University Institute of Technology (UIT)

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

(NAAC Accredited "A-Grade" University)

DEPARTMENT
of
CIVIL ENGINEERING

Course Work Syllabus

for

Doctor of Philosophy
in
Civil Engineering

Effective from the Session 2021-2022

SEMESTER-WISE COURSES OF STUDY FOR DOCTORAL PROGRAM

Course Code	**Course Title**				**Credits**	**Marks**	
SEMESTER-I							
		L	**T**	**P**	**C**	Ext.	Int.
HSMC-9010	Research Methodology	3	1	0	4	100	50
XX-XXXX	Elective-1	3	1	0	4	100	50
XX-XXXX	Elective-2	4	0	0	4	100	50
	Total	**12**			**12**	**450**	

COURSES OF STUDY FOR DOCTORAL PROGRAMME

S. No.	SubjectCode	Course Title	L	T	P	Credit
1.	CE-9001	Geotechnical Earthquake Engineering	3	1	0	4
2.	CE-9002	Geo-environmental Engineering	3	1	0	4
3.	CE-9003	Soil Dynamics	3	1	0	4
4.	CE-9004	Advance Foundation Engineering	3	1	0	4
5.	CE-7023	Engineering Geology and Rock Mechanics	3	1	0	4
6.	CE-9005	Clay Mineralogy	3	1	0	4
7.	CE-9006	Earth Retaining Structures	3	1	0	4
9.	CE-7021	Finite Element Analysis	3	1	0	4
10.	CE-7012	Ground Improvement Techniques	3	1	0	4
11.	CE-9007	Stability Analysis of slopes	3	1	0	4
12.	CE-9008	Landslide Analysis and Control	3	1	0	4
13	CE-9009	Advance Soil Mechanics	3	1	0	4
14	HSMC-9010	Research Methodology	3	1	0	4

Name of the Course	**Advance Soil Mechanics**		
Course Code	**CE-9009**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
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 five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:

Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculators is allowed.

Course Objectives

- To understand fundamental aspects of soil mechanics
- To understand the effect of rate of stress on shear parameters
- To understand how to evaluate stability analysis of slopes

Section	Course Content
Section-A	Fundamental aspects of soil mechanics, characteristics of soil, particulate nature, weight volume relationship. Flow of water through soils, permeability, flow-nets, Theory of elasticity, few aspects of elasticity, plane stress and plane strain problems, Pore water pressure, undrained loading, determination of pore water pressure parameters. Behaviour of compacted soils- General, Effect of compaction on structure, Swelling pressure, Shrinkage, Shear Strength, Pore Water pressure, Permeability, Comparison of dry of O.M.C & wet of O.M.C.
Section-B	Immediate settlement, Methods of determination, Estimation of preconsolidation pressure. Three- dimensional consolidation precompression of clay deposits with and without sand drains. Secondary consolidation factors.
Section-C	Shear strength parameters of cohesionless and saturated cohesive soils, Principles of Effective stress condition, Effect of rate of stress on shear parameters, Stress- Strain relationship, Skempton's Pore pressure coefficients,

	Hvorslev's true shear parameters, Effect of over consolidation on shear parameters.
Section-D	Consolidation, Terzaghi's 1-D consolidation theory, layered soils, time dependent loading, 2-D problems, 3-D consolidation (axisymmetric problems, vertical drains), creep/secondary consolidation and basic of rheological models. Stability analysis of slope-effective vs. total stress analysis, Bishop's rigorous analysis, Short method, Bishop Morgenstem stability co-efficients.

Course Outcomes:

Course Outcomes:

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

COs1: Describe the behaviour of the soils.
COs2: Apply principles of advanced soil mechanics to civil engineering problem
COs3: Analyse the effect of flow of fluids through soils
COs4: Evaluate the compressibility of soils.

Text Books:

1. Basic and Applied Soil Mechanics by Gopal Ranjan & A. S. R. Rao, New Age International Pvt. Ltd. (2006)
2. Advanced Soil Mechanics by Braja M Das, CRC Press. (2013)

Reference Books:

1. Soil Mechanics Fundamentals by Muni and Bhudu, John Wiley & sons.
2. Soil Mechanics and Foundation Engineering by Dr. K. R. Arora, Standard Publisher Dist.
3. Lambe & Whitman "Soil Mechanics", John Wiley & Sons.
4. Scott, R.F. Principles of Soil Mechanics, Reading, Mass., Addison-Wesley Pub. Co.

Name of the Course	**Geotechnical Earthquake Engineering**		
Course Code	**CE-9001**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
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 five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:

Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculators 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

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, List of major earthquakes, Causes of earthquakes, Sources of earthquake data, 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, Spatial Variability of Ground Motion,

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, Stiffness, damping and plasticity parameters of soil and their determination; Correlations of different soil parameters; Liquefaction (basics, evaluation and effects), Liquefaction hazard map, Lateral Spreading. Magnitude Indicators, Segmentation, Earthquake Source Characterization.
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 displacement based analysis, seismic uplift capacity of ground anchors, Codal provisions/guidelines for seismic design of geotechnical structures.

Course Outcomes:

COs1: Identify and discuss the role and importance of Geotechnical Earthquake Engineering

COs2: Identify and discuss the issues and concepts salient to damped and undamped systems.

COs3: Identify and discuss the complex issues inherent in Ground Response Analysis,

COs4: Analyze and able understand earthquake magnitude, ground motion

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. Milutin Srbulov,"Geotechnical Earthquake Engineering: Simplified Analyses with Case Studies and Examples", Springer-Verlag.
3. D. D. Barkan,"Dynamics of Bases and Foundations", McGraw-Hill Book Company.

Name of the Course	**Geo-Environmental Engineering**		
Course Code	**CE-9002**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
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 five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculators 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

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. Waste Disposal Facilities: Types, Siting criteria, Waste containment principles, Types of barrier materials.
Section-B	Planning and design aspects relating to waste disposal in landfills, in ash ponds and tailings ponds, and in rocks. Landfill design and considerations: Precipitation, hydrological consideration in land fill design, site selection for landfills, characterization of land fill sites, waste characterization, stability of landfills, current practice of waste disposal, passive containment system.
Section-C	Environmental monitoring around landfills. Detection, control and remediation of subsurface contamination. Geosynthetics in environmental geotechnics: Application of geo synthetics in solid waste management, rigid or flexible liners, bearing capacity of compacted fills, foundation for waste fill ground.

Section-D	Ground water pollution: Ground water pollution, pollution of aquifers by mixing of liquid waste, protecting aquifers.

Course Outcomes:

COs1: Identify and discuss the role and significance of concepts related to environmental geotechnics

COs2: Identify and discuss the complex issues related to ground water pollution.

COs3: Predict the potential for methane production in a landfill and assess the feasibility of waste-to-energy conversion.

COs4: Conduct research on geoenvironmental topic.

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	**Soil Dynamics**		
Course Code	**CE-9003**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
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 five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:

Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculators 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

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, Principles 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:

COs1: Identify and discuss the role and importance of concepts related to soil dynamics

COs2: Identify and discuss the issues and concepts related to Dynamic Earth Pressure Problem and Retaining wall

COs3: Identify and discuss the complex issues related to foundations.

COs4: Identify and discuss the issues related to liquefaction.

Text Books:

1. Soil Dynamics by Shamsher Prakash, McGraw Hill Higher Education.
2. Soil Dynamics by Swami Saran Pvt LTD, New Delhi.

Reference Books:

1. Geotechnical Engineering by C. Venkatramaiah,New Age International Publishers.

Name of the Course	**Advance Foundation Engineering**		
Course Code	**CE-9004**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
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 five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculators is allowed.

Course Objectives

- 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	Assessments of foundation loads, Choice of foundation types, Determination of bearing capacity by theoretical approaches, penetration tests and plate load tests, Proportioning of footings by conventional and uniform settlement methods.
Section-B	Shallow foundations, requirements for satisfactory performance of foundations, methods of estimating bearing capacity, settlements of footings and rafts, proportioning of foundations using field test data, Footings on layered soils and sloping grounds.
Section-C	Classification of pile foundations, axial load carrying capacity of a single pile by different methods, negative skin friction, pile group efficiency, distribution of load to piles in groups, Design of pile sand pile cap; settlement analysis of single pile and pile groups; Laterally loaded piles, under-reamed piles; Construction of pile foundation, pile driving equipment and Pile load tests; durability and protection of piles, economics of pile foundations.

Section-D	Well foundation, IS and IRC codal provisions, elastic theory and ultimate resistance methods. Coffer dams, various types, analysis and design, Foundations under uplifting loads

Course Outcomes:

COs1: Identify and discuss the role and importance of advancements in foundation engineering

COs2: Identify and discuss the issues and concepts related to different type of foundations

COs3: Identify and discuss the IS and IRC codal provisions provided for foundation systems

COs4: Identify a suitable foundation system for a structure.

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	**Engineering Geology and Rock Mechanics**		
Course Code	**CE-7023**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
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 five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:

Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non- programmable calculators is allowed.

Course Objectives

- To understand fundamental aspects of engineering geology and 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 simplified 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, Chamber test & 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, shear zone 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:

COs1: Identify and discuss the role and importance of rock mechanics and classification of rocks

COs2: Identify and discuss the issues and concepts related to situ testing of rocks and stabilization of rocks.

COs3: Identify and discuss the complex issues inherent in stabilization of rocks and foundation of rocks.

COs4: Assess the impact of natural forces on Civil engineering structures and other such projects.

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. (2010)

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, Jojn 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	**Ground Improvement Techniques**		
Course Code	**CE-7012**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
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 five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

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

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 Prefabricated 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 – under reamed piles.

Course Outcomes:

COs1: Identify and discuss the role and importance of ground improvement methods

COs2: Identify and discuss the complex issues related to stabilization of problematic soils

COs3: Identify and discuss the complex issues related to expansive soils

COs4: Identify and Discuss various compaction techniques vibratory method.

Text Books:

1. Ground Improvement by M.P. Moseley and K. Kirsch, Spon Press. (2005)
2. Ground Control and Improvement by Petros P Xanthakos, Lee W Abramson and Donald A Bruce, Wiley Inter science.

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	**Clay Mineralogy**		
Course Code	**CE-9005**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
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 five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:

Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

Course Objectives:

- To understand fundamental aspects of origin of soils and its chemical and physical properties
- To understand the effect of effect of clay minerals on engineering properties of soils

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. pHhydrolylic, 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:

COs1: Identify and discuss the issues related to chemical and physical characterization of soils.
COs2: Identify and discuss the various methods for stabilization of soils.
COs3: Identify and discuss the issues related to saline and alkaline soils.
COs4: Identify and discuss the Effect of clay minerals on engineering properties of soils.

Text Books:

1. Clay mineralogy by Ralph, E. Grim, McGraw hill book Co., New York, 1953.
2. Blyth " Engineering Geology", CRC Press

Reference Books:

1. Clay mineralogy by Ralph, E. Grim, McGraw hill book Co., New York, 1953.

Name of the Course	**Finite Element Analysis**		
Course Code	**CE-7021**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
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 five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

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

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 Isoparametric 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:

COs1: Identify and discuss the issues and concepts related to FE Formulation and analysis of structural frames
COs2: Identify and discuss the complex issues related to Nonlinear Problems.
COs3: Apply principles of different Finite Element Formulation Techniques
COs4: Assess the Application of FEM in Civil Engineering

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 Finite Element Analysis", 3rd Ed., John Wiley. 1989

Reference Books:

1. T. J. R. Hughes, "The Finite Element Method: Linear Static and Dynamic Analysis", Prentice Hall. 1987 4. Klaus Juergen Bathe, "Finite Element Procedures", Prentice Hall of India. 2003
2. O. C. Zienkiewicz, R. L. Taylor & J. Z. Zhu., "The Finite Element Method Its Basis & Fundamentals", Elsevier Publications. (2005)

Name of the Course	**Earth Retaining Structures**		
Course Code	**CE-9006**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
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 five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:

Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

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

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, Counterfort 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:

COs1: Identify and discuss the role and importance of rigid and flexible retaining

structures

COs2: Identify and discuss the issues and concepts related to analysis and design of sheet piles

COs3: Identify and discuss the complex issues inherent to stability of slopes

COs4: Identify and discuss the complex issues related to Reinforced soil walls.

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.

Reference Books:

3. Earth pressure and earth retaining structures by Clayton, Milititski and Woods, Taylor & Francis Group, London.

Name of the Course	**Stability Analysis of Slopes**		
Course Code	**CE-9007**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
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 five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

Course Objectives:

- To understand fundamental aspects of stability analysis of slopes
- To understand the effect of seepage on stability of soil and rock slopes
- To understand how to evaluate stability of slopes and design of slope stabilization measures

Section	**Course Content**
Section-A	Introduction, classification of natural slopes and excavation failures, slope stability – mechanics of slope failure, failure modes Collection and analysis of geological data, field survey and testing, graphical presentation of geological data and evaluation of potential slope problems
Section-B	Seepage analysis, in-situ permeability tests, two-dimensional flow – Laplace equation and it's solution, graphical method, determination of phreatic line, flow nets in homogeneous and zoned earth dams under steady seepage and draw-down conditions, seepage control in earth dams, influence of seepage on slope stability
Section-C	Soil slopes, infinite slope, method of slices, friction circle methods etc., Bishop's modified method, Bishop's rigorous method, Janbu's method, Morgenstern and Price, Spencer's method, stability analysis of dam body during steady seepage

	Rock slopes, methods of slope stability analysis, plane failure, wedge failure, over toppling failure, Hoek & Bray's charts, three-dimensional wedge analysis, seismic considerations, computer programs, use of non-linear failure criterion in rock slope stability analysis
Section-D	Strengthening measures, stabilization of slopes by drainage methods, surface and subsurface drainage, use of synthetic filters, retaining walls, stabilization and strengthening of slopes, shotcreting, rock bolting and rock anchoring . Instrumentation and monitoring of slopes, slope movements, warning devices, maintenance of slopes

Course Outcomes:

COs1: Identify and discuss the role and importance of collection and analysis of various data for slope stability

COs2: Identify and discuss the issues and concepts salient to seepage analysis

COs3: Identify and discuss the slope strengthening measures

COs4: Identify and discuss the methods of slope stability analysis.

Text Books:

1. Hoek, E. and Bray, J.W, "Rock Slope Engineering" Institution of Mining Engineering.
2. Singh, B. and Goel, R. K, "Software for Engineering Control of Landslides and Tunneling Hazards", A A Balkema.

Reference Books:

1. Giani, G.P., "Rock Slope Stability Analysis", A A Balkema.
2. Wyllie Duncan C and Christofer W Mah, "Rock Slope Engineering" Spon Press, Taylor and Francis Group.
3. Harr M. E, " Ground Water and Seepage", McGraw Hill.
4. Chowdhary Robin and Chowdhary Indrajit, "Geotechnical Slope Analysis", CRC Press.

Name of the Course	**Landslide Analysis and Control**		
Course Code	**CE-9008**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
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 five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:
Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. A non- programmable calculator is allowed to use in examinations.

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.

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, Groundwater system analysis for landslides
Section-D	Remediation techniques Early warning systems, Disaster Mitigation, Sustainability and environmental issues

Course Outcomes

COs1: Identify and discuss the role and importance of landslides in earth systems.
COs2: Identify and discuss the issues and concepts salient to stability analysis soil and rock slopes.
COs3: Identify and discuss the remediation techniques for landslide control
COs4: Identify and discuss the role and importance of Sustainability and Environmental issues.

Text Books:

1. Singh, B. and Goel, R.K., "Rock Mass Classification – A Practical Engineering, Approach", (2011)
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	**Research Methodology**		
Course Code	**HSMC-9010**	Credits-4	L-3, T-1, P-0
Total Lectures	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	Max Marks: 100	Min. Pass Marks: 40	Max. Time: 3 Hrs.
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 five Sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective Sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For Candidates:

Candidates are required to attempt five questions in all selecting one question from each of the Sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

Course Objectives:

- To formulate a viable research question.
- To distinguish probabilistic from deterministic explanations.
- To analyse 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 database 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 a research finding, Copy right, Cyber laws.

Course Outcomes:

COs1: Identify and discuss the role and importance of research in the social sciences.
COs2: Identify and discuss the issues and concepts salient to the research process.
COs3: Identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design, and implementing a research project.
COs4: 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.
2. Wayne L. Winston, "Microsoft Excel Data Analysis and Business Modelling", Microsoft Press.

Reference Books:

1. Kumar, "Research Methodology: A Step-by-Step Guide for Beginners", Pearson Education. 2018
2. Dawson, C., "Practical Research Methods", UBSPD Pvt. Ltd. (2000)