MODULE DESCRIPTION FORM

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

CL803 – Geotechnics of Unsaturated Soils

Module Registrar: Prof Alessandro Tarantino	**Taught To (Course):** MEng Civil Engineering / MEng Civil and Environmental Engineering / MSc Civil Engineering / MSc Civil Engineering with Industrial Placement		
Other Lecturers Involved:	**Credit Weighting: 10-**	**Semester: 2**	
Assumed Prerequisites: UG Students: CL217, CL314, and CL419 PG Students: Soil mechanics (water flow, compressibility, consolidation, and shear strength) and fundamentals of Mechanics of Collapse	**Compulsory/ optional/ elective class** Compulsory for Geotechnical Stream in the MSc Civil Engineering / MSc Civil Engineering with Industrial Placement	**Academic Level: 5**	**Suitable for Exchange: Y**

Module Format and Delivery (HOURS i.e. 1 credit = 10hrs of study):

Lecture	Tutorial	Laboratory	Groupwork	External	Online	Project	Assignments	Private Study	**Total**
24	16		20					40	100

Educational Aim

This module aims to introduce advanced tools to analyse geotechnical structures at the ultimate limit state taking into account the effect of climate load

Learning Outcomes

On completion of the class the student is expected to be able to

LO1 Characterise the hydro-mechanical behaviour of soils under saturated and unsaturated conditions.

LO2 Develop analytical solutions to analyse the collapse of geotechnical structures under saturated and unsaturated conditions

LO3 Apply bounding theorems of plasticity to analyse collapse of simple slopes and retaining walls subjected to climate load.

LO4 Use numerical codes to analyse the stability of complex geotechnical structures subjected to climate load

Syllabus

The module will teach the following:

Topic 1: Water flow in saturated and unsaturated soils
Concept of suction, water retention behaviour, mass balance equation, Darcy's law for unsaturated porous media, analytical solutions for uncoupled flow, 'engineering' approach for conservative analysis of uncoupled water flow,

Topic 2: Shear strength of saturated and unsaturated soils
Extension of Mohr-Coulomb criterion to unsaturated soils, characterisation of shear strength of unsaturated soils using conventional equipment

Topic 3. Collapse of geotechnical structures
Plane-strain and stress in a plane. Rigid-perfectly plastic behaviour.
Plastic deformation and associated flow rule.
Lower bounding theorem of plastic collapse and application to drained and undrained analysis
Upper bounding theorem of plastic collapse and application to drained and undrained analysis

Topic 4. Analysis of collapse of geotechnical structures under saturated and unsaturated conditions
Prediction of excavation critical height.
Calculation of active thrust on gravity walls using bounding theorems of plasticity and basic design of gravity walls.
Calculation of active and passive thrust on diaphragm walls using bounding theorems of plasticity and basic design of diaphragm walls.
Calculation of slope factor of safety

Assessment of Learning Outcomes

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

LO1 Characterise the hydro-mechanical behaviour of soils under saturated and unsaturated conditions
C1 Estimate the shear strength of soils under unsaturated conditions.
C2 Estimate hydraulic behaviour of soils under unsaturated conditions.

LO2 Develop analytical solutions to analyse the collapse of geotechnical structures under saturated and unsaturated conditions
C1 Write down and solve equations to analyse stability of geostructures using lower bound theorem of plasticity
C2 Write down and solve equations to analyse stability of geostructures using upper bound theorem of plasticity

LO3 Apply bounding theorems of plasticity to analyse collapse of simple slopes and retaining walls
C1 Calculate critical height of excavation
C2 Analyse collapse condition of retaining structures
C3 Analyse collapse condition of slopes

LO4 Use numerical codes to analyse the stability of complex geotechnical structures subjected to climate load
C1 Analyse rainwater flow in flat and sloping ground
C2 Determine factor of safety of geotechnical structures with complex collapse mechanisms

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

Principles of Assessment and Feedback

(within Assessment and Feedback Policy at: https://www.strath.ac.uk/staff/policies/academic/)

Principle 1. Assessment and feedback practices promote effective student learning
Feedback is provided in real-time in an interactive fashion. Students are asked to solve problems of different level of complexity during the lecture and the lecture is tuned to the gaps shown by the students. In tutorials sessions, students are asked to become teachers by explaining tasks

Principle 2. Assessment and feedback practices are appropriate, fair, and transparent
These are discussed with the students at the beginning of the course and students' comments are taken into account

Principle 3. Assessment and feedback practices are clearly communicated to students and staff
These are discussed with the students at the beginning of the course and any point during the course should practices be revised

Principle 4. Assessment and feedback practices are continuously reviewed
We made use of mid-term questionnaires design to possibly adjust teaching approach

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

	Examinations				Courseworks		Projects	
	Number	Month(s)	Duration	***Weighting***	Number	***Weighting***	Number	***Weighting***
	1		3h	80	1	20		
L/Outcomes	L1 to L3				L4			

Indicate which learning outcomes (LO1, LO2 etc) are to be assessed by exam/coursework/project as required.

Coursework / Submissions deadlines (*academic weeks*):
Week 10 (Semester 2)

Resit Assessment Procedures:
Re-examination consists of exam only if the summative mark is lower than 50% and the exam mark is lower than 50%

Re-examination consists of coursework only if the summative mark is lower than 50%, coursework mark is lower than 50%, and exam mark is equal or greater than 50%

PLEASE NOTE:
Students must gain a summative mark of 50% to pass the module. Students who fail the module at the first attempt will be re-examined during the August diet.
If the re-examination consists of exam only, no marks from any previous attempts will be transferred to a new resit attempt.
If the re-examination consists of coursework only, the mark from first attempt exam will be transferred to a new resit attempt.

Recommended Reading

*****Purchase recommended **Highly recommended reading *For reference**

**Tarantino, A & Di Donna, A. (2019). Mechanics of unsaturated soils: simple approaches for routine engineering practice. *Italian Geotechnical Journal*.

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

*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.

Additional Student Feedback
(Please specify details of when additional feedback will be provided)

Date	Time	Room No
TBC	TBC	TBC

Session:

Approved:

Course Director Signature:

Date of Last Modifications: July 2021

ASSESSMENT TIMETABLE

Module Code	CL5xx	Module Title	Geotechnics of Unsaturated Soils

Indicate in the tables below the Hand-Out (H), Submission (S) and Feedback (F) week number for each assignment (lab report/coursework/project etc) and the timing of each Exam (E), Class Test (CT) or Quiz (Q)

Semester 1

Assessment type & title	LOs	Weight (%)	Individual or Group	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period

Semester 2

Assessment type & title	LOs	Weight (%)	Individual or Group	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period
Exam	1-3	80%	Individual												E (3h)
Coursework	4	20%	Group					H					S	F	