MODULE DESCRIPTOR 2021/22

CL419 Geotechnical Engineering 2

Course Registrar: Dr Stewart Beattie	**Taught To (Programme)** Civil Engineering / Civil and Environmental Engineering	
Other Lecturers Involved: Dr Alessia Amabile	**Credit Weighting: 20**	**Semester: 1 & 2**
Assumed Pre-requisites: CL314 Geotechnical Engineering 1	**Compulsory course**	**Academic Level: 4**

Class Format and Delivery (hours):

Lecture	Tutorial	Laboratory	Coursework	Project	Private Study	**Total**
32	16		40	40	72	200

Class Aim(s)

The aim of this course are to introduce students to the principles of the design of geotechnical structures to Eurocode 7, and then apply this knowledge together with the fundamental analytical methods, to the design of slopes, retaining walls and foundations. Design will be taught in the context of foundations, ground investigation and the development of ground models, in order to demonstrate how design is carried out in practice.

Learning Outcomes

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

LO1 Understand and apply the principles of geotechnical design based on Eurocode 7, considering limit states (ultimate & serviceability) and design geotechnical structures to Eurocode 7, including interpretation of ground investigation information.

LO2 Understand the principles governing the stability of slopes and in various ground conditions, design engineering slopes and understand how to mitigate natural slope failures.

LO3 Understand the principles governing the stability retaining walls in various ground conditions, and design gravity and embedded walls including anchor systems.

LO4 Calculate the design bearing capacities of shallow foundations and pile foundations, taking account of foundation shape, load inclination, load eccentricity and ground conditions.

Syllabus

The course will teach the following;

Semester 1

Topic 1. Introduction to geotechnical design
Introduction to geotechnical structures; slopes and embankments, shallow foundations, pile foundations, retaining walls. Serviceability limit state and ultimate limit state in Geotechnics. Design according to EC7 and application of partial factors. Process of geotechnical design. Analytical methods; limit equilibrium, plasticity theories, finite element, observational method.

Topic 2. Shallow Foundations
Bearing capacity of shallow foundations. Basis of bearing capacity theory (introduction to upper bound solutions). General shear failure, local shear failure and punching shear failure. Bearing capacity calculations for strip footings, bearing capacity factors for shape, depth and inclination. Ground movements related to foundations. Calculation of design resistance according to EC7. Geotechnical investigations and reporting.

Topic 3. Deep Foundations
Bearing capacity calculations for pile foundations. Pile load testing. Settlement of piled foundations. Negaive skin friction and piles in tension. Calculation of design resistance according to EC7.

Semester 2

Topic 4. Stability of slopes
Different types of slopes and slope failures (rotational, translational and compound slips). Stability analysis of infinite slopes, with and without seepage. Limit equilibrium methods and their limitations. Method of slices for undrained and drained analysis (Fellenius, Bishop). Surcharges and line loads, tension cracks, submerged slopes. Use of stability charts (Taylor and Bishop).

Topic 5. Stability of retaining walls
Earth pressure distributions for horizontal and sloping backfill using Coulomb and Rankine theories. Design of gravity retaining walls to EC7.
Types of embedded walls. Design of cantilever walls. Design of tied and propped walls. Anchors for sheet pile walls.

Assessment Criteria

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

LO1 Understand and apply the principles of geotechnical design based on Eurocode 7, considering limit states (ultimate & serviceability), to the design geotechnical structures.
C1 Develop a ground model from site investigation information and use this to identify characteristic values of properties.
C2 Identify a suitable design approach for the appropriate loading combinations and ground model.
C3 Optimise the design of geotechnical structures.
C4 Produce a concise geotechnical report.

LO2 Understand the principles governing the stability of slopes in various soil types, and design slopes.
C1 Analyse the stability of infinite slopes under different pore water pressure conditions.
C2 Analyse the stability of slopes under drained and undrained conditions using the method of slices.
C3 Design engineered slopes for different ground conditions using hand calculation and computer software.
C4 Understand the mechanisms of failure of natural slopes and strategies for landslide mitigation.

LO3 Understand the principles governing the stability of embedded walls in various soil types, and design embedded walls.
C1 Understand the behaviour of embedded walls and the influence of the water table.
C2 Analyse the stability of embedded walls under free-earth and fixed-earth conditions.
C3 Design embedded walls including the use of ground anchors to Eurocode 7.

LO4 Calculate the design bearing capacities of shallow foundations and pile foundations, taking account of foundation shape, load inclination, load eccentricity and ground conditions.
C1 Calculate the bearing capacity of shallow foundations under drained and undrained conditions.
C2 Calculate the bearing capacity of pile foundations under drained and undrained conditions.
C3 Design shallow and deep foundations to Eurocode 7.

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
Please state briefly how these are incorporated in this module.

1. A range of assessment activities are used including tutorial work and coursework submitted on-line. 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.

Programme Threads

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

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.

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.

Tomlinson, M.J., *Foundation Design and Construction*, 6th edition, Longman, 1995.

CIRIA C580. Embedded retaining walls.

EC7 and relevant British Standards (BS5930, 8002).

Various papers, articles and brochures made available on MyPlace.

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 of an exam and/or coursework.

Resit Arrangements

Examination and/or coursework (100%)

Approved

Programme Director Signature:

Date of Last Modifications: September 2021

Assessment and Feedback Schedule

Class Code	CL419	Class Title	Geotechnical Engineering 2

Brief Description of Assessment

Semester 1 (50% weighting in total)

CW 1 – 4 (12% weighting) There are four short courseworks which will be submitted via MyPlace. The final coursework (CW 5) is an exam preparation exercise based on past paper questions, which is issued in class and must be submitted before the end of the class. Further details are given on MyPlace.

CW 5 – Open book exam preparation exercise (3% weighting).

End of semester exam, of 2 hours duration (35% weighting). One exam at the end of semester 1 covering Topics 1, 2 and 3.

Semester 2 (50% weighting in total)

Coursework to be confirmed. (15% weighting)

End of semester exam, of 2 hours duration (35% weighting). One exam at the end of semester 2 covering Topics 4 and 5.

Assessment Schedule

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	Form of Submission*	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period
CW 1	LO1	3%	All students	MyPlace		H	S	F								
CW 2	LO4	3%	All students	MyPlace				H	S	F						
CW 3	LO1, LO4	3%	All students	MyPlace						H	S	F				
CW 4	LO1, LO4	3%	All students	MyPlace								H	S	F		
CW 5	LO1, LO4	3%	All students	MyPlace											H/S/F	
Exam	LO1, LO4	35%	All Students	Exam												E (2h)

Semester 2

Assessment type (& title)	LOs	Weight (%)	Individual / Group	Form of Submission*	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period
CW TBC		15%	All students	MyPlace												
Exam		35%	All Students	Exam												E (2h)

*Form of Submission: *Department* – report submitted to the Department; *MyPlace* – online submission through MyPlace; *Tutor* – work handed directly to the tutor.

Mapping Module Learning Outcomes to AHEP

Module Learning Outcome	**Engineering Council AHEP competencies: Knowledge, Understanding and Ability**
LO1 Understand and apply the principles of geotechnical design based on Eurocode 7, considering limit states (ultimate & serviceability) and design geotechnical structures to Eurocode 7, including interpretation of ground investigation information.	*Design* ➢ Investigate and define the problem, identifying any constraints including environmental and sustainability limitations; ethical, health, safety, security and risk issues; intellectual property; codes of practice and standards. ➢ Work with information that may be incomplete or uncertain, quantify the effect of this on the design and, where appropriate, use theory or experimental research to mitigate deficiencies. ➢ Apply advanced problem-solving skills, technical knowledge and understanding to establish rigorous and creative solutions that are fit for purpose for all aspects of the problem including production, operation, maintenance and disposal. *Engineering practice* ➢ Understanding of appropriate codes of practice and industry standards.
LO2 Understand the principles governing the stability of slopes in various soil types, and design slopes. LO3 Understand the principles governing the stability of embedded walls in various soil types, and design embedded walls. LO4 Calculate the design bearing capacities of shallow foundations and pile foundations, taking account of foundation shape, load inclination, load eccentricity and ground conditions.	*Engineering analysis* ➢ A comprehensive knowledge and understanding of mathematical and computational models relevant to the engineering discipline, and an appreciation of their limitations. ➢ Understanding of concepts from a range of areas, including some outside engineering, and the ability to evaluate them critically and to apply them effectively in engineering projects. *Engineering practice* ➢ Understanding of the use of technical literature and other information sources ➢ A thorough understanding of current practice and its limitations, and some appreciation of likely new developments. ➢ Ability to work with technical uncertainty.