POSTGRADUATE DIPLOMA IN GEOTECHNICAL ENGINEERING

Department of Civil Engineering
Faculty of Engineering
University of Peradeniya

Course Structure

Course code	Title	Compulsory/ Optional	Credits
CE 6101	Research Methods in Civil Engineering	Optional	2
CE 6301	Engineering Geology and Rock Mechanics	Compulsory	3
CE 6302	Advanced Foundation Engineering	Compulsory	3
CE 6303	Slope Stability and Earth retaining Structures	Compulsory	3
CE 6304	Problematic Soils and Ground Improvement	Compulsory	2
CE 6305	Application of Numerical Methods in Geotechnical Engineering	Compulsory	2
CE 6306	Site investigation, testing and instrumentation	Compulsory	3
CE 6307	Earth and rockfill dams	Optional	2
CE 6308	Engineering Geological Exploration	Optional	2
CE 6309	Geology for Engineers	Optional	1
CE 6310	Soil Mechanics and Geotechnical Engineering	Optional	1
CE 6311	Theoretical Soil Mechanics	Optional	2
CE 6313	Geo-Environmental Engineering	Optional	2
CE 6314	Mitigation and Control of Natural Geo-hazards	Optional	2
CE 6315	Geotechnical Construction	Optional	2
CE 6316	Forensic Geotechnical Engineering	Optional	2
CE 6102	**Independent Study**	**Compulsory**	**3**

Number of credits from compulsory courses: 16
Number of credits from optional courses: 6
Number of credits from Independent Study: 3
Total number of credits: 25

Course Code	**: CE 6101**
Course Title	**: Research Methods in Civil Engineering**
No. of Credits	**: 2**
Pre-requisites	**: -**
Compulsory/Optional	**: Optional**

Aim(s): To give the skills needed to plan and conduct a research study in order to create new knowledge in the field of Civil Engineering and related disciplines.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

1. Describe the scientific research methods and how this applies to graduate research studies
2. Prepare a literature review on a topic relevant to their area of concentration by critically reviewing published papers
3. Analyse the collected data and identify the appropriate methods for displaying the data.
4. Prepare an extended abstract and present the research findings in an oral/poster format.

Time Allocation (Hours)	Lectures: 18 Tutorials: 02 Practicals: Assignments: 20 Independent learning: 60 (Notional hours=100)

Course Content/Course Description:

Fundamentals of Research:

Definition and Objectives of Research; Qualitative vs Quantitative Research; The Scientific Research Process; Identification, selection, and formulation of research problems; Characteristics of good research problems; Review of literature

Data Collection, Analysis and Presentation:

Methods and techniques of data collection; Design of Experiments; Sampling and sampling designs; Statistical modelling and analysis including introduction to statistical package; Probability Distributions; Multivariate methods; Concepts of correlation and regression, error analysis; Effective presentation of information using Tables, illustrations, graphs, etc.

Scientific writing and presentation:

Essential components of abstract, introduction, literature review, materials and methods, results, discussion, and conclusions; Formatting of contents; Methods of referencing and the use of referencing tools, Preparing and presenting a technical presentation.

Recommended Texts

Fellows R.F., Liu A.M.M., (2015). "Research Methods for Construction", 4th edition, Wiley Blackwell.

Thiel D.V, (2014)."Research Methods for Engineers", 1st edition, Cambridge university press.

Wayne C., Booth G.G.C., Joseph M.W., (2008). "The Craft of Research", 3rd Edition University of Chicago Press.

Willie T., (2017). Research Methods: A Practical Guide for Students and Researchers, World Scientific.

Assessment		Percentage Marks
In-Course	Assignments/Course work	100
End of Semester Examinations		-

Course Code	**: CE 6301**
Course Title	**: Engineering Geology and Rock Mechanics**
No. of Credits	**: 3**
Pre-requisites	**: None**
Compulsory/Optional	**: Compulsory**

Aim(s): To impart knowledge on engineering properties of rocks and rock masses and to apply the same for civil engineering projects.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to,

1. Classify different types of rock masses and select suitable rock support systems.
2. Evaluate physical and engineering properties of rocks for engineering purposes.
3. Select suitable earth materials for different types of construction projects.
4. Describe effect of bedrock and unconsolidated materials, and the geological structures for large civil engineering projects.
5. Define failure criteria of rocks and determine the failure modes of rock slopes based on stereo-nets

Time Allocation (Hours)	Lectures: 36 Tutorials: Practical: 12 Assignments: 06 Independent learning: 96 (Notional hours = 150)

Course Content/Course Description:

Engineering classification of rock masses:

Rock Quality Designation (RQD), Rock structure rating (RSR) , Rock Mass Rating (RMR), and Slope Mass Rating (SMR) in engineering classification of rock masses

Engineering properties of rocks:

Physical, mechanical, hydraulic and chemical properties of Rock masses, general range of values in different rock types

Construction materials and energy sources:

Different types of coarse aggregates for civil engineering projects, sources of aggregates, selection of suitable materials for construction purposes, introduction to energy sources such as coal, petroleum, gas and geothermal sources

Geological consideration for civil engineering projects:

Selection of suitable sites for dams and reservoir projects, tunnels and underground openings, roads, bridges and other constructions, Effect of geological structures and types of foundation on rock

Failure criteria of rocks

Theory of rock failures, failure criterion for rocks, Introduction to stereographic analysis , use of stereo-nets for stability analyses

Underground excavations and rock supports:

Design for tunnel supports on the basis of rock classification

Recommended Texts

Attewell P.B., Farmer I.W. (2012). "Principles of Engineering Geology", Springer.
Bell F.G., (1980). "Engineering Geology and Geotechnics", Newnes-Butterworths.
Blyth F.G.H., Freitas M.H.de., (1984). "Geology for Engineers", ELBS Publication.
Jumikis A.R., (1979). "Rock mechanics", Trans Tech Publ. - Technology & Engineering.
Vutukuri V.S., Katsuyama K., (1994). "Introduction to Rock Mechanics", Industrial Publishing and Consulting, Inc.

Assessment		**Percentage Marks**
In-Course	Assignments/Course work	40
	Mid Semester Examination	-
End of Semester Examinations		60

Course Code	**: CE 6302**
Course Title	**: Advanced Foundation Engineering**
No. of Credits	**: 3**
Pre-requisites	**: None**
Compulsory/Optional	**: Compulsory**

Aim(s): To impart knowledge and understanding of fundamental concepts of bearing capacity theory, to analyse and design different types of shallow foundations subjected to static and dynamic loads and deep foundations subjected to axial/lateral loads and uplift using Eurocode 7.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to,

1. Analyse and design different types of shallow foundations including spread, strap, combined and raft foundations subjected to static and dynamic loads.
2. Analyse and design axially loaded single and group piles and caisson foundations in granular and cohesive soils.
3. Analyse and design laterally loaded piles and piles subjected to uplift.
4. Carry out a comprehensive design of foundations of a proposed building considering the soil stratigraphy at the site and loading conditions

Time Allocation (Hours)	Lectures: 40 Tutorials: Designs: 10 Assignments: Independent learning: 100 (Notional hours = 150)

Course Content/Course Description:

Shallow foundations:

Bearing capacity theories, Shallow foundation design using Eurocode 7, eccentric and inclined loads, bearing capacity on slopes, Bearing capacity of layered soils, foundation settlements

Design of combined and raft foundations:

flexible and rigid design of combined footings and raft foundations

Machine foundations:

Types of machines, design criteria, elements of vibration theory, governing equations

Deep foundations:

Introduction, bearing capacity of group piles, Quality Control and Quality assurance of pile foundation, Design of deep foundations using Eurocode 7, Negative skin friction, Pile group settlement, Rock socketed piles, Laterally loaded piles, Piles subjected to uplift, Design of Caissons in sand and clay

Design Exercise:

Design of foundation of a building

Recommended Texts

Das B.M., (2011).“Principles of Foundation Engineering”, 7th edition, PWS Publishers.

Coduto D.P., (2001). “Foundation design principles and practices”, 2nd edition, Prentice Hall.

Smith I., (2014). “Smith’s Element of Soil Mechanics (Design to Eurocode)”, 9th edition, Blackwell publishing.

Tomlinson M., Woodward J., (2007). “Pile design and construction practice”, 5th edition, Taylor and Francis.

Frank R., (2004). “Designers' guide to EN 1997-1 Eurocode 7: Geotechnical design-General rules”, Thomas Telford.

Orr T.L.L., Eric R.F.,(2012). “Geotechnical design to Eurocode 7”, Springer Science & Business Media.

PLAXIS 2D, (2015). “Scientific Manual”.

STN E., (2004). “Eurocode 7: “Geotechnical design. Part 1: General rules, BS EN 1997-1: 2004”, Bratislava: Slovak Standards Institute, Slovak Republic.

Assessment		Percentage Marks
In-Course	Assignments/Course work/Design	20
	Mid Semester Examination	30
End of Semester Examinations		50

Course Code	**: CE 6303**
Course Title	**: Slope Stability and Earth Retaining Structures**
No. of Credits	**: 3**
Pre-requisites	**: None**
Compulsory/Optional	**: Compulsory**

Aim(s): To impart knowledge and skills to enable students to analyse stability of slopes and earth retaining structures.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to,

1. Classify mass movements, describe factors causing mass movements and propose suitable remedial measures to control mass movements.
2. Analyse the stability of slopes using limit equilibrium method and Bishop and Morgenstern chart.
3. Analyze and design various earth retaining structures for internal and external stability.
4. Identify the reason for real field slope and retaining wall failures and propose measures to mitigate such failures in the future.

Time Allocation (Hours)	Lectures: 40 Tutorials: Practicals: Assignments: 10 Independent learning: 100 (Notional hours = 150)

Course Content/Course Description:

Mass movements:

Classification, causative factors, instrumentation, preventive, remedial and control measures

Slope Stability Analysis using EC7:

EC7 guidelines for slope stability analysis, Design of slopes to EC7, Limit equilibrium methods, Bishop and Morgenstern Chart

Design of rigid and flexible earth retaining structures using EC7:

Lateral earth pressure: Rankine's and Coulomb's theory, Introduction to earth retaining structures, EC7 guidelines for designing earth retaining structures, Design of mass concrete retaining wall and cantilever retaining wall to EC7

Introduction to sheet pile walls (Cantilever and anchored sheet pile walls), EC7 guidelines for sheet pile wall design, Fixed and free earth support methods of design of anchored sheet pile walls. Analyse internally stabilized earth wall (MSE walls), Soil nailing

Case study on slope and retaining failure:

Case studies on slope and retaining wall failures

Recommended Texts

Abramson L.W., (2002). "Slope Stability and Stabilization Methods", 2nd edition, John Wiley & Sons.

Budhu M., (2008). "Foundations and Earth Retaining Structures", John Wiley & Sons, Inc., New York, 483 pp.

Smith, I. (2014). "Smith's elements of soil mechanics", 9th Edition, John Wiley & Sons.

Assessment		Percentage Marks
In-Course	Assignments/Course work/Design	40
	Mid Semester Examination	-
End of Semester Examinations		60

Course Code	**: CE 6304**
Course Title	**: Problematic Soils and Ground Improvement**
No. of Credits	**: 2**
Pre-requisites	**: None**
Compulsory/Optional	**: Compulsory**

Aim(s): To give knowledge on problematic soils and to design suitable ground improvement technique to be used for construction in problematic soils, testing of geosynthetics and designing with geosynthetics for drainage, filtration and reinforcement.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

1. Identify problematic soils, describe methods of evaluating them, and propose suitable measures to overcome their effects on geotechnical construction.
2. Describe different types of geosynthetics and their engineering applications, tests to evaluate physical, mechanical and hydraulic properties, and design for drainage, filtration and reinforcement.
3. Describe widely used ground improvement techniques and appraise their applicability and limitations, and design relevant ground improvement measures.

Time Allocation (Hours)	Lectures: 27 Tutorials:03 Practical: Assignments: Independent learning: 70 (Notional hours=100)

Course Content/Course Description:

Problematic soils:

Collapsible soils - formation, types, identification methods, construction techniques; Expansive soils - identification, testing, swell potential, construction techniques; Peat - formation, types, construction techniques; sanitary landfills - introduction, settlement considerations.

Geosynthetics:

Types and applications of geosynthetics, Testing geosynthetics to evaluate physical, mechanical and hydraulic properties, designing for drainage, filtration and reinforcement.

Ground Improvement techniques:

Importance of ground improvement, prerequisites for ground improvement, common ground improvement methods: surface and deep compaction, sand columns, preloading and vertical drains, dynamic consolidation, geotextiles, mechanical and chemical stabilization, preliminary design considerations in ground improvement methods.

Recommended Texts

Han J., (2015). "Principles and Practices of Ground Improvement", 1st edition, Wiley PWiley& Sons, Inc.

Kirsch K., Bell A., (2013). "Ground Improvement", 3rd edition, CRC Press.

Koerner R.M., (1998). "Designing with Geosynthetics", 4th edition, Prentice Hall.

Raisan C.A., (2004). "Ground Improvement", 1st edition, Thomas Telford Publishers.

Assessment		**Percentage Marks**
In-Course	Assignments/Course work	30
	Mid Semester Examination	-
End of Semester Examinations		70

Course Code **Course Title** **No. of Credits** **Pre-requisites** **Compulsory/Optional**	**: CE 6305** **: Application of Numerical Methods in Geotechnical Engineering** **: 2** **: None** **: Compulsory**
Aim(s): To develop the ability of the students to learn and apply numerical methods to solve geotechnical problems through the effective use of computer software, understanding the limitations.	
Intended Learning Outcomes: On successful completion of the course, the student should be able to; 1. Explain the use of numerical techniques in solving boundary and initial value problems in Engineering, understanding their limitations. 2. Describe the use of finite element analysis in solving Geotechnical Engineering problems using appropriate models of soil behaviour. 3. Utilize numerical software such as GeoStudio (Slope/W, Sigma/W and Seep/W) and PLAXIS to analyse geotechnical problems and interpret the results.	
Time Allocation (Hours)	Lectures: 15 Tutorials: Practical: 20 Assignments: 10 Independent learning: 55 (Notional hours=100)
Course Content/Course Description: **Basic Numerical methods**: Finite difference method (FDM), finite element method(FEM), boundary element method (BEM), discrete element method (DEM) **Models of soil behaviour**: Model soil behaviour using linear elastic, Mohr-Coulomb, modified Cam Clay. Selection of material parameters for analysis. **Use of Numerical software**: GeoStudio (eg. Slope/W, Sigma/W and Seep/W to analyse slopes, stress-strain and seepage respectively) and PLAXIS (eg. to analyse shallow foundation, deep foundation and embankments)	
Recommended Texts Geo-Slope (2007). www.geo-slope.com Plaxis - Essential for geotechnical professionals. https://www.plaxis.com Potts D.M., Zdravkovic L., (1999). "Finite Element Analysis in Geotechnical Engineering – Theory", Thomas Telford Publishing Ltd., U.K. Wood D.M., (2004). "Geotechnical Modelling", Spon Press, London.	

Assessment		**Percentage Marks**
In-Course	Assignments/Presentations Mid Semester Examination	60 -
End of Semester Examinations		40

Course Code	**: CE 6306**
Course Title	**: Site Investigation, Testing and Instrumentation**
No. of Credits	**: 3**
Pre-requisites	**: None**
Compulsory/Optional	**: Compulsory**

Aim(s): To impart knowledge on ground investigation planning, testing and report preparation and monitoring of the field performance through instrumentation.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to,

1. Describe principles of site investigation, Plan a site investigation programme and prepare a site investigation report.
2. Describe direct methods of site investigation and obtain required quality samples for laboratory testing.
3. Use appropriate semi-direct/ indirect techniques in a site investigation programme and interpret results.
4. Select soil parameters for design and describe relevant testing methods for the evaluation of such soil parameters.
5. Use field instrumentation for load, displacement, inclination and pore pressure measurements to monitor the field performance.

Time Allocation (Hours)	Lectures: 30 Tutorials: 04 Practical:20 Assignments: 02 Independent learning: 94 (Notional hours = 150)

Course Content/Course Description:

Planning of exploration

Planning an exploration program, methods of exploration, exploration for preliminary and detailed design, spacing and depth of bores, data presentation

Exploration techniques

Methods of boring and drilling, limitations of various drilling techniques, stabilization of boreholes, bore logs.

Soil and rock sampling

Disturbed and undisturbed sampling

Laboratory and Field Testing of soils

Testing procedure, limitations, correction and data interpretation of laboratory and field testing methods.

Field Instrumentation and Monitoring

Field instrumentation for load, displacement and pore pressure measurements, Monitoring and interpretation of field measurements

Recommended Texts

Dunnicliff J., Green G.E., (1993). "Geotechnical Instrumentation for Monitoring Field Performance", John Wiley.

Hanna T.H., (1985). "Field Instrumentation in Geotechnical Engineering", Trans Tech.

BS 5930:2015.,(2015).“Code of Practice for Ground Investigations”

Assessment		**Percentage Marks**
In-Course	Assignments/presentations	40
	Quizzes	20
	Mid Semester Examination	-
End of Semester Examinations		40

Course Code	**: CE 6307**
Course Title	**: Earth and Rockfill Dams**
No. of Credits	**: 2**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): To impart knowledge on earth and rockfill dams with regard to selection of dam type, salient features in design, influence of pore water pressure, construction and design aspects, construction problems, special shear tests, effects of impounding and drawdown, seepage and stability analyses, instrumentation and monitoring with case histories.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

1. Describe different types and features of earth and rockfill dams for different site conditions, design considerations on seepage, pore pressure development and deformations, and protective measures.
2. Develop filter design criteria for different filter types.
3. Apply analytical, experimental and numerical methods to estimate the rate of seepage through or under the dam and evaluate the effects of seepage on the stability of the dam under various operational conditions using numerical analysis.
4. Describe construction aspects and problems with regard to earth and rockfill dams.
5. Specify special shear strength tests to be performed and propose an instrumentation and monitoring plan for the assessment of the stability of the dam.

Time Allocation (Hours)	Lectures: 30 Tutorials: Practicals: Assignments: Independent learning: 70 (Notional hours =100)

Course Content/Course Description:

Types and Features of Earth and Rockfill Dams:

Different types of earth and rockfill dams, Functions of earth and rockfill dams, Controlling factors in selection of dam types, Failures and Damages of embankment dams, Shear strength of embankment.

Design considerations of Earth and Rockfill Dams:

Selection of a dam type, Types of slope protection, Selection of type of slope protection, Foundation Design of rockfill dams, Modification of existing dams.

Treatment for Earthfill Dams:

Foundation treatment of earth fill dams, Shaping of foundations, Excavation dewatering.

Protective Filters in Earth and Rockfill Dams:

Filter types, Drainage and Transition Filters, Design of filters

Seepage through Dams:

Methods of analysis of seepage, Numerical analysis of seepage through dams using software

Stability Analysis of Dams:

Effective and total stress analysis, Loading conditions, Drawdown analysis, Factor of safety criteria, Numerical methods of analysis for different loading conditions using software.

Construction Aspects and Problems:

Case study on construction aspects of a dam: Study of regional geology, Site inspection, In-situ tests to evaluate strength-deformation and hydraulic characteristics, Remedial works

Dam Instrumentation and Monitoring:

Instrumentation and Monitoring Considerations, Instrumentation types (seepage, water pressure, earth pressure, deformation), Instrumentation installation and construction considerations

Recommended Texts

Christian Kutzner, (1997), Earth and Rockfill Dams: Principles for Design and Construction, CRC Press.

Robert B. Jansen, (1988), Advanced dam engineering for Design, Construction and Rehabilitation. VanNostrand Reinhold. Task Committee to Revise Guidelines for Dam Instrumentation (Author), Kim de Rubertis (Editor), (2018). Monitoring Dam Performance: Instrumentation and Measurements, American Society of Civil Engineers		
Assessment		**Percentage Marks**
In-Course	Assignments/Course work	50
End of Semester Examinations		50

Course Code	**: CE 6308**
Course Title	**: Engineering Geological Explorations**
No. of Credits	**: 2**
Pre-requisites	**: None**
Compulsory/Optional	**: Compulsory/Optional**

Aim(s): To apply knowledge on engineering properties of rock masses and to familiarize in geological exploration for civil engineering practice.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

1. Describe methods of engineering geological investigations for large projects.
2. Evaluate engineering properties of rocks.
3. Determine methods to be used to prevent possible unstable sites, and long term investigation methods.
4. Describe methods of assessments of the environmental impact during and after completion of a project.
5. Select methods of solid waste management in urban areas.

Time Allocation (Hours)	Lectures: 26 Tutorials: Practicals: Assignments: 08 Independent learning: 66 (Notional hours=100)

Course Content/Course Description:

Methods of geological and geophysical explorations for site selections:

Detail investigation methods for large projects such as dams and reservoirs, roads, bridges, tunnel construction and other underground opening, subsurface investigation methods of resistivity survey and seismic refraction survey and analysis.

Field and Laboratory testing of rocks:

Determination of physical, mechanical and hydraulic properties of rock masses, chemical tests for mineral identification, sulphate attack, etc.

Landslide investigation, mapping, prevention and control:

Methods of investigation, methods to stabilize unstable slopes.

Environmental Impact Assessment:

Method of assessment, guidelines for dams and reservoirs, etc.

Solid waste management:

Classification of solid wastes, selection of waste disposal sites, management methods.

Recommended Texts

Attewell P.B., Farmer I.W., (2012). "Principles of Engineering Geology", Springer.
Bell F.G., (1980). "Engineering Geology and Geotechnics", Newnes-Butterworths.
Vutukuri V.S., Katsuyama K., (1994). "Introduction to Rock Mechanics", Industrial Publishing and Consulting, Inc.

Assessment		**Percentage Marks**
In-Course	Assignments/Course work	30
End of Semester Examinations		70

Course Code	**: CE 6309**
Course Title	**: Geology for Engineers**
No. of Credits	**: 1**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): To introduce basic geology for civil engineering students and to familiarize with geological terminology and concepts commonly encountered in engineering practice.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

1. Identify the rock forming minerals, formation process of rocks and different rock types.
2. Apply knowledge of geological structures for professional civil engineering practice.
3. Define geological processes.
4. Interpret geological maps for Civil Engineering purposes.

Time Allocation (Hours)	Lectures: 13 Tutorials: Practical: Assignments: 04 Independent learning: 33 (Notional hours=50)

Course Content/Course Description:

Rock types:

Rock forming minerals, metamorphic, igneous rocks, sedimentary rocks.

Geological processes:

structure of the earth, internal and external processes, Theory of plate tectonics, Plate boundaries,, Earthquakes and volcanoes, weathering and erosion , mass movement , Physical features of ground, land formation

Geological structures:

Faults, Folds, Joints, and other geological structures.

Geological Maps:

Different types of geological maps, introduction to engineering consideration of rocks and rock distribution

Recommended Texts

Blyth F.G.H, Freitas M.H.de., "Geology for Engineers", (2006). 7th edition, ELBS Publication.
Cooray P.G., (1984). "An Introduction to the Geology of Sri Lanka", National Museums of Sri Lanka, Vol 38.

Assessment		Percentage Marks
In-Course	Assignments/Course work	20
End of Semester Examinations		80

Course Code	**: CE 6310**
Course Title	**: Soil Mechanics and Geotechnical Engineering**
No. of Credits	**: 1**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): To impart the knowledge on the factors governing the engineering behaviour of soils and the suitability of soils for different geotechnical engineering applications.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

1. Select suitable soils for various geotechnical engineering applications based on the factors governing the engineering behaviour of soils.

Time Allocation (Hours)	Lectures: 10 Tutorials: Practical: 10 Assignments: Independent learning: 30 (Notional hours=50)

Course Content/Course Description:

Soil Deposits and Clay Minerals

Different soil deposits and their engineering properties, Genesis of clay minerals: classification and identification

Compaction, Swelling and Shrinkage behaviour of Soils

Problems associated with swelling and shrinkage behaviour of soils, factors influencing swell – shrink characteristics, sensitivity, soil suction, soil compaction: factors affecting soil compaction.

Compressibility, Shear Strength and Permeability of Soils

Compressibility, shear strength and permeability behaviour of fine and coarse grained soils, mechanisms and factors influencing engineering properties, liquefaction potential

Recommended Texts

Craig R.F., "Soil Mechanics", (2004). Chapman & Hall, New York.
Lamb T.W., Whitman R.V., (1969). "Soil Mechanics", John Wiley & Sons, New York.

Assessment		**Percentage Marks**
In-Course	Practicals/Course work	30
End of Semester Examinations		70

Course Code	**: CE 6311**
Course Title	**: Theoretical Soil Mechanics**
No. of Credits	**: 2**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): To impart knowledge required for computing stress and deformation at any point in the soil through limit theorems, characterize stress-strain behaviour, failure criteria and to evaluate shear strength parameters of soils.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to,

1. Evaluate upper and lower bounds and true collapse loads of soil structures.
2. Select shear strength and compressibility parameters of soil to be used in designing structures for different conditions of loading, drainage and failure criteria.
3. Predict soil response due to various loading conditions using the Critical State framework.

Time Allocation (Hours)	Lectures: 25 Tutorials: 04 Practical: Assignments: 02 Independent learning: 69 (Notional hours = 100)

Course Content/Course Description:

Failure Theories:

Concepts of yield and failure in soils: Failure theories of von Mises, Tresca and their extended form, their applicability to soils.

Theory of Plasticity:

Hardening law, flow rule, bound theorems, mechanism for plane plastic collapse, discontinuities, solutions for undrained and drained loading conditions

Critical State Soil Mechanics:

The critical state line, Roscoe's surface, Hvorslev's surface, Behaviour of sand: Effects of dilation, Elastic and plastic deformation: Cam clay model, Modified Cam clay model, Soil Parameters for design

Recommended Texts

Atkinson J.H., (2007). "The Mechanics of Soils and Foundations", Taylor and Francis, London.
Craig R.F., (2004). "Soil Mechanics", Chapman & Hall, New York.
Lamb T.W., Whitman R.V., (1969). "Soil Mechanics", John Wiley & Sons, New York.
Scott C.R.., (1974). "An Introduction to Soil Mechanics and Foundations", Applied Science Publishers Ltd., London.
Wood D.M., (1990). "Soil Behaviour and Critical State Soil Mechanics", Cambridge University Press.

Assessment		Percentage Marks
In-Course	Assignments/Course work	30
	Mid Semester Examination	-
End of Semester Examinations		70

Course Code	**: CE 6313**
Course Title	**: Geo-Environmental Engineering**
No. of Credits	**: 2**
Pre-requisites	**: None**
Compulsory/Optional	**: Elective**

Aim(s): To impart knowledge of engineering principles related to characterization of fluids and geomedia, fate and transport of contaminants in soil and groundwater, characterization of contaminated geosystems and remediation techniques, and modelling of contaminant migration in geo-environments.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

1. Characterize geomaterials, fluids, and environmental contaminants in relation to mass and energy transport in different geosystems (e.g., soil, groundwater, landfills etc.)
2. Evaluate fate and transport of environmental contaminants in subsurface and their implications on geo-environmental problems, and apply relevant mathematical frameworks for transport simulations.
3. Evaluate different contaminated geosystems, risk assessment methods and selection of appropriate remediation techniques

Time Allocation (Hours)	Lectures: 25 Tutorials: Practical: Assignments:10 Independent learning: 65 (Notional hours=100)

Course Content/Course Description:

Basic characteristics of soils:

Soil formation, soil texture, structure, particle and pore networks

Phase relationship, physico-chemical interactions between phases, electrokinetics and double layer theory

Transport of fluids in soils:

Energy state of water in soil, flow in saturated and unsaturated soils, steady/unsteady flow, governing equations in saturated and unsaturated flow in soil, gas flow in unsaturated subsystems.

Governing equations for transport of fluids in soil and groundwater

Introduction to multiphase flow in soil-water-gas systems

Characterization of environmental contaminants:

Hazardous environmental chemicals, organic and inorganic chemical background in contaminants, analytical methods for physical, chemical and biological characterisation of contaminants.

Contaminant fate and transport in soil and groundwater:

Main contaminant transport mechanisms in subsurface, physical, chemical and biological contaminant transfer in soil, contaminant transport and fate modelling

Contaminated site characterization and risk assessment:

Preliminary and detailed site investigations, standard risk assessment procedures and methods

Design and application of site remediation techniques:

Vertical barriers, surface caps, groundwater pumping systems, subsurface drains, soil vapour extraction, electrokineric remediation, thermal desorption, phytoremediation, pump and treat, permeable reactive barriers, air sparging, landfill cover design and maintenance.

Recommended Texts

Reddy L.N., Hilary I.I.,(2000). "Geo-environmental Engineering, Principles and Applications", Marcel Dekker, Inc. ISBN: 0-8247-0045-7.

Sharma H.R., Reddy K.R.,(2004). "Geo-environmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies", Wiley and sons. ISBN: 978-0-471-21599-8.

Assessment		Percentage Marks
In-Course	Assignments/Course work Mid Semester Examination	40 -
End of Semester Examinations		60

Course Code	**: CE 6314**
Course Title	**: Mitigation and Control of Geo Hazards**
No. of Credits	**: 2**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): To provide knowledge on identification, risk assessment, mitigation and control of geo-hazards.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

1. Classify major types of geo-hazards.
2. Perform reliability/risk analyses.
3. Apply suitable mitigation and control measures.

Time Allocation (Hours)	Lectures: 25 Tutorials: Field Visit:08 Assignments: 02 Independent learning: 65 (Notional hours=100)

Course Content/Course Description:

Introduction to Geo-hazards :

Different types of geo-hazards, causes for geo-hazards, case studies.

Rock falls and Landslides:

Classification of mass movements of soils and rocks, failure mechanisms, Investigation and instrumentation, Prevention, control and mitigation, Early warning systems

Land Subsidence and Sinkholes:

Sinkholes, ground water depletion

Volcano and Earthquakes :

Theory of plate tectonics, Volcanoes and Earthquakes

Salinity intrusion:

Types, causes, mitigation methods

Manmade hazards:

Eg. - Underground storage of hazardous waste, spill of hazardous materials, mining, land fills

Recommended Texts

Bolt B.A., Horn W.L., MacDonald G.A., Scott R.F, (1975)."Geological Hazards, Earthquakes-Tsunamis - Volcanoes, Avalanches - Landslides – Floods", Springer.

Davies T.,ShroderJr.J.F.(2004). "Landslide Hazards, Risks, and Disasters", Elsevier.

McCallG., LamingD., ScottS., (1992). "Geohazards, Natural and Man-Made", Springer.

Assessment		**Percentage Marks**
In-Course	Assignments/Course work	40
End of Semester Examinations		60

Course Code	**: CE 6315**
Course Title	**: Geotechnical Construction**
No. of Credits	**: 2**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): To impart knowledge on construction with regard to both surface and underground structures including construction techniques, stability and maintenance aspects.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

1. Demonstrate understanding of fundamental construction principles and techniques.
2. Use production modelling techniques to select suitable plant and techniques for construction projects recognising the construction environment.
3. Recognise the limitations of the theory when applied to construction, and appreciate the relevance performance monitoring during and after construction.

Time Allocation (Hours)	Lectures: 24 Tutorials: Practical: Assignments: 12 Independent learning: 64 (Notional hours=100)

Course Content/Course Description:

Earth moving:

Equipment, Excavation, Lifting, Loading and Hauling

Piling:

Cast in-situ piles, Driven pile, Quality Control, Handling

Dewatering and Grouting method:

Cofferdam, Caissons, grouting methods

Offshore Construction:

Dredging, offshore piling

Ground Improvement:

Compaction, Dynamic Compaction, Soil stabilisation, preloading, PVD

Recommended Texts

Bergado B.T., Anderson L.R., Miura N., Balasubramaniam A.S., (1996). "Soft Ground Improvement in Lowland other Environments", ASCE Press, New York.

McNally G., (1998)."Soil and Rock Construction Materials", E & FN Spon, London and New York.

Moseley M.P., Kirsch K., (2004). "Ground Improvement", Spon Press, London and New York.

Nunnally S.W., (2011)."Construction Methods and Management", Prentice-Hall, New York.

Assessment		**Percentage Marks**
In-Course	Assignments/Course work	40
End of Semester Examinations		60

Course Code	**: CE 6316**
Course Title	**: Forensic Geotechnical Engineering**
No. of Credits	**: 2**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): To impart knowledge and skills on how to investigate and determine the geotechnical causes contributing to distress of a structure and propose and design suitable remedial measures as required.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

1. Identify various types of structural failures due to geotechnical and other reasons.
2. Differentiate between problems related to: structures in problematic soil, lateral movements, ground water, moisture and vibration, and propose suitable mitigation/design measures.
3. Explain various techniques used to repair foundations and slopes.
4. Identify soil and foundation problems based on crack diagnosis.

Time Allocation (Hours)	Lectures: 22 Tutorials: Case Study: 08 Assignments: 08 Independent learning: 62 (Notional hours=100)

Course Content/Course Description:

Forensic Geotechnical and Foundation investigation:

Forensic investigation – site visit, non-destructive testing, monitoring, sampling and laboratory testing, report writing

Settlement of structures - types of structures, causes of settlement, allowable settlement.

Expansive soil – swelling, types of expansive soil movements, foundation design for expansive soil, pavements.

Lateral movement - rock falls, slope failures, landslides, retaining walls, deep excavations, ground improvement, dam failures

Ground water and moisture problems - moisture migration through floor slabs, moisture migration through basement walls, pipe breaks, surface drainage

Repairs and crack diagnosis:

Repair of slab-on-grade foundations - reinforced mat, partial removal/strengthening of foundation, concrete crack repairs

Repair of slope failures - Rebuilding, geogrid, soil-cement repair, pipe piles

Crack diagnosis - introduction, pavement cracks, cracks in walls, foundation cracks, ground cracks and fissures

Recommended Texts

Day R.W., (2011). "Forensic Geotechnical and Foundation Engineering", 2nd edition, The McGraw Hill companies.

Assessment		**Percentage Marks**
In-Course	Assignments/Course work	50
End of Semester Examinations		50

Course Code	: CE 6102
Course Title	: Independent Study
No. of Credits	: 3
Pre-requisites	: None
Compulsory/Optional	: Compulsory

Aim(s): To train the students to carry out a literature review, identify a research gap/complex engineering problem, formulate a methodology and present the preliminary findings.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

1. search for technical literature and information from various sources and conduct a review.
2. formulate a research/complex engineering problem based on the identified knowledge gap and develop appropriate methodology to solve the problem.
3. carry out a preliminary analysis based on the developed methodology.
4. write a report and present the findings in a precise and coherent manner with all relevant information.

Time Allocation (Hours)	Notional hours = 300

Course Content/Course Description:

Self-studies:

Search of technical literature, identify the knowledge gap, formulate aim, objectives and scope, develop a methodology, collect data, carry out a preliminary analysis, and present the findings in the form of presentations and a report.

Meetings with supervisor:

Conduct progress meetings with the supervisor, discuss the progress, and receive feedback from the supervisor for the presentation and report.

Recommended Texts

Geoffrey R.M., David D., David F., (2005). "Essentials of Research Design and Methodology", John Wiley & Sons.

Creswell J. W., David J. C., (2017). "Research Design: Qualitative, Quantitative, and Mixed Methods", John SAGE Publications.

Assessment	**Percentage Mark**
In-Course **Progress evaluations:** **Three progress evaluations:** Progress evaluation 1: Oral presentation 1 Progress evaluation 2: Oral presentation 2 Progress evaluation 3: Oral presentation 3	30
Final Evaluation: Final report Presentation	 40 30