Module Descriptor Form

Civil and Environmental Engineering

CL314 - Geotechnical Engineering 1

Module Code	CL314	**Module Title**	Geotechnical Engineering 1				
Module Registrar	Pedrotti, Dr Matteo						
Other Staff Involved							
Credit Weighting	20	**Semester**	1/2	**Elective**	No	**Academic Level**	3
Pre-requisites							
Required for	CL810						

Module Format and Delivery (hours):

Lectures	Tutorials	Assignments	Labs	Private Study	Total
32	16	12	12	128	200

Educational Aim

This module aims to:

This class introduces geology with an emphasis on engineering geology and practical rock mechanics. We introduce some basic concepts of geology with the aim of understanding the formation of geological features that impact on engineering geology. We also consider how the Earth's climate has influenced geological processes through time and how future climate change will impact engineering practice. This class aims to give the student an understanding of the fundamental behaviour of soils in compression and shear and how the shear strength is applied to the design of geotechnical structures. The course covers in detail, both in lectures and laboratories, the main tests for shear strength and their interpretation. We will also consider the differences between how the concepts of shear strength , Mohr circles and stress states are applied to soils and rocks.

CL314 - Geotechnical Engineering 1

Syllabus

This module will teach the following:

The course will teach the following;
Semester 1 Engineering Geology
Topic 1.1: How the Earth works: surface processes and rock types. Planet Earth and plate tectonics; geological time and unconformities; igneous, sedimentary and metamorphic rocks; mineral and rock identification.
Topic 1.2: Formation and failure of rock mass features. Rock deformation: fractures, folding and faulting. Intrusions. Rock weathering products, transportation and deposition. Engineering behaviour of rocks, three primary modes of failure in slopes: plane, toppling, wedge failure.
Topic 1.3: Interpreting geological maps. How to read geological and draft geological maps. Common uncertainties and errors. Mapping and description of rock masses, intact behaviour, influence of discontinuities on strength and permeability.
Topic 1.4: Stresses in rocks. Stresses in rocks. Mohr's circles applied to rock failure
Topic 1.5: Glaciation. The influence of glaciation on the engineering properties of rocks and soils.
Topic 1.6: Surface processes. Weathering, erosion, mass wasting, soil formation. Climate change mitigation, adaptation and effects on infrastructure.

Semester 2: Geotechnical engineering
Revision of stress and strain analysis
Definitions of normal and shear stresses. Stress-strain relationships for compressive tests. Models for soil shear strength, elasticity and plasticity.
Topic 2.1: Shear strength from direct shear testing
Direct shear apparatus, typical results from direct shear tests, laboratory direct shear testing of sand samples. Interpretation of laboratory data and derivation of shear strength criterion in terms of effective stress .
Topic 2.2: Mohr's Circle of Stress
Derivation and application of Mohr's circle to geotechnical engineering. Determination of the normal and shear stresses on any plane using the graphical method for Mohr's circle. Principal stresses. Pole method.
Topic 2.3: Shear strength from triaxial testing
Laboratory triaxial shear testing. Analysis of triaxial test data. Derivation of shear strength parameters using the Mohr-Coulomb failure criteria.
Topic 2.4: Types of Triaxial Test
Control of drainage in triaxial tests. Drained and undrained tests and derivation of drained and undrained shear strength. The three principal types of triaxial test and their application to geotechnical problems.
Topic 2.5: Stress Invariants and Stress Paths
The various definitions of stress invariants. Derivation of shear strength parameters from stress invariants. Stress paths for drained and undrained conditions.
Topic 2.6: Shear Strength in Practice
Field testing; SPT, CPT and field vane tests. Application of shear strength parameters to geotechnical design problems.

CL314 - Geotechnical Engineering 1

Learning Outcomes

On Completion of the module, the student is expected to be able to:

LO: 1	Demonstrate how surface and tectonic processes produce textures within a rock mass that are of relevance to engineers (mechanical and hydraulic properties).
LO: 2	Discuss how stresses within rock can lead to failure of natural and engineered rock slopes.
LO: 3	Discuss the climate system and the implications of climate change for engineering in practice
LO: 4	Understand stress analysis and the mechanisms underlying soil shear strength.
LO: 5	Determine shear strength under drained and undrained conditions from direct shear and triaxial test data.
LO: 6	Understand and determine shear strength in practice.

(UK SPEC suggests no more than 4 learning outcomes per module. Statements must be broad and be syllabus free and link in with the intended learning outcomes on the programme specifications.)

CL314 - Geotechnical Engineering 1

Assessment of Learning Outcomes - Criteria

Learning Outcome: **1**

	Criteria
1	C1 Describe the three major rock types and their typical rock mass characteristics s
2	C2 Describe the formation of soils from weathering of rock
3	C3 Discuss how geological maps are made and the uncertainties within geological maps

Learning Outcome: **2**

	Criteria
1	C1 Describe the typical features within a rock mass that affect its engineering properties (mechanical and hydraulic properties)
2	C2 Discuss how stresses within rock can lead to failure of natural and engineered slopes.

Learning Outcome: **3**

	Criteria
1	C1 Discuss the pace and scale of the changes to Earth’s climate system
2	C2 Discuss the implications of climate change for engineering practice, such as increased storminess, rising sea levels etc

Learning Outcome: **4**

	Criteria
1	C1 Analyse stresses in uniaxial and triaxial stress states.
2	C2 Understand and apply Mohr’s circle of stress.

Learning Outcome: **5**

	Criteria
1	C1 Derive effective stress shear strength parameters from direct shear test data.
2	C2 Derive effective and total stress shear strength parameters from triaxial test data.

Learning Outcome: **6**

	Criteria
1	C1 Understanding the behaviour of real soils during shearing, residual strength and sensitivity
2	C2 Use field test data to estimate shear strength, and how to analyse the results of shear vane tests.

CL314 - Geotechnical Engineering 1

Assessment Method(s) Including Percentage Breakdown and Duration of Exams

To Pass the module, students need to gain a summative mark of: 40%

Description	Semester	Start Week	Duration	Weight	Submission Week	Linked Criteria
Lab 1 Rock classification	1	3		5%	3	LO 1: C1
Lab 2: Map Interpretation	1	5		10%	5	LO 1: C3
Lab 3: Making maps	1	10		10%	10	LO 1: C3
Exam Rocks. Closed Book	1		2.00	25%	E	LO 1: C1, C2, C3 LO 2: C1, C2 LO 3: C1, C2
Quiz 1 – Direct Shear	2	1		3%	2	LO 4: C1, C2
Quiz 2 – Mohr's circles	2	2		3%	3	LO 5: C1, C2
Quiz 3 – Triaxial Test	2	3		3%	4	LO 5: C1, C2
Quiz 4 – Types of Triaxial Tests	2	5		3%	6	LO 6: C1, C2
Quiz 5 – Stress Invariants	2	6		3%	7	LO 5: C1, C2
Lab 4: Shear stress experiments	2	7		10%	10	LO 5: C1, C2 LO 6: C1, C2
Quiz 6 - Shear Strength in Practice	2	8		3%	10	LO 5: C1, C2 LO 6: C1, C2
Exam Soils. Closed Book	2		1.00	25%	E	LO 4: C1, C2 LO 5: C1, C2 LO 6: C1, C2

Principles of Assessment Feedback

1. A range of assessment activities are used including tutorial work and on-line quizzes. Model answers for assessment tasks are provided giving opportunities for students to make comparisons against their own work.
2. All assessments are clearly related to the learning outcomes and assessment feedback is provided against clearly stated criteria.
3. Assessments and methods are clearly explained to students at the start of the course
4. The effectiveness of the assessment and feedback methods are reviewed at the end of the course and any recommended changes are implemented in the next academic year.

Additional Information

Assessments for Labs 1, 2, and 3 are due at the end of each three-hour lab session. The assessment for Lab 4 is due at the end of Week 10.
All lab dates are currently indicative until the final lab timetable is confirmed.

Resit Procedure

Formal examination in July.

NB: The July examination marks are 100% of the resit marks.

Recommended Reading

Essential Reading;

Grotzinger J., Jordan T. H., Press F., Siever R.. Understanding Earth, Eighth Edition (2020). ISBN:9781319059859 Paperback. https://www.macmillanlearning.com/college/ca/product/Understanding-Earth/p/131905532X

Fossen, Haakon, Structural Geology. 480 pages, Cambridge University Press ISBN-13: 978-0521516648 eBook: http://www.uib.no/People/nglhe/StructuralGeoBook.html
Associated online resources: http://folk.uib.no/nglhe/StructuralGeoBookEmodules.html

Craig, R.F. & Knappett, J.A., Craig's Soil Mechanics, 8th edn., (2012) Spon Press, ISBN 978-0-415-56126-6.

Further reading;
Powrie, W., Soil Mechanics; Concepts and Applications, 2nd edn., (2004), Spon Press, ISBN 0-415-31156-X.
Atkinson, J.H., Mechanics of Soils and Foundations, 2nd edition (2007). CRC Press, ISBN 978-0-415-36256-6.
John McPhee Control of Nature, 288 pages Farrar, Straus and Giroux, ISBN-13: 978-0374522599

CL314 - Geotechnical Engineering 1

Module Timetable

Week	Semester 1	Semester 2
0		
1		
2		Submission 3%
3	Lab 5%	Submission 3%
4		Submission 3%
5	Lab 10%	
6		Submission 3%
7		Submission 3%
8		
9		
10	Lab 10%	Lab 10%, Submission 3%
11		
E	Examination 25%	Examination 25%

Date of Last Modification

15-09-2025