MODULE DESCRIPTOR 2021/22

CL314 Geotechnical Engineering 1

Course Registrar: Professor Zoe Shipton	**Taught To (Programme)** Civil Engineering / Civil and Environmental Engineering	
Other Lecturers Involved: New Geotechnical Engineering lecturer – to be appointed	**Credit Weighting: 20**	**Semester: 1 & 2**
Assumed Pre-requisites: CL217 Soil Mechanics	**Compulsory course**	**Academic Level: 3**

Course Format and Delivery (hours):

Lecture	Tutorial	Laboratory	Coursework	Project	Private Study	**Total**
32	16	12	12		128	200

Course Aim(s)

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 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.

Learning Outcomes

On completion of the course the student is expected to be able to;

LO1 Understand stress analysis and the mechanisms underlying soil shear strength.

LO2 Determine shear strength under drained and undrained conditions from direct shear and triaxial test data.

LO3 Understand the behaviour of soil during consolidation.

LO4 Demonstrate how surface and tectonic processes produce textures within a rock mass that are of relevance to engineers (mechanical and hydraulic properties).

LO5 Discuss how stresses within rock can lead to failure of natural and engineered slopes.

LO6 Discuss the climate system and the implications of climate change for engineering in practice

Syllabus

The course will teach the following;

Semester 1 Engineering Geology

Topic 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 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 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 4: Stresses in rocks. Recap of semester 1 with an emphasis on stresses in rocks. Mohr's circles applied to rock failure

Topic 5: Glaciation. The influence of glaciation on the engineering properties of rocks and soils.

Topic 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 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: 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 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 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 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 6: Shear Strength in Practice
Field testing; SPT, CPT and field vane tests. Application of shear strength parameters to geotechnical design problems.

Programme Threads

Thread	Primary	Secondary	Contributory
Design		**LO1, LO2, LO4, LO5**	
Health, Safety & Risk Assessment	**LO5**		**LO2, LO4**
Sustainability	**LO6**		
Maths for Engineers	**LO1 – LO2**		**LO3**
Industry		**LO3, LO4**	**LO1 – LO6**
Professional Skills	**LO2**		

Assessment Criteria

For each of the Course Learning Outcomes the following criteria will be used to make judgements on student learning:

LO1 Understand stress analysis and the mechanisms underlying soil shear strength.
C1 Analyse stresses in uniaxial and triaxial stress states.
C2 Understand and apply Mohr's circle of stress.

LO2 Determine shear strength under drained and undrained conditions from direct shear and triaxial test data.
C1 Derive effective stress shear strength parameters from direct shear test data.
C2 Derive effective and total stress shear strength parameters from triaxial test data.
C3 Predict failure conditions in the triaxial test.

LO3 Understand the behaviour of soil during consolidation
C1 Calculate degree of consolidation of clay deposit
C2 Calculate pore-water pressure evolution in a consolidating clay deposit
C3 Determine consolidation coefficient from oedometer testing
C4 Determine 1-D compressibility from oedometer testing
C5 Calculate consolidation and final settlements

LO4 Demonstrate how surface and tectonic processes produce textures within a rock mass that are of relevance to engineers (mechanical and hydraulic properties).
C1 Describe the three major rock types and their typical rock mass characteristics
C2 Describe the formation of soils from weathering of rock
C3 Discuss how geological maps are made and the uncertainties within geological maps

LO5 Discuss how stresses within rock can lead to failure of natural and engineered slopes.
C1 Describe the typical features within a rock mass that affect its engineering properties (mechanical and hydraulic properties)
C2 Discuss how stresses within rock can lead to failure of natural and engineered slopes.

LO6 Discuss the climate system and the implications of climate change for engineering in practice
C1 Discuss the pace and scale of the changes to Earth's climate system
C2 Discuss the implications of climate change for engineering practice, such as increased storminess, rising sea levels etc

The standards set for each criterion per Learning Outcome to achieve a pass grade are indicated on the assessment sheet for all assessments.

Principles of Assessment and Feedback
See https://www.strath.ac.uk/staff/policies/academic/
Please state briefly how these are incorporated in this module.

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.

Recommended Reading

Essential Reading;

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

Grotzinger J., Jordan T. H., Press F., Siever R. Understanding Earth**,** Fifth Edition (2007). ISBN-10: 0-7167-6682-5 Paperback, 672 pages WH Freeman. https://store.macmillanlearning.com/us/product/Understanding-Earth/p/1464138745

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

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

PLEASE NOTE:
Students need to gain a summative mark of 40% to pass the course. Students who fail the course at the first attempt will be re-examined during the August diet. This re-examination will consist entirely of an examination.

Resit Arrangements

Examination (100%)

Approved

Programme Director Signature:

Date of Last Modifications: August 2021

Assessment and Feedback Schedule

Class Code	CL314	Class Title	Geotechnical Engineering 1

Brief Description of Assessment

Semester 1 (50% weighting in total)

Engineering Geology is worth 50% of the total course. Laboratory coursework is undertaken in groups. Students must attend all 3 labs and submit their work within 2 weeks of the Laboratory via a MyPlace assessment. The labs are worth 5%, 10% and 10%.

End of semester exam, 2 hour duration (25% weighting).

Semester 2 (50% weighting in total)

CL314 Shear Strength Lab (8% weighting).

The laboratory coursework is undertaken in groups. See laboratory timetable for date and time of laboratories for each group. Students must attend all laboratory sessions for their group and complete the laboratory work to a satisfactory standard.

Each group will write a coursework report. The reporting requirements are fully described in a separate handout and the lectures.

One assessed tutorial, for exam preparation (2% weighting).

End of semester exam, of 2 hours duration (40% weighting).

Indicate in the tables below the Hand-Out (H), Submission (S) and Feedback (F) dates for each lab report/coursework/project and the timing of each Exam/Class Test (E), (T). Include duration of exam in brackets (e.g. E (2)).

Semester 1

Assessment type (& title)	LOs	Weight (%)	Individual / Group	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Wk12 Exam Period
Lab 1 Rock classification	LO4	5%	Group 1,2,3			H		S	F						
			4,5,6				H		SF						
Lab 2: Map Interpretation	LO4	10%	Group 1,2							H		S	F		
			3,4								H		SF		
Lab 3: Making map	LO4, 5	10%	Group 1,2									H		S	F
			3,4										H		SF

Exam	LO4-6	25%	Individual												E

*All submissions online through MyPlace apart from the exam

Semester 2 TBC

Assessment type (& title)	LOs	Weight (%)	Individual / Group	Form of Submission*	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period
Lab A	LO1-2	8%	Groups 1-6	Department					H		S		F			
Lab A	LO1-2	8%	Groups 7-12	Department						H		S		F		
Lab A	LO1-2	8%	Groups 13-18	Department							H		S		F	
Lab A	LO1-2	8%	Groups 19-24	Department								H		S	F	
Assessed Tutorial	LO1-2	2%	All Students	Tutor										S/F		
Exam	LO1-2	40%	All Students	Exam												E (2h)