels, site investigation of tunnels, types, alignment and grade, size and shape of a tunnel, method of constructions, tunneling in hard rocks- full face method-heading and bench method-drift method, different methods of tunneling in soft soils. Shafts in tunnels-ventilation of tunnel, lining of tunnels- drainage and lighting in tunnels-ground treatment and problems in tunnel constructions.

**References**


**Structure of the Question paper**

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
Structure of the Course

Lecture : 3 hrs/Week               Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives

• Should impart in-depth knowledge about the stability of earth dams.
• Should impart knowledge about the analysis and design of earth dams.
• Should help the students to take proper engineering decisions in practical situations.

Learning Outcomes

• Capability to analyse and design earth dams.
• Capability to conduct seismic analysis of earth dams.
• Capability to design excavations.

Module I

Module II

Module III

References
3. Earth Manual -USBR

Structure of the Question paper
For the End Semester Examination, there will be three questions from each module out of which two questions are to be answered by the students.
CGE 2004  Ground Modification Techniques

Structure of the Course
Lecture: 3 hrs/ Week  Credits: 3
Internal Continuous Assessment: 40 Marks
End of Semester Examination: 60 Marks

Course Objectives
• To demonstrate how theoretical knowledge and observation of engineering performance assist in rational application of ground modification procedure.
• To give a thorough understanding of the various techniques used in ground improvement.

Learning Outcomes
• A study of the many different approaches to ground modification broadens the minds and inspires creativity and innovation in geotechnical construction and related fields.
• Equips to make an informed decision on which technique to be used in a particular situation.

Module I

Module II

Module III
Grouting – Types – Rheology – Applications – Electro chemical stabilization – Physical and chemical aspects of stabilization – Stabilization with cement, lime etc.

References

Structure of the Question paper
For the End Semester Examination, there will be three questions from each module out of which two questions are to be answered by the students.
CGE 2005                  Pavement Engineering

Structure of the Course
Lecture : 3 hrs/ Week          Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives
• To make the students understand the design and construction of pavements.

Learning Outcomes
• Knowledge about the design of pavements
• Knowledge about the evaluation of performance
• Knowledge about the applications of geosynthetics to pavements.

Module I
   Introduction - Pavement as layered structure - Pavement types - flexible and rigid - Stress
   and deflections in pavements under repeated loading. Introduction to pavement design. Flexible
   pavement design - Empirical - Semi empirical and theoretical Methods – Design procedure as per
   latest IRC guidelines – Design and specification of rural roads

Module II
   Rigid pavements - Cement concrete pavements - Modified Westergard approach - Design
   procedure as per latest IRC guidelines - Joints in rigid pavements - Concrete roads and their scope
   in India. Pavement Evaluation [Condition and evaluation surveys (Surface Appearance, Cracks,
   Patches And Pot Holes, Undulations, Ravelling, Roughness, Skid Resistance), Structural Evaluation
   By Deflection Measurements, Present Serviceability Index]

Module III
   Pavement maintenance. [IRC Recommendations Only]. Stabilisation with special reference
   to highway pavements - Choice of stabilisers - Testing and field control – Stabilisation for rural roads
   in India - use of Geosynthetics (geotextiles & geogrids) in roads.

References

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each
module out of which two questions are to be answered by the students.
Structure of the Course
Lecture : 3 hrs/ Week           Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination      : 60 Marks

Course Objectives
- Understanding the basic seismology concepts
- Estimation of seismic hazard
- Estimation of liquefaction potential
- Measurement of dynamic soil properties
- Understanding local site effects
- Estimation of Bearing Capacity under seismic loading
- Seismic design of retaining walls

Learning Outcomes
- The student will get an overall view of the nature of seismic hazards, the methods used to assess their impacts and the techniques available to mitigate their damaging effects.

Module I
Seismology and earthquakes (basic concepts only), Ground motion parameters, Estimation of Ground motion parameters, waves in unbounded media, waves in a layered body, Attenuation of stress waves, Seismic hazard analysis. Soil liquefaction - Susceptibility, initiation and effects of soil liquefaction, Laboratory and Field methods for estimation of liquefaction potential- CSR and CRR.

Module II
Measurement of dynamic soil properties- Seismic reflection and seismic refraction tests – Seismic cross hole, down hole/up hole tests, SPT- High strain element tests, Cyclic tri-axial test-shake table and centrifuge tests. Ground response analysis-one dimensional ground response analysis (linear approach), one dimensional ground response analysis (equivalent linear approach), local site effects.

Module III
Introduction to bearing capacity and settlement analysis under earthquake loading- Seismic design considerations, Codal provisions, Dynamic response of retaining walls- Seismic design considerations of retaining walls, Site improvement methods for mitigation of earthquake hazards

References

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
CGD 2001

Geoenvironment and Landfill

Structure of the Course

Lecture: 3 hrs/Week  Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination: 60 Marks

Course Objectives

• To make the students aware about environmental geotechnics, landfill engineering, contaminant transport and soil remediation.

Learning Outcomes

• Exposure in landfill design and soil remedies

Module I


Module II

Waste disposal facilities, Parameters controlling the selection of site for sanitary and industrial landfill. Site characterisation and ranking of sites. MOEF guidelines for waste management and handling. landfill layout and capacity, components of landfill and its functions, liner and cover systems, functional requirements of daily, intermediate and final cover system. compacted clay liner:- selection of soil, flow through liner and methodology of construction, instrumentation of cover system, leachate and gas collection facilities:- functional requirements, design, leachate disposal facilities and gas disposal/utilization. closure and post closure system, selection, testing design of geosynthetics for landfill. geosynthetics clay liner:- requirements, types and testing

Module III

Remediation of contaminated soil-insitu/exitu remediations, bio remediation, thermal remediation, pump and treat method, phytoremediation and electrokinetic remediation, control measures for waste dump- case studies on long term performance of landfills, utilisation of landfill gas, foundation failure by ground contamination, engineering properties of soil due to change in environment.

References


Structure of the Question paper

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
Structure of the Course
Practical: 14 hrs/ Week Credits : 5
Internal Continuous Assessment: 200 Marks

Course Objectives
Thesis-Preliminary Part II comprises of a preliminary thesis work, two seminars and submission of thesis-preliminary report. The first seminar would highlight the topic, objectives, and methodology and the second seminar will be a presentation of the work they have completed till the third semester and scope of the work which is to be accomplished in the fourth semester, mentioning the expected results.
Structure of the Course

Lecture: 3 hrs/ Week  
Credits: 3  
Internal Continuous Assessment: 40 Marks  
End Semester Examination: 60 Marks

Course Objectives

• Should impart sufficient knowledge about the various numerical methods and optimisation techniques.  
• Should give idea to the students on how complicated problems in engineering, which can not otherwise be solved, can be analysed using numerical techniques.

Learning Outcomes

• The students understand the procedure and applicability of different numerical methods and optimisation techniques.  
• The students acquire knowledge needed to solve complicated engineering problems using numerical methods and optimisation techniques.

Module I


Module II


Module III


References


Structure of the Question paper

For the End Semester Examination, there will be three questions from each module out of which two questions are to be answered by the students.
Structure of the Course

Lecture: 3 hrs/ Week  Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination: 60 Marks

Course Objectives

• To make the students aware about Environmental geotechnics, contaminant transport and soil remediation

Learning Outcomes

• Exposure to effect soil contamination and its remedies

Module I
Soil three phases of system soil structure, clay mineralogy, attenuation capacity clay-contaminant interaction cation exchange capacity, surface area of soil, causes of soil deterioration, procedure for mineral identification, binding forces in soil.

Module II
Contamination of soil-waste dump, transport of contaminated through soil, dielectric constant of contaminant, change in properties of soil plasticity volume change-compressibility characteristics quasi pre-consolidation and shear characteristics, effect of drying properties of soil.

Module III
Remediation of contaminated soil-Insitu/exitu remediations, bio remediation, thermal remediation, pump and treat method, phytoremediation and electrokinetic remediation, Control measures for waste dump, landfill: components and functions, case studies on contaminant transport, foundation failure by ground contamination. engineering properties of soil due to change in environment.

References

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
Structure of the Course

Lecture: 3 hrs/Week  
Credits: 3  
Internal Continuous Assessment: 40 Marks  
End Semester Examination: 60 Marks

Course Objectives

• The ability to identify the situations where the topic is relevant  
• Should be able to apply the effects of interaction between soil and foundation  
• The ability to apply the concepts for solving multi task applications

Learning Outcomes

• Understand various theories involved in soil structure interaction  
• Understand capabilities of various models used to simulate the interaction  
• Understand the features of methods of analysis and apply them in real life applications

Module I


Module II


Module III

Elastic analysis of piles: Elastic analysis of single pile, theoretical solutions for settlement and load distributions, analysis of pile group, interaction analysis, load distribution in groups with rigid cap. Laterally loaded pile: Load deflection prediction for laterally loaded piles, sub-grade reaction and elastic analysis, interaction analysis, pile raft system, solution through influence charts.

References


Structure of the Question paper

For the End Semester Examination the question paper will consist of 60% Design problems and 40% Theory. There will be three questions from each module out of which two questions are to be answered by the students.
CGE 3004  Reinforced Soil and Geosynthetics

Structure of the Course
Lecture : 3 hrs/ Week  Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

• Detailed understanding of the history and mechanism of reinforced soil
• Knowledge of the various types of geosynthetics, their functions and applications.
• Detailed knowledge about the design of few reinforced soil structures.

Learning Outcomes

• Ability to adopt reinforced soil technique against conventional techniques.
• Ability to select suitable reinforcement material and type to suit the functional requirements.
• Carry out analysis and design of reinforced soil structures.

Module I

Module II

Module III

References

Structure of the Question paper
For the End Semester Examination there will be three questions from each module out of which two questions from each module are to be answered by the students.
CGE 3005                                   Critical State Soil Mechanics

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
• The ability to identify the situations where the critical state concepts has to be applied
• Should be able to do further research into the various critical state aspects
• The ability to arrive at theoretical formulations from experimental observations

Learning Outcomes
• Understand various theories involved in critical state soil mechanics
• Understand capabilities of various models used to simulate the critical state
• Understand the formulation of the theories and to carry out enhanced research on the topic

Module I
States of stress and strain in soils stress and strain paths and Invariants, Stress paths strain paths invariants of stress-Invariants of strain-volumetric strain-stress and strain behaviour of ideal elastic soil.

Module II
Compression, One dimensional Consolidation and Shear testing Isotropic compression of clays one dimensional compression of clays one dimensional consolidation compression index and swelling index tests in triaxial apparatus and typical test results. The critical Stateline and Roscoe Surface Drained tests-Undrained tests Critical state line Drained and Undrained Planes-Roscoe surface-Shape of Roscoe surface and as state boundary surface.

Module III

References

Structure of the Question paper
For the End Semester Examination the question paper will consist of 60% Design problems and 40% Theory. There will be three questions from each module out of which two questions are to be answered by the students.
Structure of the Course

- Lecture: 3 hrs/ Week  
  - Credits: 3
- Internal Continuous Assessment: 40 Marks
- End Semester Examination: 60 Marks

Course Objectives

- To teach Geotechnical Engineers to think about the way in which the Unsaturated Soil behaves.

Learning Outcomes

- To understand the behaviour of Unsaturated soil.
- To reduce the complexity involved in numerical computations in unsaturated soil.
- Characterising the unsaturated soil.

Module I


Module II

- Effective stress concepts- Effective stress relations in unsaturated soil. Matric suction and osmotic suction-collapse and heave characteristics of unsaturated soil-strength characteristics of unsaturated soil- Flow through unsaturated soil.

Module III

- Laboratory evaluation of swell pressure and swell potential-tests to evaluate collapse potential-measurement of soil suction- Measurement of air pressure.

References

4. Problems and practice in foundation and pavement engineering.

Structure of the Question paper

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
CGC 4101 Thesis

Structure of the Course

Hours/week: 21  Credits: 12

Continuous Assessment: 300 Marks

End Semester Examination: 300 Marks

The student has to continue the Thesis work done in second and third semesters. There would be an interim presentation at the first half of the semester to evaluate the progress of the work and at the end of the semester there would be a Pre-Submission seminar before the Evaluation committee for assessing the quality and quantum of work. This would be the qualifying exercise for the students for getting approval from the Department Committee for the submission of Thesis. At least once technical paper is to be prepared for possible publication in Journals/Conferences. The final evaluation of the Thesis would be conducted by the board of examiners constituted by the University including the guide and the external examiner.

Distribution of marks

Internal evaluation of the Thesis work by the guide: 150 marks

Internal evaluation of the Thesis by the Evaluation Committee: 150 marks

Final evaluation of the Thesis Work by the Internal and External Examiners:

\[ \text{Evaluation of Thesis: 200 marks } + \text{ Viva Voce: 100 marks (} * 5\% \text{ of the marks is earmarked for publication in Journal/Conference) } \] TOTAL – 300 marks