University Institute of Technology (UIT)

Silver Wood Estate, H. P. University, Shimla-171005

(NAAC accredited "A-Grade" University)

DEPARTMENT
of
CIVIL ENGINEERING

Course Structure & Syllabus

for

Master of Technology

in

Civil Engineering

(Geotechnical Engineering)

Semester I-IV

Effective for the session 2024-2025 and onwards

SCHEME OF THE SYLLABUS

First Semester

Course Code	Course Title				Credits	Marks	
		L	T	P	C	Ext.	Int.
MCE-1001	Geotechnical Earthquake Engineering	4	0	0	4	100	50
MCE-1002	Geo-environmental Engineering	4	0	0	4	100	50
MCE-1003	Advanced Soil Mechanics	4	0	0	4	100	50
RM-1001	Research Methodology	3	0	0	3	100	50
MCE- 1004	Computing in Geotechnical Engineering Lab	0	0	3	3	100	50
MPCE- XXXX	Elective-1	4	0	0	4	100	50
	Total	**22**			**22**	**900**	

Second Semester

Course Code	Course Title				Credits	Marks	
		L	T	P	C	Ext.	Int.
MCE- 2001	Engineering Geology and Rock Mechanics	4	0	0	4	100	50
MCE- 2002	Advanced Geotechnical Engineering Lab	0	0	2	2	100	50
MCE- 2003	Finite Element Analysis	4	0	0	4	100	50
MT(IT)- 2004	MATLAB	3	0	0	3	100	50
MCE- XXXX	Elective-2	4	0	0	4	100	50
MCE- XXXX	Elective-3	4	0	0	4	100	50
	Total	**21**			**21**	**900**	

Third Semester

Course Code	Course Title				Credits	Marks	
		L	T	P	C	Ext.	Int.
MCE- 3001	Dissertation Phase-I	-	-	24	12	250	100
	Total	**24**			**12**	**350**	

Fourth Semester

Course Code	Course Title				Credits	Marks	
		L	T	P	C	Ext.	Int.
MCE-4001	Dissertation Phase-II	-	-	30	15	250	100
	Total	**30**			**15**	**350**	

**The dissertation evaluation shall be done twice in a semester (mid-semester at the internal level and end semester at the external level by the Departmental Master Programme Committee (DMPC) under the Faculty of Engineering and Technology as mentioned on the last page).*

Total Credits = 70

Program Electives

	Course Code	Subject
Elective-1	MCE- 5011	Clay Mineralogy
	MCE- 5012	Landslide Analysis and Control
Elective-2	MCE- 5013	Soil Dynamics
	MCE- 5014	Ground Improvement Techniques
	MCE- 5015	Soil Reinforcement & Geosynthetics
Elective-3	MCE- 5016	Advanced Foundation Engineering
	MCE- 5017	Earth Retaining Structures
	MCE- 5018	Soil- Structures Interaction Analysis

Name of the Course	Geotechnical Earthquake Engineering		
Course Code	**MCE-1001**	Credits: 4	L-4, T-0, P-0
Lectures	4 Hours/Week		
Semester End Examination	Max. Time: 3 hrs.	Max. Marks: 100	Min. Pass Marks: 40
Internal Assessment (based on sessional tests 50%, Tutorials/Assignments30%, Quiz/Seminar10%, Attendance 10%)		Max. Marks: 50	

Instructions:

For Paper Setters: The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates: Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objectives

- ✓ To understand fundamental aspects of Geotechnical Earthquake Engineering
- ✓ To understand the aspects related to magnitude and intensity of earthquake
- ✓ To understand Engineering Seismology and dynamic Soil Properties.
- ✓ To focus on describing earthquake hazards and developing methods used for seismic analysis and design of geotechnical engineering systems.

Section	Course Content
Section A	Nature and types of earthquake loading; Importance of Geotechnical Earthquake Engineering. Concept of dynamic load, Earthquake load, Single degree of freedom system, Multiple degree of freedom system, Free and forced vibrations, Damped and undamped systems, Equation of Motion, Response spectra. Basic Seismology, Earthquake, Elastic rebound Theory, Faults, Plate tectonics, Seismograph and Seismogram, Prediction of Earthquakes, Protection against earthquake damage, Origin of Universe, Layers of Earth, Theory of Continental Drift, Hazards due to Earthquakes.
Section B	Size of Earthquake: Magnitude and Intensity of Earthquake, Modified Mercalli Intensity Scale, Measuring of Earthquake, Earthquake Magnitude, Local (Richter) magnitude, surface wave magnitude, Moment magnitude, Seismic energy, Correlations. Spectral Parameters: Peak Acceleration, Peak Velocity, Peak Displacement, Frequency Content and duration.
Section C	Elastic response of continua (one, two- and three-dimensional wave equations); Waves in unbound media; Waves in semi-infinite media; Waves in layered media, Seismic Travel Time Curve, Three Circle Method for locating an Earthquake's epicenter. Stiffness, damping and plasticity parameters of soil and their determination (laboratory testing, intrusive and non-intrusive in-situ testing); Correlations of different soil parameters; Liquefaction (basics, evaluation and effects), Liquefaction hazard map, Lateral Spreading. Magnitude Indicators, Deterministic Seismic Hazard Analysis (DSHA), Probabilistic Seismic Hazard Analysis (PSHA), Earthquake Source Characterization, computations,
Section D	Ground Response Analysis, Transfer Function, Non-linear approach. Site classification. Pseudo-static method, Pseudo, dynamic method, other dynamic methods, Seismic analysis of retaining wall, Seismic slope stability analysis, Behaviour of reinforced soil under seismic conditions, Seismic design of retaining structures, seismic design of pile foundations, seismic uplift capacity of ground anchors, codal provisions/guidelines for seismic design of geotechnical structures.

Course Outcomes

- ✓ Identify and discuss the role and importance of Geotechnical Earthquake Engineering
- ✓ Identify and discuss the issues and concepts salient to damped and undamped systems.
- ✓ Identify and discuss the complex issues inherent in Ground Response Analysis.
- ✓ They would be able to analyze and quantify earthquake hazard in terms of ground amplifications, deformations and liquefaction and would be able to design earthquake resistant structures.

Text Books:

1. Shamsher Prakash, "Soil Dynamics", McGraw-Hill Book Company.
2. Steven L.Kramer, "Geotechnical Earthquake Engineering", Prentice Hall Inc.
3. Robert W. Day, "Geotechnical Earthquake Engineering Handbook", McGraw Hill, New York

Reference Books:

1. Kenji Ishihara,"Soil Behaviour in Earthquake Geotechnics", Oxford University Press, USA.
2. MilutinSrbulov,"GeotechnicalEarthquakeEngineering:SimplifiedAnalyseswithCaseStudiesandExamples",Springer-Verlag.
3. D. D.Barkan,"Dynamics of Bases and Foundations", McGraw-Hill Book Company.
4. Geotechnical Earthquake Engineering By Steven L. Kramer, Pearson Education, 2003

Name of the Course	Geo-Environmental Engineering		
Course Code	**MCE-1002**	Credits: 4	L-4, T-0, P-0
Lectures	4 Hours/Week		
Semester End Examination	Max. Time: 3 hrs.	Max. Marks: 100	Min. Pass Marks:40
Internal Assessment (based on sessional tests 50%, Tutorials/Assignments30%, Quiz/Seminar10%, Attendance 10%)		Max. Marks: 50	

Instructions :

For Paper Setters: The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates: Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objectives

- ✓ To understand fundamental aspects of Geo-Environmental Engineering
- ✓ To understand the fundamentals related to waste disposal in landfills
- ✓ To understand how to evaluate environmental monitoring around landfills
- ✓ To understand the fundamentals related to application of geosynthetics.

Section	Course Content
Section A	Introduction: Sources and effects of subsurface contamination; Waste characteristics; Soil-water-waste interaction: Contaminant transport; Laboratory and field evaluation of permeability.
Section B	Waste Disposal on land: Types of landfill, Siting criteria, Waste containment principles, Types of barrier materials. Planning and design aspects relating to waste disposal in landfills, in ash ponds and tailings ponds, and in rocks.
Section C	Landfill design and considerations: Precipitation, hydrological consideration in land fill design, site selection for landfills, characterization of land fill sites, stability of landfills, current practice of waste disposal, passive containment system. Environmental monitoring around landfills. Detection, control, and remediation of subsurface contamination.
Section D	Engineering properties and geotechnical reuse of waste, demolition waste dumps; Regulations; Case studies. Ground water pollution: Ground water pollution, pollution of aquifers by mixing of liquid waste, protecting aquifers., Energy Geotechnics

Course Outcomes

- ✓ Identify and discuss the role and significance of concepts related to environmental geotechnics
- ✓ Identify and discuss the planning and design aspects relating to waste disposal in landfills
- ✓ Identify and discuss the complex issues related to ground water pollution
- ✓ Identify and discuss the application of geo synthetics in solid waste management

Text Books:

1. Qian, X., Koerner, R., and Gray, D.H., Geotechnical aspects of landfill design and construction, Prentice Hall, 2002.
2. Datta, M., Waste disposal in Engineered landfills, Narosa Publishers, 1998.
3. Gulhati, S.K. and Datta M., Geotechnical Engineering, Mcgraw Hill, 2005.

Reference Books:

1. Daniel, D.E., Geotechnical practice for waste disposal, Chapman and Hall, 1993.
2. Sarsby, R., Environmental Geotechnics, Thomas Telford, 2000.
3. Bagchi, A., Design, construction and monitoring of landfills, Wiley Interscience, 1994.
4. Vick, S.G., Planning, analysis and design of tailings dams, John Wiley & Sons, 1970
5. Yong, R. N., Catheriene, M and Fukue, M,Geoenvironmental Sustainability, CRC Press, 2007.

Name of the Course	Advanced Soil Mechanics		
Course Code	**MCE- 1003**	Credits:4	L-4, T-0, P-0
Lectures	4 Hours/Week		
Semester End Examination	Max. Time: 3 hrs.	Max. Marks:100	Min. Pass Marks: 40
Internal Assessment (based on sessional tests 50%, Tutorials/Assignments30%, Quiz/Seminar10%, Attendance10%)		Max. Marks: 50	

Instructions :

For Paper Setters: The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates: Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objectives

- ✓ To impart knowledge about the engineering properties of soils with a focus on consolidation and shear strength
- ✓ To introduce the fundamental concepts relevant to the strength behaviour of soils
- ✓ To enable the students to understand the factors that control the strength behaviour of the soils
- ✓ To better understand fundamental aspects of the stress-strain response of soil

Section	Course Content
Section A	Introduction: Origin, Nature and distribution of soils, Description of individual particle, Clay mineralogy, clay water-electrolytes, Soil fabric and structure. Effective stress and permeability: Effective stress principle, Steady state flow in soils, Effect of flow on effective stress, Determination of coefficient of permeability.
Section B	Consolidation: Consolidation, one, two, three and radial consolidation, Variation of effective stress during consolidation, Various consolidation tests and determination of parameters
Section C	Shear strength: Stress-path, Triaxial and direct shear tests, Shear behaviour of granular soils. Factors affecting shear behaviour, Determination of parameters, Shear behaviour of fine-grained soils, Pore pressure parameters, UU, CU, CD tests, Total and effective stress strength parameters, Total and effective stress-paths.
Section D	Factors affecting strength such as stress history, rate of testing, structure and temperature. Determination of in-situ undrained strength. Stress-strain characteristics of soils, Critical state model, Engineering Behaviour of soils of India such as Black cotton soils, alluvial silts and sands, laterites, Collapsible and sensitive soils, aeoline deposits.

Course Outcomes

Upon successful completion of the course, the students will be able to

- ✓ Describe the behavior of the soils
- ✓ Apply principles of advanced soil mechanics to civil engineering problem
- ✓ Calculate and analyze the stresses on soil and be able to draw the stress paths.
- ✓ Evaluate the stress strain strength behavior of soil in drained and undrained conditions

Text Books

1. Basic and Applied Soil Mechanics by Gopal Ranjan& A. S. R. Rao, New Age International Pvt Ltd.
2. Soil Mechanics and Foundation Engineering by Dr. K. R. Arora, Standard Publisher Dist.

Reference Books:

1. Soil Mechanics Fundamentals by Muni and Bhudu, John Wiley & sons.
2. Advanced Soil Mechanics by Braja M Das, CRC Press.

Name of the Course	Research Methodology		
Course Code	**RM- 1001**	Credits:3	L-3, T-0, P-0
Lectures	3 Hours/Week		
Semester End Examination	Max. Time: 3 hrs.	Max. Marks:100	Min. Pass Marks: 40
Internal Assessment (based on sessional tests 50%, Tutorials/Assignments30%, Quiz/Seminar10%, Attendance10%)		Max.Marks:50	

Instructions :

For Paper Setters: The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates: Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objectives

- ✓ 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.

Section	Course Content
Section A	Research Aptitude: Meaning of Research, Objectives of Research, and Motivation in Research, Types of Research, Research Approaches, and Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is done. Research Process: Reviewing the literature, Formulation of research problem, Nature and type of variables, Hypothesis-meaning, types, development of hypothesis and its testing, Meaning & Functions of Research Design.
Section B	Data Analysis: Sources, acquisition and interpretation of data, Quantitative and qualitative data, Graphical representation and mapping of data, Sensitivity Analysis with Data Tables, Optimization with EXCEL Solver, Summarizing Data with Histograms and Descriptive Statistics, Pivot Tables, Summarizing Data with data base statistical functions, using correlation, Multiple Regression, Using Sampling to Analyse Data
Section C	Significance of Report Writing: Different Steps in writing Report, Layout of the Research Report, Types of Reports, Mechanics of Writing a Research Report, Art of scientific writing- Steps to better writing, flow method, organization of material and style, Drawing figures, graphs, tables, footnotes, references etc. in a research paper
Section D	Use of Internet in Research Work: Use of internet networks in research activities in searching material, paper downloading, submission of papers, relevant websites for journals and related research work. Introduction to Patent laws etc., process of patenting research finding, Copy right, Cyber laws.

Course Outcomes

- ✓ Identify and discuss the role and importance of research in the social sciences.
- ✓ Identify and discuss the issues and concepts salient to the research process.
- ✓ Identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design, and implementing a research project.
- ✓ Identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting.

Text Books:

1. Kothari, C. R., "Research Methodology Methods and Techniques", Wiley Eastern Ltd.

Reference Books:

1. Wayne L. Winston, "Microsoft Excel Data Analysis and Business Modelling", Microsoft Press.
2. Kumar, "Research Methodology: A Step-by-Step Guide for Beginners", Pearson Education.
3. Dawson, C., "Practical Research Methods", UBSPD Pvt. Ltd.

Name of the Course	**Computing in Geotechnical Engineering Lab**		
Course Code	**MCE- 1004**	Credits:3	L-0, T-0, P-3
Lectures	3 Hours/Week		
Semester End Examination	Max. Time: 3 hrs.	Max. Marks: 50	Min. Pass Marks: 20
Internal Assessment (based on sessional tests 50%, Tutorials/Assignments30%, Quiz/Seminar 10%, Attendance10%)		Max. Marks: 50 Min. Pass Marks: 25	

Course Objectives

- ✓ To provide basic knowledge on how to implements of software for solving practical and research related problems.
- ✓ To provide skills for writing program and using GIS/Arc-GIS, PLAXIS, FLAC, ABAQUS, GEO5.
- ✓ Toenableandmotivatethestudentsperformanalysisusingsoftwareforvariousresearchworksand projects.

List of Experiments

1. Arc-GIS:

a. Geo-referencing.
b. Digitizing and shape-file creation.
c. Mapping, DEM.

2. SOFTWARES: PLAXIS, FLAC, ABAQUS, GEO5, ANSYS, ROCSCIENCE:

a. Introduction to PLAXIS, FLAC, ABAQUS, GEO5.
b. Basics of mesh generation.
c. Analysis of foundations and tunnels.
d. Basic design problems of shallow and deep foundations.
e. Analysis of retaining structures and slope stability problems.

Note: The concerned Course *Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

- ✓ Upon successful completion of the course, the students will be able to:
- ✓ Perform GIS/Arc-GIS, ANSYS, PLAXIS, FLAC, ABAQUS, GEO5.
- ✓ Design and develop programming skills, GIS maps.
- ✓ Analyze and design geotechnical structures.

Text Books:

1. Modeling and Computing for Geotechnical Engineering: An Introduction by M.S. Rahman, M.B. Can ulcer
2. Balasubramaniam A. S. **Chandra V**, Bergado D.T. Younger J.S and Prinzl, F. eds. (1985), **Recent Developments in Ground Improvement Techniques**, A.A. Balkema Publishers, The Netherlands,
3. **Rajesh, S.**, and Viswanathan, B.V.S. (2012). **Performance of geogrid reinforced soil barriers of landfill covers**. Verlag: LAP LAMBERT Academic Publishing GmbH & Co. KG, Germany. (ISBN: 978-3-659-14981-8)

Reference Books:

1. **Ray Chowdhury, P**. (2009). **Response of Seismically Loaded Structures with Nonlinear SFSI- A Numerical Study**. VDM Verlag Dr. Muller, Germany (ISBN: 978-3-639-12226-8).
2. **Ghosh, P**. and Kumar. J.(2006), "**Numerical solution of different foundation problems: application of method of characteristics and upper bound limit analysis**". VDM Verlag Dr. Muller GmbH & Co. KG (Publisher), Saarbrucken, Germany (ISBN: 978-3-639-23134-2).

Name of the Course	Engineering Geology and Rock Mechanics		
Course Code	**MCE- 2001**	Credits:4	L-4, T-0, P-0
Lectures	4 Hours/Week		
Semester End Examination	Max. Time: 3 hrs.	Max.Marks:100	Min. Pass Marks:40
Internal Assessment (based on sessional tests 50%, Tutorials/Assignments30%, Quiz/Seminar10%, Attendance10%)		Max. Marks: 50	

Instructions:

For Paper Setters: The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates: Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objectives

- ✓ To understand fundamental aspects of engineering geology and rock mechanics
- ✓ To develop an understanding of the rock failure theories, in-situ stresses in rock, and the fundamental concepts andprinciples of rock mechanics.
- ✓ To understand the various criteria for stability of rock slopes
- ✓ To understand the various methods for stabilization of rock slopes

Section	Course Content
Section A	Introduction: Rock Mechanics and its relationship with soil mechanics and engineering geology, application of rock mechanics to civil engineering problems. Classification of rocks: Lithological classification, engineering classification of rocks, classification based on wave velocity ratio, R.Q.D. Classification of rock masses i.e., RMR and Q systems.
Section B	Engineering Properties of Rock Masses Lab. Tests: Void-index test, Compression & tensile tests, Permeability, Strength characteristics, Strength of intact and fissured rocks, Effect of test conditions. Stability in Rock Slopes: Modes of failures in rock masses implified Bishop's method, Janbu's method,Hock's method, Wedge's method.
Section C	In Situ Testing of Rocks: Field direct shear test, Triaxial test, Use of flat jacks, Cable jacking, Chambertest & Plate load test. Stabilization of Rocks: Rock Bolting, Principle of rock Bolting, Rock grouting, Grouting materials,Grouting operations & method of grouting. Foundation of Rocks: Stress distribution in foundation, methods of determination of bearing capacity of rocks, improvement of rock properties, pressure grouting for tunnels and dams, dental concreting, shearzone treatment.
Section D	Stabilization of Rocks: Rock Bolting, Principle of rock Bolting, Rock grouting, Grouting materials, Grouting operations & method of grouting. Foundation of Rocks: Stress distribution in foundation, methods of determination of bearing capacity of rocks, improvement of rock properties, pressure grouting for tunnels and dams, dental concreting, shear zone treatment.

Course Outcomes

- ✓ Identify and discuss the role and importance of rock mechanics and classification of rocks
- ✓ Identify and discuss the issues and concepts related to situ testing of rocks and stabilization of rocks.
- ✓ Identify and discuss the complex issues inherent in stabilization of rocks and foundation of rocks.
- ✓ To analyse and describe the properties of rocks that affect their ability to support themselves and any imposedloads; design rock slopes and rock foundations for varying site conditions

Text Books:

1. Introduction to Rock Mechanics, by Goodman R.E., John Wiley and Sons, New York.
2. Engineering in Rocks for Slopes, Foundations and Tunnels, by Ramamurthy T., PHI Learning Pvt. Ltd.

Reference Books:

1. Rock Mechanics for Underground Mining, by Brady B.H.G. and Brown E.T., Kluwer Academic Publishers.
2. Rock Mechanics in Engineering Practice: K.G. Stagg, John Wiley & Sons.
3. Under-ground excavation in rock: Evert Hoek, Edwin T. Brown, Institution of Mining and Metallurgy.
4. Rock Mechanics in Engineering Practice: By C Jaeger, Cambridge.

Name of the Course	Advanced Geotechnical Engineering Lab		
Course Code	**MCE- 2002**	Credits:2	L-0, T-0, P-2
Lectures	2 Hours/Week		
Semester End Examination	Max. Time: 3 hrs.	Max. Marks: 50	Min. Pass Marks: 20
Internal Assessment (based on sessional tests 50%, Tutorials/Assignments30%, Quiz/Seminar10%, Attendance10%)		Max. Marks: 50 Min. Pass Marks: 25	

Course Objectives

- ✓ To train the students for collection of soil and rock specimens for testing in the laboratory.
- ✓ To provide skills for determining soil and rock properties in laboratory and in the field.
- ✓ To enable the students to assess design soil and rock parameters.
- ✓ To make the students determine the safe bearing capacity of soil and rock.

List of Experiments

1) Determination of consolidation properties of the given clay sample.
2) Direct shear test on granular soil sample.
3) Laboratory vane shear test on given soil sample and in- situ vane shear test.
4) Unconfined compression test on given soil sample.
5) Unconsolidated undrained (UU), consolidated undrained (CU) and consolidated drained (CD) triaxial sheartest on the given soil sample
6) Determination of free swell index and swelling pressure of given clay sample.
7) Collection of undisturbed and representative samples, soil samples using auger boring and by drilling bore hole.
8) Bearing capacity of soil using dynamic cone penetration test, static cone penetration test and standardpenetration test

Course Outcomes

Upon successful completion of the course, the students will be able to Collection of soil specimens from the field.

- ✓ Interpret settlement, shear strength and swell characteristics of soil.
- ✓ Assess the strength parameters of rock.
- ✓ Determine safe bearing capacity of soil and rock. Estimate load carrying capacity of pile.
- ✓ Understand the principles of design of experiments.

Text Books:

1. Basic and Applied Soil Mechanics by Gopal Ranjan& A. S. R. Rao, New Age International Pvt Ltd.
2. Soil Mechanics and Foundation Engineering by Dr. K. R. Arora, Standard Publisher Dist.

Reference Books:

1. Soil Mechanics Fundamentals by Muni and Bhudu, John Wiley & sons.
2. Advanced Soil Mechanics by Braja M Das, CRC Press.

Name of the Course	Finite Element Analysis		
Course Code	**MCE- 2003**	Credits:4	L-4, T-0, P-0
Lectures	4 Hours/Week		
Semester End Examination	Max. Time: 3 hrs.	Max. Marks:100	Min. Pass Marks: 40
Internal Assessment (based on sessional tests 50%, Tutorials/Assignments30%, Quiz/Seminar10%, Attendance10%)		Max. Marks: 50	

Instructions :

For Paper Setters: The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates: Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objectives

- ✓ To understand basic concepts of Finite Element Analysis
- ✓ To understand the applications of Finite Element Analysis in Solid Mechanics
- ✓ To understand how to evaluate Nonlinear Problems
- ✓ To learn the theory and characteristics of finite elements that represent engineering structures.

Section	Course Content
Section A	Basic Concepts, Discretization; Displacement, Force and Hybrid Models. Interpolation Functions for General Element Formulations: Compatibility and Completeness, Polynomial Forms: One Dimensional Elements, Geometric Isotropy, Triangular Elements, Rectangular Elements, Three Dimensional Elements, Isoperimetric Formulations, Axisymmetric Elements; Numerical Integration
Section B	Applications in Solid Mechanics: Plane Stress/Strain: FE Formulation: CST, LST; Stiffness Matrix, Load Matrix Formation Rectangular Element Iso parametric Formulation: Plate Elements and Shell Elements, Three-Dimensional Elements FE Formulation: Axisymmetric Stress Analysis, Torsion, Interface Elements, Infinite Elements
Section C	Application in Structural Dynamics and Vibrations: Mass (Consistent and Diagonal) and Damping Matrices; Modal Analysis, Time History Analysis, Explicit Direct Integration/Implicit Direct Integration and Mixed Methods.
Section D	Introduction to Nonlinear Problems: Geometric and Material (Elasto-plastic), Solution Methods: Newton Ralphson Method, Modified Newton-Ralphson Method, Arc Method, A Problem of Geometric Nonlinearity Stationary Principles, Rayleigh Ritz Method and Interpolation; Weighted Residual Methods and Variational Methods, Numerical Errors and Convergence

Course Outcomes

- ✓ Identify and discuss the issues and concepts related to FE Formulation and analysis of structural frames
- ✓ Understand the role and significance of shape functions in finite element formulations and use linear, quadratic, and cubic shape functions for interpolation
- ✓ Understand global, local, and natural coordinates and direct and formal (basic energy and weighted residual) methods for deriving finite element equations
- ✓ Identify and discuss the complex issues related to Nonlinear Problems.

Text Books:

1. David Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw Hill 2005
2. R.D. Cook, Malkus and Plesha, "Concepts and Applications of FiniteElementAnalysis",3rd Ed., JohnWiley,1989

Reference Books:

1. T. J. R. Hughes, "The Finite Element Method: Linear Static and Dynamic Analysis", Prentice Hall. 1987
2. Klaus Jurgen Bathe, "Finite Element Procedures", Prentice Hall of India. 2003
3. O. C. Zienkiewicz., R. L. Taylor & J. Z. Zhu., "The Finite Element Method Its Basis & Fundamentals," Elsevier Publications.

Name of the Course	**MATLAB**		
Course Code	**MT (IT)- 2004**	**Credits:** 3	L-3, T-0, P-0
Lectures	3 Hours/Week		
Semester End Examination	Max. Time: 3 hrs.	Max. Marks: 100	Min. Pass Marks: 40
Internal Assessment (based on sessional tests 50%, Tutorials/Assignments30%, Quiz/Seminar10%, Attendance10%)		Max. Marks: 50	

Instructions :

For Paper Setters: The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates: Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objectives

- ✓ The aim of this module is to study, learn, and understand the main *concepts* of MATLAB

Section	Course Content
Section A	MATLAB Usage and Computational Errors: Introduction to MATLAB, Types of Computer Errors, IEEE 64- bit Floating-Point Number Representation, Vectors in MATLAB, Efficient programming techniques System of Linear Equations: Solution for a System of Linear Equations, solving a System of Linear Equations, Inverse Matrix, Decomposition (Factorization), Iterative Methods to Solve Equations
Section B	Interpolation and Curve Fitting: Interpolation by Lagrange, Newton, and Chebyshev Polynomial, Hermite Interpolating Polynomial, Cubic Spline interpolation, Straight Line, Polynomial Curve, and Exponential Curve Fit, Fourier transform Nonlinear Equations: Bisection Method, Regula Falsi Method, Newton Raphson Method, Secant Method, Newton Method for a System of Nonlinear Equations
Section C	Numerical Differentiation/Integration: Difference Approximation for First Derivative, Approximation Error of First Derivative, Numerical Integration and Quadrature, Trapezoidal Method and Simpson Method, Romberg Integration, Adaptive and Gauss Quadrature. Ordinary Differential Equations: Euler's Method, Rung– Kutta Method, Pred MEor –Corrector Method, Vector Differential Equations, Boundary Value Problem (BVP)
Section D	Optimization: Unconstrained Optimization, Constrained Optimization, MATLAB Built-In Routines for Optimization, Matrices and Eigenvalues: Eigenvalues and Eigenvectors, Power Method, Jacobi Method Partial Differential Equations: Elliptic, Hyperbolic, and Parabolic PDE, Finite Element Method (FEM) for solving PDE

Course Outcomes

- ✓ Upon successful completion of the course, the students will be able to
- ✓ Use Computational techniques are to be learnt and executed using MATLAB.

Text Books:

1. "Applied Numerical methods using MATLAB", By W.Y. Yang,WileyPublications,2005
2. "AppliedNumerical Methods with MATLAB," Steven C. Chapra, McGraw-Hill, 2005

Reference Books:

1. "NumericalMethodsusingMATLAB", JohnH.Mathews, PrenticeHall2."IntroductiontoMATLAB®forEngineers", W.J Palm, McGraw-Hill

Name of the Course	Clay Mineralogy		
Course Code	**MCE- 5011**	Credits:4	L-4, T-0, P-0
Lectures	4 Hours/Week		
Semester End Examination	Max. Time: 3 hrs.	Max. Marks:100	Min. Pass Marks: 40
Internal Assessment (based on sessional tests 50%, Tutorials/Assignments30%, Quiz/Seminar10%, Attendance10%)		Max. Marks: 50	

Instructions :

For Paper Setters: The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates: Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objectives

- ✓ To understand fundamental aspects of origin of soils and its chemical and physical properties
- ✓ To understand the composition of soil solid phase and learning the various methods of soil mineral analysis
- ✓ To understand the effect of effect of clay minerals on engineering properties of soils
- ✓ To provide knowledge on modern Mineralogy-Crystallography needed principally in Geology

Section	Course Content
Section A	Origin of soils. Processes and agents of earthing, Formation of clay minerals, Classification and nomenclature. Structures & Properties of clay minerals-Isomorphous substitution and base exchange in clay minerals-orientation and randomness, crystal, chemistry, Nature of Bonds.
Section B	Clay minerals Identification: X-ray diffraction, Differential thermal analysis, Electro-microscopy and dehydration.
Section C	Colloids: Particle size, Properties, Electrical charge, Coagulation of colloids Zeta potential, Nature of the soil groups, Colloidal Properties of soil colloids and clay minerals, Adsorption and exchange of cations, Base exchange of cations, Organic soils, Percentage base saturation and its relation to soils pH. pH hydrolylic, pH Isohydric acid soil, Saline and alkaline soils.
Section D	Effect of clay minerals on engineering properties of soils: Permeability, Swelling potential, Plasticity& characteristics, compressibility, sensitivity strength. Soil Admixture with lime, cement& other materials, Effect on the properties of the stabilized clay soils.

Course Outcomes

- ✓ Identify and discuss the issues related to chemical and physical characterization of soils
- ✓ Identify and discuss the various methods for stabilization of soils
- ✓ Teach students the occurrence and classification of crystal structures
- ✓ To analyse physical and chemical properties, such as rheological, mechanical, thermal and organic reactions, clay minerals and their industrial application.

Text Books:

1. Grim R.E." Clay Mineralogy"
2. Blyth " Engineering Geology".

Reference Books:

1. Joe B. Dixon and Darrell G. Schulze (ed.) 2012. Soil Mineralogy with Environmental Applications. Soil Science Society of America.
2. Alain M, 2006, Clays, Springer.
3. Duane M. Moore and Robert C. Reynolds, 1997, X-Ray Diffraction and the Identification and Analysis of Clay Minerals, Oxford Publication.
4. Soil Science Society of America Book Series, No:1, 1989, Minerals in Soil Environment.

Name of the Course	Landslide Analysis and Control		
Course Code	**MCE- 5012**	Credits:4	L-4, T-0, P-0
Lectures	4 Hours/Week		
Semester End Examination	Max. Time: 3 hrs.	Max. Marks:100	Min. Pass Marks: 40
Internal Assessment (based on sessional tests 50%, Tutorials/Assignments30%, Quiz/Seminar10%, Attendance10%)		Max. Marks: 50	

Instructions :

For Paper Setters: The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates: Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objectives

- ✓ To understand fundamental aspects of landslide hazard and risk
- ✓ To understand the effect of rainfall on the stability of slopes rate of stress on shear parameters
- ✓ To understand Numerical modelling of landslides
- ✓ Study principles of slope stability analysis, evaluate stability of earth slopes and investigate landslides and other slope failures

Section	Course Content
Section A	Landslide hazard and risk. Landslides in earth systems. Earthquake and seismically induced landslides. Stability analysis soil and rock slopes.
Section B	Rainfall analysis and rainfall induced landslides. Risk assessment, Landslide hazard zonation,
Section C	Numerical modelling of landslides. Remote sensing techniques, Ground water system analysis for landslides
Section D	Remediation techniques Early warning systems, Disaster Mitigation, Sustainability and environmental issues

Course Outcomes

- ✓ Identify and discuss the role and importance of landslides in earth systems.
- ✓ Identify and discuss the risk and landslide hazard due to rainfall.
- ✓ Identify and discuss the issues and concepts salient to stability analysis soil and rock slopes.
- ✓ Identify and discuss the remediation techniques for landslide control

Text Books:

1. Singh, B. and Goel, R.K., "Rock Mass Classification – A Practical Engineering, Approach",
2. Hoek, E. and Bray, J.W., "Rock Slope Engineering", Institute of Mining Engg., 1981.
3. Singh, B. and Goel, R.K., "Software for Engineering Control of Landslide and Tunneling Hazards", A.A.Balkema, 2002.

Reference Books:

1. Landslides: Analysis and Control, Volume 176 of Special report -Transportation Research Board, National Research Council, National Research Council (U.S.). Transportation Research Board, 1978. Elsevier, 2006.
2. Giani, G.P., "Rock Slope Stability Analysis", A.A. Balkema, 2002.
3. Deoja, B., Dhital, M., Thapa, B., Wagner, A., "Mountain Risk Engineering Handbook", ISIMOD, Kathmandu,2002.

Name of the Course	Soil Dynamics		
Course Code	**MCE- 5013**	Credits: 4	L-4, T-0, P-0
Lectures	4 Hours/Week		
Semester End Examination	Max. Time: 3 hrs.	Max. Marks: 100	Min. Pass Marks:40
Internal Assessment (based on sessional tests 50%, Tutorials/Assignments30%, Quiz/Seminar10%, Attendance 10%)		Max. Marks: 50	

Instructions :

For Paper Setters: The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates: Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objectives

- ✓ To understand fundamental aspects of Engineering problems involving soil dynamics
- ✓ To understand the aspects of Dynamic Earth Pressure Problem and Retaining wall
- ✓ To understand how to evaluate dynamic bearing capacity
- ✓ To understand the aspects of Dynamic load on footing.

Section	Course Content
Section A	Introduction: Nature of dynamic loads, Stress conditions on soil, Engineering problems involving soil dynamics; Role of inertia; Elements under E.Q. loading, Theory of Vibrations: Single and two-degree freedom systems, Theory of vibrations, vibration measuring instruments, Vibration absorption and isolation techniques.
Section B	Dynamic Earth Pressure Problem and Retaining wall: Behavior of Retaining Walls during Earth Quakes Modification of Coulomb's Theory, Modified Coulomb's construction, Analytic solution for c- soils, Indian standard code of Practice.
Section C	Dynamic Bearing Capacity: General, Failure Zones & Ultimate Bearing capacity criteria for satisfactory action of footing, Earthquake load on footing, Dynamic analysis for vertical loads. Liquefaction of soil: Definition, Assessment of liquefaction susceptibility, Evaluation of liquefaction potential, Principle of liquefaction remediation
Section D	M/C Foundations: Introduction, Criteria for satisfactory M/C foundation, Methods of analysis, Degree of freedom of a Block, I.S. for design of reciprocation M/C design Procedure for Block Foundation, Vibration Isolation & Screening of Waves.

Course Outcomes

- ✓ Identify and discuss the role and importance of concepts related to soil dynamics
- ✓ Identify and discuss the issues and concepts related to Dynamic Earth Pressure Problem and Retaining wall
- ✓ Identify and discuss the complex issues related to foundations.
- ✓ Identify and discuss the complex issues related to liquefaction remediation.

Text Books:

1. Soil Dynamics by Shamsher Prakash, McGraw Hill Higher Education.
2. Soil Dynamics by Swami Saran, CRC Press, Taylor & Francis Group.

Reference Books:

1. Geotechnical Engineering by C. Venkat ramaiah, New Age International Publishers.

Name of the Course	**Ground Improvement Techniques**		
Course Code	**MCE- 5014**	Credits:4	L-4, T-0, P-0
Lectures	4 Hours/Week		
Semester End Examination	Max. Time: 3 hrs.	Max. Marks:100	Min. Pass Marks:40
Internal Assessment (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%		Max. Marks: 50	

Instructions :

For Paper Setters: The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates: Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objectives

- ✓ To understand fundamental aspects of various ground improvement techniques
- ✓ To understand the various types of soil stabilization methods
- ✓ To understand in detail expansive soils and methods available for its stabilization thereafter
- ✓ To make capable of choosing and designing the appropriate method of Ground Improvement according to site conditions and requirement of the project.

Section	Course Content
Section A	Introduction to engineering ground modification, need and objectives, Soil stabilization techniques; Mechanical modifications (shallow and deep compaction methods); Hydraulic modification. Dewatering systems, methods of de-watering, use of Geosynthetics and Pre-fabricated vertical drains, Preloading and Vertical drains, criteria for selection of fill material around drains –Electro-osmosis.
Section B	Grouting: Chemical grouting, operation, application, compaction grouting, application and limitations, grouting- deep jet mixing methods, stabilization using industrial wastes; Modification by inclusion and Confinement. Compaction: Principles of compaction, Engineering behaviour of compacted clays, techniques of field compaction, environmental considerations, soil improvement by thermal treatment, preloading techniques, surface compaction, introduction to bio technical stabilization.
Section C	Stabilization: Chemical Modifications, Modification by admixtures, sand column, stone column, sand drains, prefabricated drains, lime column, soil lime column, stabilization of soft clay or silt with lime, bearing capacity of lime treated soils, settlement of lime treated soils, improvement in slope stability, control methods.
Section D	Expansive soils: Problems of expansive soils – tests for identification – methods of determination of swell pressure. Improvement of expansive soils – Foundation techniques in expansive soils – underreamed piles.

Course Outcomes

- ✓ Identify and discuss the role and importance of ground improvement methods
- ✓ Identify and discuss the complex issues related to stabilization of problematic soils
- ✓ Give solutions to solve various problems associated with soil formations having less strength.
- ✓ Utilize properly the locally available materials and techniques for ground improvement so that economy in the design of foundations of various civil engineering structures

Text Books:

1. Ground Improvement by M.P. Moseley and K. Kirsch, Spon Press.
2. Ground Control and Improvement by Petros P Xanthakos, Lee W Abramson and Donald A Bruce, Wiley Interscience.

Reference Books:

1. Ground Improvement Techniques by P. Purushothama Raj, Laxmi Publications.
2. Ground Improvement by Klaus Kirsch & Alan Bell, CRC Press

Name of the Course	**Soil Reinforcement & Geosynthetics**		
Course Code	**MCE- 5015**	Credits:3	L-3, T-0, P-0
Lectures	3 Hours/Week		
Semester End Examination	Max. Time: 3 hrs.	Max. Marks: 100	Min. Pass Marks: 40
Internal Assessment (based on sessional tests 50%, Tutorials/Assignments30%, Quiz/Seminar 10%, Attendance10%)		Max. Marks: 50	

Instructions :

For Paper Setters: The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates: Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objectives

- ✓ To determine the properties, functions and applications of various geosynthetic materials
- ✓ To understand the importance of soil reinforcement and applications.
- ✓ To understand the applications of various geosynthetic materials and to design reinforced soil structures.
- ✓ To understand the history and mechanism of reinforced soil.

Section	Course Content
Section A	Historical background, RCC, Vida lean concept of reinforced earth, Mechanisms, Types of reinforcements, Backfill soil properties, soil-reinforcement interaction studies, Internal and external stability criteria.
Section B	Design principles of steep reinforced soil slopes, reinforced earth walls, MSE walls, reinforced soil footings, embankments on soft soils
Section C	Geo synthetic clay liners, construction details; geo synthetic materials, functions, property characterization
Section D	Geosynthetics in roads and railways; Separations drainage and filtering in road pavements and railway track. Testing methods for geosynthetics. Recent research & developments.

Course Outcomes

- ✓ Identify and discuss the role and importance of geosynthetics.
- ✓ Able to apply the appropriate geosynthetic material for improving ground for various Civil Engineering projects, and design of various reinforced soil structures.
- ✓ To illustrate the principles and mechanisms of reinforced soil.
- ✓ Analyse the durability of reinforcing materials

Text Books:

1. Koerner, R. M. – Designing with Geosynthetics, Prentice Hall; 2nd edition (1991)
2. Rao, G. V., & Raju G. V. S. S. – Engineering with Geosynthetics, Tata-McGraw Hill. Publication, New Delhi. (2004.)

Reference Books:

1. Hausmann, M. R. – Engineering Principles of Ground Modifications, McGraw Hill Pub Co, 1989
2. Siva Kumar Babu .GL 2013-Introduction to Soil Reinforcement &Geosynthetics, University Press
3. M. P. Moseley and K. Krisch (2006) – Ground Improvement, II Edition, Taylor and Francis
4. Jones C. J. F. P. (1985) – Earth Reinforcement and soil structures – Butterworths, London.

Name of the Course	**Advance Foundation Engineering**		
Course Code	**MCE- 5016**	Credits:4	L-4, T-0, P-0
Lectures	4 Hours/Week		
Semester End Examination	Max. Time: 3 hrs.	Max. Marks:100	Min. Pass Marks:40
Internal Assessment (based on sessional tests 50%, Tutorials/Assignments30%, Quiz/Seminar10%, Attendance10%)		Max. Marks: 50	

Instructions :

For Paper Setters: The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates: Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objectives

- ✓ To apply the soil mechanics principles and engineering behavior of soils
- ✓ To understand fundamental aspects of advance foundation engineering
- ✓ To understand in detail various types of foundations
- ✓ To understand various types of codal provisions available related to foundations

Section	Course Content
Section A	Shallow Foundation: Choice of foundation types, Terzaghi's bearing capacity equation, General bearing capacity equation, different bearing capacity theories, I.S. Code method, Effect of eccentricity, inclination of load, and water table. Raft Foundation: Settlement and Bearing Capacity analysis.
Section B	Proportioning of footing, Settlement of footings on stratified deposits. Influence of adjacent footings, Bearing Capacity from SPT and SCPT and Plate load Test data, proportioning of footing based on settlement criteria, Foundations on Problematic soils - Problems and Remedies.
Section C	Deep Foundation: Modes of failure, bearing capacity and settlement of pile foundation, Types of piles, Allowable load, Pile Load test, Dynamic and static formulae, Bearing Capacity factors, Pile group bearing capacity and settlement, Behavior of piles under lateral loading, Winkler's assumption, Pile resistance and deflection under lateral loads, elastic method, Broms method.
Section D	Well Foundation, Bearing capacity, settlement and lateral resistance, Tilts and shifts, Drilled Shaft, Construction procedures, Design Considerations, Load Carrying Capacity and settlement analysis.

Course Outcomes

- ✓ Evaluate the importance of raft foundation and principles of design for buildings and tower structures.
- ✓ Identify and discuss the role and importance of advancements in foundation engineering
- ✓ Identify and discuss the issues and concepts related to different type of foundations
- ✓ Identify and discuss the IS and IRC codal provisions provided for foundation systems

Text Books:

1. Principles of Foundation Engineering by Braja M Das, Cengage Learning Custom Publishing.
2. Poulos, H. G. and Davis, F. H., “Pile Foundation Analysis and Design”, Wiley and Sons.

Reference Books:

1. Foundation Design Principles and Practice by D.P. Coduto, Pearson Education India
2. Bowles, Joseph E., “Foundation Analysis and Design”, Mc-Graw Hill.

Name of the Course	Earth Retaining Structures		
Course Code	**MCE- 5017**	Credits:4	L-4, T-0, P-0
Lectures	4 Hours/Week		
Semester End Examination	Max. Time: 3 hrs.	Max. Marks:100	Min. Pass Marks: 40
Internal Assessment (based on sessional tests 50%, Tutorials/Assignments30%, Quiz/Seminar10%, Attendance10%)		Max. Marks: 50	

Instructions :

For Paper Setters: The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates: Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objectives

- ✓ To understand fundamental aspects of Rankine and Coulomb theories
- ✓ To understand the behaviour of different type of retaining walls
- ✓ To understand how to evaluate stability analysis of Reinforced soil walls and Braced excavations
- ✓ To understand lateral earth pressure theories and pressure theories and design of retaining walls

Section	Course Content
Section A	Introduction, Rankine and Coulomb theories, Graphical method, Passive earth pressure by curved rupture surface. Stability analysis of gravity type, Cantilever type, Counter fort type retaining walls, Design of Soil reinforced retaining walls.
Section B	Rigid retaining structures: Types; stability analysis. Flexible retaining structures: Types; material; cantilever sheet piles; anchored bulkheads– methods of analysis, moment reduction factors; anchorage.
Section C	Reinforced soil walls: Elements and stability. Soil arching. Braced excavation: Pressure distribution in sands and clays; bottom heave. Underground structures in soils: Pipes; tunnels. Tunneling techniques.
Section D	Braced excavations, Analysis and design of sheet piles, Stability of slopes, Finite and infinite slopes, Swedish circle method, Taylor's modified Swedish circle method, Taylor's stability charts and Bishop's method of analysis.

Course Outcomes

- ✓ Identify and discuss the role and importance of rigid and flexible retaining structures
- ✓ Identify and discuss the issues and concepts related to analysis and design of sheet piles
- ✓ Identify and discuss the complex issues inherent to stability of slopes
- ✓ To learn various earth retaining structures and computation of earth pressure against these structures
- ✓ Basic geotechnical design aspects of some of these structures

Text Books:

1. Principles of Geotechnical Engineering by Braja M. Das, Thomson
2. Soil Mechanics and Foundation Engineering by Dr. K. R. Arora, Standard Publisher Dist.
3. Das B.M., Principles of Foundation Engineering, Cengage Learning, 2007.

Reference Books:

1. Earth pressure and earth retaining structures by Clayton, Milititski and Woods, Taylor & Francis Group, London.
2. Bowles J.E., Foundation Analysis and Design, McGraw Hill, 1996.
3. Ranjan G. and Rao A.S.R., Basic and Applied Soil Mechanics, New Age Publishers, 2000.

Name of the Course	**Soil- Structures Interaction Analysis**		
Course Code	**MCE- 5018**	**Credits:** 4	L-4, T-0, P-0
Lectures	4 Hours/Week		
Semester End Examination	Max. Time: 3 hrs.	Max. Marks: 100	Min. Pass Marks: 40
Internal Assessment (based on sessional tests 50%, Tutorials/Assignments 30%, Quiz/Seminar10%, Attendance10%)		Max. Marks: 50	

Instructions :

For Paper Setters: The question paper will consist of 6 questions from four sections A, B, C & D. There will be at least one question from each section and will carry 20% of the total marks of the semester end examination for the course. Question may consist of subparts.

For Candidates: Candidates are required to attempt five questions in total. Use of non- programmable calculator is allowed.

Course Objectives

- ✓ To impart knowledge about soil-structure-interaction under different foundations.
- ✓ To familiarize the students with design and analysis of sub-structures incorporating with the effect of soil-structure interaction.
- ✓ To introduce the analysis and concepts of shallow and deep foundations.
- ✓ To enable the students to design shallow foundations embankments, transmission towers, piles and water front structures using advanced analytical techniques and software

Section	Course Content
Section A	Soil-Foundation Interaction: Introduction to soil-foundation interaction problems, Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behavior.
Section B	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.
Section C	Module III Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions.
Section D	Elastic Analysis of Pile: 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, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system, Solutions through influence charts.

Course Outcomes

- ✓ To know different types of foundations, their general requirements and loads imposed.
- ✓ To learn the analysis of conventional footings.
- ✓ To analyze the behavior of pile foundations, transmission towers and water front structures.
- ✓ To learn various techniques of soil-structure interaction analysis.

Text Books:

1. Soil-Structure Interaction by A. S. Cakmak, Elsevier
2. Soil-Structure Interaction: Numerical Analysis and Modelling by J.W. Bull, CRC Press.
3. Principles of Geotechnical Engineering by Braja M. Das, Thomson.

Reference Books:

1. N.P. Kurien, Design of Foundation Sytems: Principles & Practices, Narosa, New Delhi 1992,
2. E.S. Melerski, Design Analysis of Beams, Circular Plates and Cylindrical Tanks on Elastic Foundation, Taylor and Francis, 2006.
3. L.C. Reese, Single piles and pile groups under lateral loading, Taylor & Francis, 2000
4. G. Jones, Analysis of Beams on Elastic foundation, Thomas Telford, 1997.

Admission & Eligibility Criteria for M. Tech. Admissions

1. The admission process and eligibility criteria for the Master of Technology (M. Tech.) in Civil Engineering program shall be in accordance with the norms prescribed by the All India Council for Technical Education (AICTE), which are as follows:
   - B.Tech./B.E./AMIE in Civil Engineering with 55% (50% for SC/ST/PC candidates) marks in qualifying examination.
2. The admission to the M.Tech. program shall be based on the merit of valid GATE score and left out seats will be filled on the basis of the merit of qualifying exam.

OR

University may conduct entrance examination for deciding the merit, in case the number of applications received are more than 100.

3. The total number of student intake shall be 18, plus supernumerary seats as per HPU norms.
4. The entrance test will be based on Multiple Choice Questions (MCQ) with a total of 100 marks, each question carrying one mark. There will be no negative marking.

Course Duration

The M. Tech. programmes in UIT shall be of two (02) year duration, spread over four (04) semesters and shall be run-on Full-Time basis. It may be extended to a maximum duration of 5 years with approval from the appropriate authority.

The details of semester wise course outlines and syllabi are available on UIT website.

Departmental Master Programme Committee (DMPC) under Faculty of Engineering and Technology

Each academic Department shall have a Departmental Master Programme Committee (DMPC) for dealing with academic matters (admission process: counseling, presentation/thesis evaluation, etc.) pertaining to Master's Degree Programme.

Constitution of DMPC

Any faculty member holding an Engineering degree may be appointed as a member of the DMPC. The DMPC shall have the following constitution:

1.	Chairperson, DMPC	HoD
2.	Convener, DMPC	To be nominated by the Head of the Department (HoD)
3.	***Additional Members**	
	1. One Professor, if available (otherwise Associate/Assistant Professor with PhD)	Member
	2. One Associate Professor, if available (otherwise Assistant Professor with PhD)	Member
	3. One Assistant Professor	Member
	4. One Professor/ Associate Professor/ Assistant Professor	
	from anotherDepartment (To be nominated by the HoD, in consultation with the Departmental)	Member

**In case there is not a sufficient faculty member in a particular Department/Centre, Head may nominate faculty holding an Engineering degree from other Departments/Centres of the university.*

3. The student may choose to have a co-supervisor, subject to the approval of the DMPC.

4. The final evaluation of the M.Tech. Thesis shall be conducted through a public defense, open to all, wherein the candidate shall present and defend their research work before a panel of examiners. In the event that the candidate's performance is deemed unsatisfactory, He/She shall be required to reappear for a subsequent defense, subsequent to incorporating the necessary revisions and improvements, until the evaluation process is successfully completed.