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

Code No.	Name of Subject	Credits	Hrs / week	End Sem Exam hours	Marks			Remarks
					Internal Continuous Assessment	End Semester Exam	Total	
CMA 1001	Applied mathematics	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 1001	Fundamentals of soil behaviour	3	3	3	40	60	100	do
CGC 1002	Theoretical geomechanics	3	3	3	40	60	100	do
CGC 1003	Earth pressure and retaining structures	3	3	3	40	60	100	do
CGC 1004	Geotechnical investigations for infrastructure projects	3	3	3	40	60	100	do
CGC 1005	Advanced foundation engineering	3	3	3	40	60	100	do
CGC 1101	Experimental Geotechniques I	1	2	-	100	-	100	No End Sem Examination
CGC 1102	Seminar	2	2	-	100	-	100	do
	TOTAL	21	22					7 Hours of Departmental Assistance work

SEMESTER II

Code No.	Name of Subject	Credits	Hrs / week	End Sem Exam hours	Marks			Remarks
					Internal Continuous Assessment	End Semester Exam	Total	
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
CCC 2000	Research Methodology	2	2	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 Individual Institutions
CGC 2101	Experimental Geotechniques II	1	2	-	100		100	No End Sem Examination

CGC 2102	Thesis – Preliminary – Part I	2	2	-	100		100	Do
CGC 2103	Seminar	2	2	-	100		100	Do
	TOTAL	22	23	---				6 hours of Departmental assistance work

*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

SEMESTER III

Code No.	Name of Subject	Credits	Hrs / week	End Sem Exam hours	Marks			Remarks
					Internal Continuous Assessment	End Semester Exam	Total	
*	Stream Elective III	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 Individual Institutions
*	Stream Elective IV	3	3	3	40	60	100	Do
**	Non- Dept. (Interdisciplinary) Elective	3	3	3	40	60	100	Do
CGC 3101	Thesis – Preliminary – Part II	5	14	-	200		200	No End Sem Examinations
	TOTAL	14	23					6 hours of departmental assistance work

*Students can select a subject from the subjects listed under stream electives as advised by the course co ordinator.
**Students can select a subject from the subjects listed under interdisciplinary electives as advised by the course co ordinator.

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

SEMESTER IV

Code No	Subject Name	Credits	Hrs/week	Marks					Remarks
				Continuous Assessment		University Exam		Total	
				Guide	Evaluation Committee	Thesis Evaluation	Viva Voce		
CGC 4101	Thesis	12	21	150	150	200*	100	600	* 5 % of the evaluation mark is earmarked for Publication in journal/conference
	Total	12	21	150	150	200	100	600	8 hrs of departmental assistance work

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
5. CTD 2001 Soft Computing Tools for Engineering
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 3001philosophy 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.

Integral transforms and partial differential equations: Solutions of simultaneous linear equations with constant coefficients and ordinary differential equations with variable coefficients using Laplace transforms. Partial differential equations Elliptic, Parabolic and hyperbolic equations. Reduction to canonical form, Fourier transforms, Boundary value problems.

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

Probability distribution and testing: Probability density function, distribution function, properties. Binomial, Poisson, Normal and Exponential distributions. Mean, variance and fitting of the above distributions. Statistical inference: Sampling distribution: Interval estimation: Confidence interval for mean and variance. Test of significance of (i) Single mean (ii) Mean of two samples (iii) Propositions (iv) Variance (v) Two variances (vi) Goodness of fit (vii) Test of independence.

References

1. Gupta.S.C. and Kapoor.V.K. Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 1978.
2. Richard A. Johnson, Miller and Freunds Probability and Statistics for Engineers (6^{th} edition) Pearson.
3. Dr.B.S. Grewal, Higher Engineering Mathematics; Khanna Publishers.
4. K.Sankara Rao, Introduction to partial differential equation, Prentice Hall of India.
5. Peter V.,O'Neil, Advanced Engineering Mathematics (4^{th} edition).
6. Santi Swaroop, Integral Equations, Krishna Prakasan Media.

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

Soil minerals – coarse and fine grained soils – Bonding and inner particles forces – clay mineralogy – atomic bonds – clay water relations – clay particles in aqueous suspension – flocculation and dispersion of clay minerals – electrical effects – clay mineral identification.

Module II

Consolidation – consolidation test and interpretation – swelling – secondary consolidation and its effects - pre-consolidation pressure – consolidation by sand drains – free strain and equal strain case – effect of smear zone. Evaluation of soil settlement – settlement prediction in sand – simplified strain influence factor – Settlement of normally consolidated and over-consolidated clay – pre-compression for improving foundation.

Module III

Shear strength – stress strain relationships. Direct shear test, triaxial tests, volumetric behaviour - critical void ratio, liquefaction– effect of rate of strain on undrained shear test – Rendaulic plot – Drained and undrained strength parameters – sensitivity and thixotropy – pore water pressure due to undrained loading and isotropic stress application – Skempton's pore pressure parameters – Henkel's modification. Stress paths. Compaction – compaction tests – zero air voids curve – Field compaction equipment. Compaction control in field. Applications of compaction in field problems.

References

1. Mitchell, J.K. and Saga, K. (2005) Fundamentals of soil behaviour, John Wiley and Sons, NY.
2. Ayyar, T.S.R. (2003). Soil Engineering in Relation to Environment. L.B.S. Centre, Trivandrum.
3. Das, B.M. (2008). Advanced Soil Mechanics. Taylor and Francis, UK.
4. Lamb, T.W. and Whitman, R.V. (1979). Soil Mechanics, John Wiley and Sons, UK.
5. Terzaghi, K., Peck, R.B. and Mesri, G. (1996). Soil Mechanics in Engineering Practice. John Wiley and Sons, USA.
6. Powrie, W. (2004) Soil mechanics, Concepts and applications. Spon Press.
7. Craig, R.F. (2004)Soil Mechanics, Taylor and Francis, UK.

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 apply geomechanical techniques 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

1. Harr M. E. (1966), *Theoretical Soil Mechanics*, McGraw Hill Inc., New York.
2. Scott F. (1963), *Principles of mechanics*, Addison – Wesley London (GB)
3. Sarhi Gulhati Datta R. (2006), *Text Book of Geotechnical 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 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 requiremnts of different anchorages- Deadman and Tie-back anchors.

Module III

Lateral earth pressure on cuts and braced excavations. Stability of excavations against piping and bottom heaving - Stability of concrete retaining walls- Earth pressures against tunnels, shafts, diaphragm walls, bored pile walls, slurry walls. Principles of design of reinforced earth retaining walls.

References

1. P.Purushothama Raj- *Geotechnical Engineering*-Pearson Education, India.
2. Braja M Das- *Principles of Foundation Engineering,* Global Engineering, USA.
3. Prakash Ranjan & Saran – *Analysis &Design Of Foundation & Retaining Structures,* Oxford and IBH Publishing Co Pvt. Ltd, New Delhi.
4. Nainan P Kurian – Design of Foundation system- Principles and Practise, Alpha Science International, New York.
5. Frank Harris (1983) – *Ground Engineering equipments and methods*-McGraw Hill book company Ltd., New York.
6. Jones- *Earth Reinforcement & Soil Structures,* T. Telford, New York.

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 1004 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

Introduction – Necessity and importance of Geotechnical Investigation - Soil formation - Processes – Characteristics of major soil deposits of India - Sink holes, artesian condition – Planning an investigation programme – factors to be considered – Exploration for preliminary and detailed design. Guidelines for location, depth and spacing of drilling bore holes. Methods of Geotechnical Investigation – Accessible exploration - Test pits, Trenches, Shafts – Semi-direct methods - Bore holes – Drilling methods and equipments and applicable soil types – Auger boring, Wash boring, Rotary drilling, Percussion drilling - Stabilization of boreholes - Indirect methods – Geophysical methods - seismic refraction method - electrical resistivity methods - electrical sounding and electrical profiling – Cross hole seismic test

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

1. Tomlinson M.J. (1969), Foundation design and construction, Wiley Interscience, New York.
2. Bowles J.E. (1997), Foundation analysis and Design, Tata Mc-Graw Hill International Edition, New Delhi.

3. Winterkorn H.F. & Fang H. (1975), Foundation Engineering Handbook, Van Nostrand Reinhold Co., New York.
4. Peck R.B., Hansen W.E., and Thornburn, T.H. (1976), Foundation Engineering, John Wiley & Sons, New York.
5. Hunt R.E. (1984), Geotechnical Engineering Investigation Manual, Mc Graw Hill, New York.
6. Purushothamaraj P. (1975), Geotechnical Engineering, Tata Mc-Graw Hill Publishing Co. Ltd., New Delhi.
7. Gopal Ranjan and Rao A.S.R. (2000), Basic and Applied Soil Mechanics, New Age International(P) Ltd., New Delhi.

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 guide lines 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

Vertical stress distribution beneath footings and for loaded areas of various shapes – Different methods – Computation of settlements – immediate and consolidation settlement – Steinbrenner's method – Method of proportioning footings for equal settlement – construction period correction – Mat foundation – Modulus of subgrade reaction – Finite difference method.

Module III

Pile foundations – selections of pile types – wooden piles – concrete piles – static pile capacity of single piles in clays and sands – Dynamic formulae – Pile driving – Pile driving stresses – Pile load test – Selection of design parameters –Types of strength parameters - Effect of installation and drainage conditions – Pile group efficiency – Negative skin friction on pile groups – Tension piles – Resistance of piles subjected to uplift forces – Laterally loaded piles – Ultimate lateral resistance of vertical piles by Brom's method – Settlement of pile groups in clays and sands – Influence of pile driving on adjacent structures.

References :

1. Bowles, J. E, Foundation Analysis and Design, McGraw-Hill, New York, 2001.
2. Nayak ,N.V, Foundation Design Manual, Dhanpat Rai Publications, New Delhi,1996.
3. Teng ,W.C, Foundation Design, Prentice Hall, New Jersey, 1998.
4. Peck, R. B, Hanson,W. E, and Thornborn ,T. H,Foundation Engineering , John Wiley & Sons, Inc., New York, 1974.
5. Braja ,M .Das, Principles of Foundation Engineering, Global Engineering, USA, 2011.
6. Purushothama Raj, Soil Mechanics and Foundation Engineering, Dorling Kindersley(India) Pvt .Ltd., 2008.

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 1101 **Experimental Geotechniques I**

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

Propagation of elastic waves in soil medium- Vibrations due to earthquake loading, Industrial sources, blasting etc. Principles of vibration measuring instruments, Seismicity and Microzonation of sites. Principle of vibration isolation- Active and Passive isolation- Wave barriers.

References

1. Prakash S and Puri, *Foundations for Machines: Analysis and design,*Wiley, New York, 1988.
2. Braja M. Das, *Fundamentals of Soil Dynamics*, Elsevier Publishers, New York. 1983.
3. Swami Saran, *Soil Dynamics and machine foundations*, Galgotia Publishers, New Delhi,1997.
4. Murthy V. N. S, *Soil Mechanics and Foundation Engineering* CBS Publishers & Distributors, New Delhi, 2009.
5. Kramer S. L., *Geotechnical Earthquake Engineering* – Pearson Education Inc. New Delhi.

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

1. Ashok K. Jain (1993), *Reinforced Concrete Limit State Design*, Nem Chand & Bros., Roorkee.
2. Bowles J.E. (1997), *Foundation analysis and Design,* Tata Mc-Graw Hill International Edition, New Delhi.
3. Gopal Ranjan and Rao A.S.R. (2000), *Basic and Applied Soil Mechanics*, New Age International(P) Ltd., New Delhi.
4. Peck R.B., Hansen W.E., and Thornburn, T.H. (1976), *Foundation Engineering,* John Wiley & Sons, New York.
5. Prakash, Ranjan and Saran (1979), *Analysis & Design of Foundation & Retaining walls,* Oxford and IBH Publishing Co Pvt. Ltd, New Delhi.
6. Swami Saran (2006), *Analysis & Design of Substructures,* Oxford and IBH Publishing Co Pvt. Ltd, New Delhi.
7. Tomlinson M.J. (1969), *Foundation design and construction,* Wiley Interscience, New York.

8. Winterkorn H.F. & Fang H. (1975), *Foundation Engineering Handbook,* Van Nostrand Reinhold Co., New York.

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.

CCC 2000 **RESEARCH METHODOLOGY** **2-0-0-2**

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

Research design and methods: Research design - Basic Principles- Need forresearch design — Features of a good design. Important concepts relating to research design: Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction. Development of Models and research plans: Exploration, Description, Diagnosis, Experimentation and sample designs.Data Collection and analysis: Execution of the research - Observation and Collection of data - Methods of data collection - Sampling Methods- Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-Testing -Generalization and Interpretation.

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
2. Panneerselvam, “Research Methodology”, Prentice Hall of India, New Delhi, 2012.
3. J.W Bames,” Statistical Analysis for Engineers and Scientists”, McGraw Hill, New York.
4. Donald Cooper, “Business Research Methods”, Tata McGraw Hill, New Delhi.
5. Leedy P D, "Practical Research: Planning and Design", MacMillan Publishing Co.
6. Day R A, "*How to Write and Publish a Scientific Paper*", Cambridge University Press, 1989.
7. Manna, Chakraborti, “Values and Ethics in Business Profession”, Prentice Hall of India, New Delhi, 2012.
8. Sople,” Managing Intellectual Property: The Strategic Imperative, Prentice Hall of India, New Delhi, 2012.

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

CGC 2102 **Thesis – Preliminary – Part I**

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.

CGE 2001 Finite Element Analysis in Geotechnical Engineering

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

Geotechnical Considerations - Membrane elements, interface elements, boundary conditions; Elastic constitutive models - Linear and non linear; Elasto plastic constitutive models: Tresca, Von Mises, Mohr Coulomb, Drucker Prager models. Non linear FEA: Tangent stiffness method, Visco plastic method, Modified Newton Raphson Method. Seepage and Consolidation: FE formulation & implementation – Hydraulic boundary conditions – Permeability models

References

1. Potts, D. M. and Zdravkovic, L. (1999): “Finite Element Analysis in Geotechnical Engineering: Theory and application”, Thomas Telford, London.
2. Desai, C. S. and Abel, J. F. (1987): “Introduction to FEM”, CBS Publishers and Distributors, Delhi.
3. Krishnamoorthy C. S. (1994): “Finite Element Analysis-Theory and Programming”, Tata McGraw Hill publishing Company, New Delhi.
4. Zienkiewicz, O.C. (1979): “The Finite Element Method”, Tata Mc Graw Hill Publishing Company, New Delhi.
5. Cook, R. D., Malkus, D. S., Plesha, M. E. and Witt, R. J. (2001): “Concepts and Applications of finite Element analysis, John Wiley & Sons, New York.

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 stresss- deformability of rocks. Laboratory and in situ tests for various physical and mechanical properties. Insitu stress,Various methods of stress measurement.

Module II

Underground opening in infinite medium, Elastic and elasto-plastic approach.Stress concentration for different shapes of opening, Zone of influence. Failure criteria for rock and rock masses, Strength and deformability of jointed rock mass. Fracture strength of jointed rock mass. Concept of joint compliance. Stability of rock slopes. Foundation on rocks, Estimation of bearing capacity, Pile foundation in rocks. Methods to improve rock mass responses, Grouting in rocks, Rock bolting, Rock anchors.

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

1. Introduction to Rock Mechanics by R.E.Goodman, John Wiley & Sons, New York.
2. Rock Mechanics for Engineers by Verma B.P, Khanna publishers, New Delhi.
3. Rock Mass Classification Systems, A Practical Approach in Civil Engineering Elsevier Publishers, New York.
4. Engineering in Rocks for Slopes, Foundation and Tunnels, Editor T.Ramamurthy, Prentice Hall India Pvt.Ltd.
5. Fundamentals of Rock Mechanics, Fourth Edition, by Jaeger, Cook and Zimmerman, Blackwell Publishing, New York.
6. Rock Mechanics and the Design of Structures in Rock, L.Obert and Wilbur.I.Duvall, John Wiley & Sons, Inc., New York.

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.

CGE 2003 Earth Dam Engineering

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

Earth dam – Types- Selection – Requirements of foundation – Material of cnstruction Seepage through dams – Determination of phreatic line – Casagrande''s solution- Kozheny's parabola- Entrance & Exit correction –Flownets for homogenous earth dams-Flownets for dams under steady seepage and sudden draw down conditions- Control of seepage – Adverse effects of seepage- Liquefaction and its prevention- Methods of reducing seepage –Selection of core types – Cut off trenches – Grout curtains- Sheet pile walls – Upstream blanket – relief walls.

Module II

Stability Analysis – Role of pore pressure in stability analysis – pore pressure during construction, steady seepage & sudden drawdown conditions. Embankment construction – Methods of placement and compaction – Compaction control – Placement water content. Seismic stability – New marks approach – Goodman and Seeds approach – Methods to safeguard dams during earthquakes.

Module III

Rockfill dams- General characteristics – Impervious membrane and earth cores – Control of rock fill placement – Settlement of rockfill. Failure of earth dams - Types of failure and damages – Embankment compressibility and swelling – settlement of foundations – Movement of crest and its measurement- case history- Cases of failure of major dams- foundation treatment-Instrumentation of earth dams.

References

1. Sherad , *Earth and Rockfill dams, Principles for Design and Construction,* Balkema, Netherlands.
2. Bharat Singh and Punmia , *Earth and Rockfill dams,* Standard publishers, New Delhi, 1988.
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 tobe used in a particular situation.

Module I

Role of ground improvement – Drainage and groundwater lowering – Well point systems – Electro osmotic methods – Thermal and freezing methods – Insitu densification – Deep compaction – Dynamic compaction – Blasting – Sand piles – Preloading with sand drains – Stone columns- Lime piles.

Module II

Earth reinforcement – Rock bolts – Cables and guniting – Geotextiles as reinforcement – Filtration. Drainage and Erosion control – Soil Nailing – Micro piles.

Module III

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

References

1. Manfred Hausmann, Ground modification (1990) – McGraw Hill, New York.
2. Purushothama Raj, Ground Improvement Techniques Laxmi Publications, New Delhi, India, 1999.
3. F.G. Bell, Foundation Engineering in Difficult Ground (1978), Butterworth – Heinmann, 1978.
4. Frank Harris, Ground Engineering Equipments and Methods, McGraw hill Book company Ltd, New York, 1983.

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

1. Kadiyali, L.R. (1989). “Principles and Practice of Highway Engineering”, Khanna tech. Publications,New Delhi.
2. Wright, P.H. (1996). “Highway Engineers”, John Wiley & Sons, Inc., New York, 1996
3. Yoder R.J and Witczak M.W. (1975). “Principles of Pavement Design”, John Wiley, New York.
4. Design and Specification of Rural Roads (Manual), Ministry of rural roads, Government of India, New Delhi, 2001.
5. Guidelines for the Design of Flexible Pavements, IRC:37 - 2001, The Indian roads Congress, New Delhi.
6. Guideline for the Design of Rigid Pavements for Highways, IRC:58-1998, The Indian Roads Congress, New Delhi.

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.

CGE 2006 Earthquake Geotechnical Engineering

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

1. Robert W Day. (2007). Geotechnical Earthquake Engineering Handbook, McGraw Hill, New York.

2. Kramer, S. (1995). Geotechnical Earthquake Engineering, Pearson, New Delhi.

3. Ishihara, K.(1996). Soil Behaviour in Earthquake Geotechnics, Oxford Science, NY.

4. Lkuo Towhata. (1995), Geotechnical Earthquake Engineering, Springer, NY.

5. Kamalesh Kumar. (2009). Basic Geotechnical Earthquake Engineering, New Age International Publishers, New Delhi.

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

Introduction to geoenvironmental engineering, Soil-water-environment interaction relating to geotechnical problems. Waste: source, production, classification and management of waste-physical, chemical and geotechnical characterisation of waste, geotechnical use of waste materials-flyash and tailings. Investigation of contaminated soil, sampling, assessment and transport of contaminant.

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

1. Daniel, D.E. (1993). *Geotechnical Practice for Waste Disposal*. Chapman and Hall, London
2. Koerner, R.M. (2005). *Designing with Geosynthetics*. Fifth Edition. Prentice Hall, New Jersey.
3. Reddi L.N and Inyang HI (2000) *Geoenvironmental Engineering: Principles and Applications*, Marcel Dekker Inc Publication, NY.
4. R. N. Yong (2000) *Geoenvironmental Engineering: Contaminated Soils, Pollutant Fate* Mitigation Lewis Publication.
5. Dr. G V Rao and Dr. R S Sasidhar (2009) *Solid waste Management and Engineered Landfills*, Saimaster Geoenvironmental Services Pvt. Ltd. Publication, Hyderabad.
6. Ayyar TSR (2000) Soil engineering in relation to environment, LBS centre for Science and Technology, Trvandrum.

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 3101 **Thesis – Preliminary – Part II**

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.

CGE 3001 Applied Numerical Methods and Optimisation

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

Solution of linear system of equation: Gaussian Elimination – Gauss Jordan Method – Gauss Siedel iteration method – Factorisation method – Ill conditioned matrix. Numerical integration: Newton Cotes closed quadrature – Trapezoidal rule – Simpson's $1/3^{rd}$ rule – $3/8^{th}$ rule – Newton Cotes open quadrature – Guassian quadrature – Romberg integration.

Module II

Partial differential equation: Laplace, Poisson and wave equation – Explicit and implicit methods. Solution of ordinary differential equation: Initial value problem – Euler's method – Picard's method – Taylor series – Predictor corrector methods – Runge-Kutta methods – Boundary value problems.

Module III

Solution of system of non linear equation: Newton-Raphson method. Curve fitting – Power curve – Exponential cure – Hyperbola –Cubic spline. Optimisation techniques: Linear programming – Simplex method – transportation problem – Non linear, Geometric and dynamic programming – elementary ideas.

References

1. Akai T J (1994), *Applied Numerical methods for Engineers,* John Wiley & Sons New York
2. Chapra S.C. and Canale R.P. (1985), *Numerical methods for Engineers,* Tata Mc.Graw Hill Publishing Co. Ltd., New York.
3. Gerald (2003), *Applied Numerical Analysis,* Pearson Education, New Delhi.
4. Krishnamurthy E V and Sen S. K. (1986), *Numerical algorithms,* East- West Press Pvt Ltd., New Delhi.
5. Rajasekharan S. (1986), *Numerical methods in Science and Engineering ,* Wheeler & Co. Pvt. Ltd., New Delhi.
6. .Rao S.S. (1979), *Optimisation theory and applications,* Wiley Eastern Ltd., New York.
7. Sastri S.S. (1977), *Introductory methods of numerical analysis,* Prentice Hall of India, New Delhi.

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 3002 Environmental Geotechniques

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

1. Ayyar TSR (2000) Soil engineering in relation to environment, LBS centre for Science and Technology, Trvandrum.
2. Daniel, D.E. (1993). *Geotechnical Practice for Waste Disposal*. Chapman and Hall, London (will soon be on reserve in library).
3. Michel J K and and Saga K. (1976). Fundamentals of soil behavior, John Wiley and Sonic Inc, New York.

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.

CGE 3003 Soil Structure Interaction

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

Characteristics of soil behaviour – particle continuum duality – Hertzian contact theory, Idealised soil behaviour – foundation behaviour – interface behaviour; Idealised soil response models for the analysis of soil foundation interaction – elastic models – Winkler model – elastic continuum models – two parameter elastic models – elastic plastic behaviour of soil – time dependent behaviour of soil.

Module II

Beam on Elastic foundation-soil models: Infinite beam, two parameters, Isotropic elastic half space, analysis of beams of finite length, classification of finite beams in relation to their stiffness.Plate on Elastic medium: Infinite plate, Winkler, two parameters, isotropic elastic medium, thin and thick plates, analysis of finite plates: rectangular and circular plates, Numerical analysis of finite plates, simple solutions.

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

1. Selvadurai, A. P. S. (1979). Elastic analysis Soil foundation interaction, Elsevier Scientific Publishing Company, The Neatherlands.
2. Poulos, H.G. and Davis E.H. (1990). Pile Foundation Analysis and Design, John Wiley, New York.
3. Scott, R.F. (1981). "Foundation Analysis, Prentice Hall, NJ.

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

Historical background – advantages- recent developments - area of application – Different types of geosynthetics – Different Materials, properties and testing - Functions of geosynthetics – Reinforcement, separation, filtration, drainage, moisture barrier - mechanism of reinforced soil.

Module II

Analysis, design and construction of reinforced soil retaining walls – Problems – Construction methods - Concertina method, telescopic method, sliding method – Various types of facings - Application of geosynthetics for stabilisation of slopes- Introduction to soil nailing.

Module III

Designing for bearing capacity improvement – Binquet and Lee's approach – problems – applications in landfills - natural geotextiles – applications. Advantages, disadvantages - different types. Concept of Prefabricated vertical drains, geotubes, gabions, geocells.

References

1. Koerner, R.M. (1999). Designing with Geosynthetics, Prentice Hall, New Jersey, USA, 4th edition.
2. Jewell, R.A., (1996). Soil Reinforcement with Geotextiles, Special Publication No. 123, CIRIA, Thomas Telford. London, UK.
3. Geosynthetics - New Horizons, Eds. G.V. Rao, PK Banerjee, J.T. Shahu, G.V. Ramana, Asian Books Private Ltd., New Delhi, 2004.
4. Rao, G.V. (2007). Geosynthetics – An Introduction. Sai Master Geoenvironmental Services Pvt. Ltd., Hyderabad.
5. Jones, C.J.F.P. (1985). Earth reinforcement and soil structures. Butterworth, London.
6. Ingold, T. (1982). Reinforced Earth, Thomas Telford, London.
7. Jewell, R.A. (1996). Soil reinforcement and Geotextiles. CIRIA London, UK
8. Babu, S.G.L. (2006). An introduction to Soil reinforcement and geosynthetics. United Press (India) Pvt. Ltd., Hyderabad.
9. Swami Saran (2006). Reinforced soil and its engineering applications. I.K. International Pvt. Ltd. New Delhi.
10. Ramanatha Ayyar, T.S., Ramachandran Nair, C.G. and Balakrishnan Nair, N. (2002). A Comprehensive Reference Book on Coir Geotextiles, Ist ed., Center for Development of Coir Technology (C-DOCT), Trivandrum.

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

The behaviour of over consolidated samples: Hvorslev surface-critical state line-complete state boundary surface-volume changes and pore water pressure changes. Behaviour of soils before failure and Critical State Model: Elastic wall Calculation of elastic strains plasticity theory-Cam clay-critical state model.

References

1. Scott R. F.(1963). Principles of Soil Mechanics, Addition Wesley-Reading, Mass.
2. Schofied, A. N. and Wroth C. P. (1968). Critical State Soil Mechanics Mc Graw Hill Book Co.Ltd, London.
3. Atkinson, J. H. and Bransby, P. L. (1978) The mechanics of Soils-an introduction to critical state soil Mechanics, Mc Graw Hill Book Co.Ltd, London.
4. Wood,D. M. (1990). Soil behaviour and critical state soil mechanics, Cambridge university press.
5. Ortigao, J. A. R. (1995). Soil mechanics in the light of critical state theories, Taylor and Francis, London.

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 3006 Behaviour and Testing of Unsaturated Soils

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

Introduction-Identification of expansive soil- classification of expansive soil - Identification of collapsing soils- classification of collapsing soils .

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

1. Blight , G.E (1997),Mechanics of residual soils,Taylor & Franci
2. Fredlund,D.G and Rahardjo,R(1993) Soil Mechanics for unsaturated soils,Wiley New York.
3. Nelson,J.D and Millen,D J(1992) Expansive soils,Wiley.
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:

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