MODULE DESCRIPTION FORM

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

CL507 GROUND IMRPOVEMENT AND REINFORCEMENT

Module Registrar: Stewart Beattie	**Taught To (Course): Meng/MSc Civil Engineering/Civil and Environmental Engineering**		
Other Lecturers Involved: Industry Lecturers	**Credit Weighting: 10**	**Semester: 2**	
Assumed Prerequisites: None	**Compulsory/ optional/ elective class**	**Academic Level: 5/9**	**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**
18	6						20	56	100

Educational Aim

This module aims to provide comprehensive understanding of the principles, techniques and methods of analysis for ground improvement and soil reinforcement, piles and pile groups, and the application of these techniques for design in various ground conditions.

Learning Outcomes

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

LO1 Design single piles and pile groups in different ground conditions.

LO2 Identify the most appropriate treatment/improvement solution for various ground conditions and situations.

LO3 Design appropriate soil/rock reinforcement solutions.

LO4 Design reinforced earth walls

Syllabus

The module will teach the following:

Pile Foundations
Types of deep foundations, ultimate load capacity of pile foundations, Design of pile foundations and pile groups.

Specialist geotechnical techniques
Micro piling, ground anchoring, soil nailing

Ground Improvement
Techniques for ground improvement (mass replacement, preloading, vertical drains, deep mixing, dynamic compaction, deep vibro techniques, jet grouting, compaction grouting). Design methods for ground improvement.

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Soil Reinforcement
Principles of soil reinforcement, Types of reinforcement, properties and behaviour, Design of reinforced slopes and soil nailing, Design of reinforced earth retaining walls using the tie-back wedge method.

Grouting
Different grouting techniques, uses of the techniques, susceptibilities, constrains, applications.

Assessment of Learning Outcomes

Criteria

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

LO1
C1 Able to assess the suitability of piles and different pile types for a particular building design situation.
C2 Appreciate the construction problems which could arise from piling in different soil profiles.
C3 Able to design pile foundations and optimise the pile dimensions and spacing.
C4 Understand and apply the principles of Eurocode 7 to pile design.

LO2
C1 Understand the properties and behaviour of the various types of soil in relation to ground improvement.
C2 Able to design ground improvement by calculation.
C3 Able to optimise the design of sand drain and stone column systems using analytical methods.

LO3
C1 Understand the various options available to an engineer when reinforcing soil.
C2 Understand the behaviour of ground anchors and the fundamental design principles.

LO4
C1 Understand the properties and behaviour of the various types of soil reinforcement.
C2 Able to design reinforced earth retaining walls.
C3 Appreciate the influence of reinforcement type on the behaviour of reinforced earth retaining walls.

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/*http://www.strath.ac.uk/learnteach/informationforstaff/staff/assessfeedback/12principles/
)

Please state briefly how these are incorporated in this module.

Feedback will be provided to students individually and as a group through the tutorial sessions, which will include worked examples.
The coursework and exam will require out of class learning and library study
The coursework will have a clear set of marking criteria and standards of performance.
Coursework feedback will be provided in relation to the specific marking criteria set out in the coursework.

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

	Examinations				**Courseworks**		**Projects**	
	Number	Month(s)	Duration	***Weighting***	Number	***Weighting***	Number	***Weighting***
	1	May	2hrs	80%	1	20%		
L/Outcomes	LO1, LO2, LO3, LO4				LO3			

Indicate which learning outcomes (L01, L02 etc) are to be assessed by exam/coursework/project as required.

Coursework / Submissions deadlines (*academic weeks*):
Week 6 (indicative) Ground Anchor Design Coursework

Resit Assessment Procedures:
2hr examination in August diet

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. This re-examination will consist entirely of exam. No marks from any previous attempts will be transferred to a new resit attempt.

Recommended Reading

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

**Tomlinson, M J. and Woodward, Pile Design and Construction Practice, (6th ed), CRC Press, 2015.

**Knappet, J.A. and Craig, R.F. Craig's Soil Mechanics, 8th edition. Spon Press 2012.
**Soil Mechanics - Concepts and Application, 2nd edition by William Powrie. Spon Press 2004.
*Principles of Foundation Engineering, Braja Das, 2017

*BS EN 1997-1: 2004+A1: 2013 Eurocode 7: Geotechnical Design – Part 1: General Rules.
*NA+A1:2014 TO BS EN 1997-1:2004+A1: 2013 UK National Annex to Eurocode 7: Geotechnical design – Part 1: General rules
*BS 8006: Code of Practice for Strengthened/Reinforced Soils.
*Moseley, M.P. & Kirsch, K. Ground Improvement, 2nd Edition, Spon Press, 2004.
Various papers, articles and brochures made available on MyPlace.

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

Date	Time	Room No
Weeks 1-11	TBC	TBC

Session: 2022/23

Approved:

Course Director Signature:

Date of Last Modifications:

(Updated May 2018)

MODULE TIMETABLE

Module Code:	**CL507**	**Module Title:**	**Ground Improvement and Reinfrocement**

Brief Description of Assessment:

Coursework: Ground Anchor Design (20%) – design of a ground anchor system report.

Exam: Calculation by hand calculation and written essay style questions (80%).

Assessment Timing:-

Indicate on the table below the start/submission dates for each assignment/project and the timing of each exam/assessment using the dropdowns provided. Dropdowns can be left blank. Add extra notes below the dropdowns.

Please note: Timings can and will change, this should only be used as a guide.

Semester Two	C&D Wk	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period
	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Course work Set Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Course work Submit Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Exam