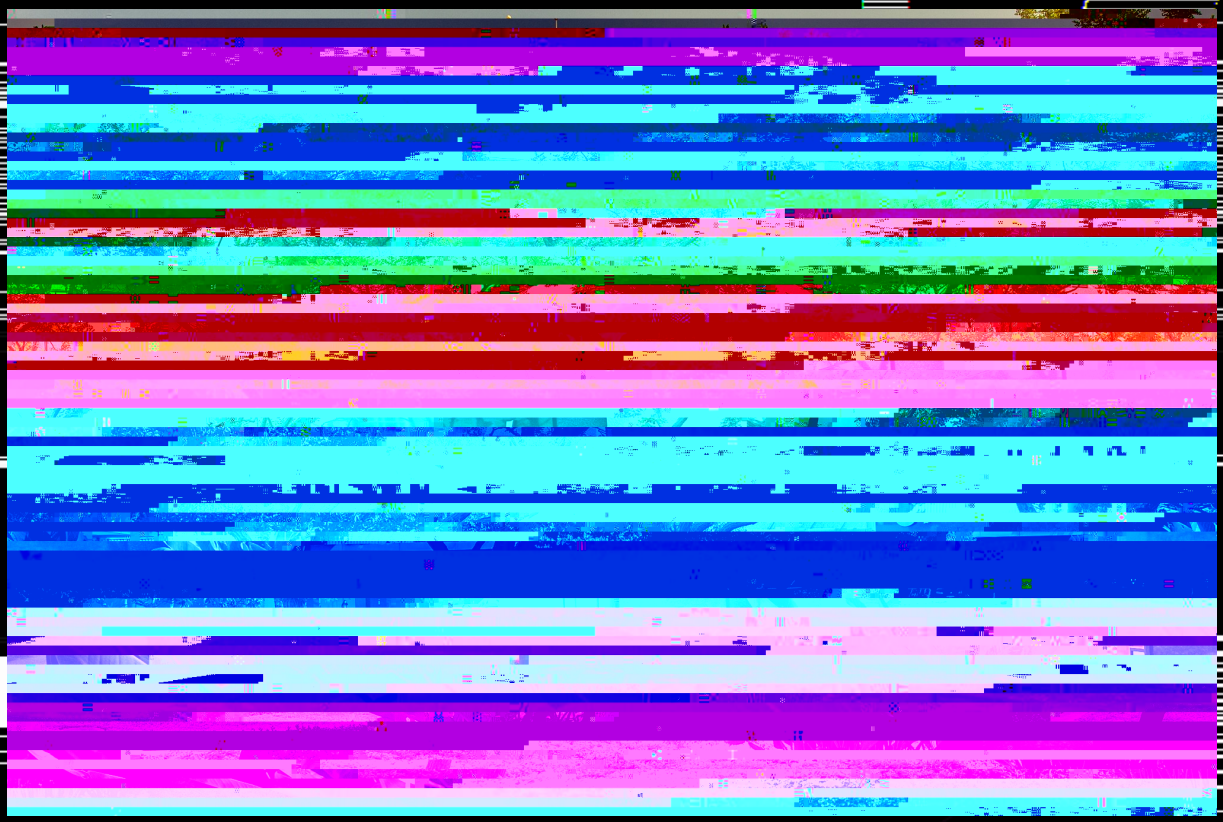
CVEN4202

Advanced Topics in Geotechnical Engineering

Term 2, 2022



Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Asal Bidarmaghz	a.bidarmaghz@unsw.edu.au	Email to make an appointment	Civil Engineering Building (H20) Level 5, Room CE502	+61430755050

Lecturers

Name	Email	Availability	Location	Phone
Asal Bidarmaghz	a.bidarmaghz@unsw.edu.au	Email to make an appointment	Civil Engineering Building (H20) Level 5, Room CE502	+61 (2) 9385 5942

School Contact Information

Engineering Student Support Services – The Nucleus - enrolment, progression checks, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries e.g. admissions, fees, programs, credit transfer

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

Course Details

Units of Credit 6

Summary of the Course

1. Introduction to shallow geothermal systems and energy geo-strcutres
2. Funadamnetals of heat and mass transfer in the subsurface (analytical methods, convection and conduction)
3. Using FEM to model geothermal energy extraction through various types of geo-strucutres
4. Design and optimise borehole heat exchangers thermal efficiency for various thermal demand and hydrogeological scenarios
5. Introduction to subsurface heat island effect and urban underground climate change

Course Aims

This course is focused on ground energy and ground source heat pump systems, common design parameters and approaches and available analytical solutions to understand the concept of shallow geothermal systems. To better understand the physics and governing equations involved in ground energy systems, the interactions between the systems and the surrounding ground, the educational finite element software COMSOL will be used to computationally model different cases of ground energy systems. This course heavily relies on computational modelling of geothermal systems as the primary tool and method for designing and optimising such systems; hence, half of the course will be held in the computer lab, working on various models and scenarios. This course is focused on ground energy and ground source heat pump systems, common design parameters and approaches and available analytical solutions to understand the concept of shallow geothermal systems. To better understand the physics and governing equations involved in ground energy systems, the interactions between the systems and the surrounding ground, the educational finite element software COMSOL will be used to computationally model different cases of ground energy systems. This course heavily relies on computational modelling of geothermal systems as the primary tool and method for designing and optimising such systems; hence, half of the course will be held in the computer lab, working on various models and scenarios.

Course Learning Outcomes

After successfully completing this course, you should be able to:

Learning Outcome	EA Stage 1 Competencies
1. Understand the concept and applications of ground energy systems. To gain insights into designs and evaluations of these systems via hand calculations and computational modelling.	PE1.1, PE1.3, PE1.4, PE1.5, PE2.2
2. Understand the basic principles of heat and mass transfer in porous medium, to simulate soil systems hydro-thermal behaviour.	PE1.1, PE1.3, PE1.4, PE1.5, PE2.1, PE2.2
3. Using finite element method to solve geo-energy problems, including geothermal energy systems and their interaction with the ground.	PE1.1, PE1.3, PE1.4, PE1.5, PE2.1, PE2.2

Teaching Strategies

Private Study	

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Multiple choice quiz	10%	20/06/2022 11:59 PM	1
2. Group Presentation	30%	Week 9	1, 2
3. Shallow Geothermal System Design	60%	12/08/2022 11:59 PM	1, 2, 3

Assessment 1: Multiple choice quiz

Due date: 20/06/2022 11:59 PM
Deadline for absolute fail: 23 June 2022
Marks returned: Weeks 1, 2 and 3

A simple multiple-choice quiz covering the first three weeks of the course - Marks to be out before the census date.

Assessment 2: Group Presentation

Due date: Week 9
Marks returned: 15 August 2022

The presentation will be a 15 minute group activity (group of 2-3 students) on the concept of energy geo-structures and energy geotechnics. The presentation shall cover recent findings and knowledge advancements in the field of shallow geothermal systems. This activity will significantly assist students in understanding the status of these systems and their applications globally.

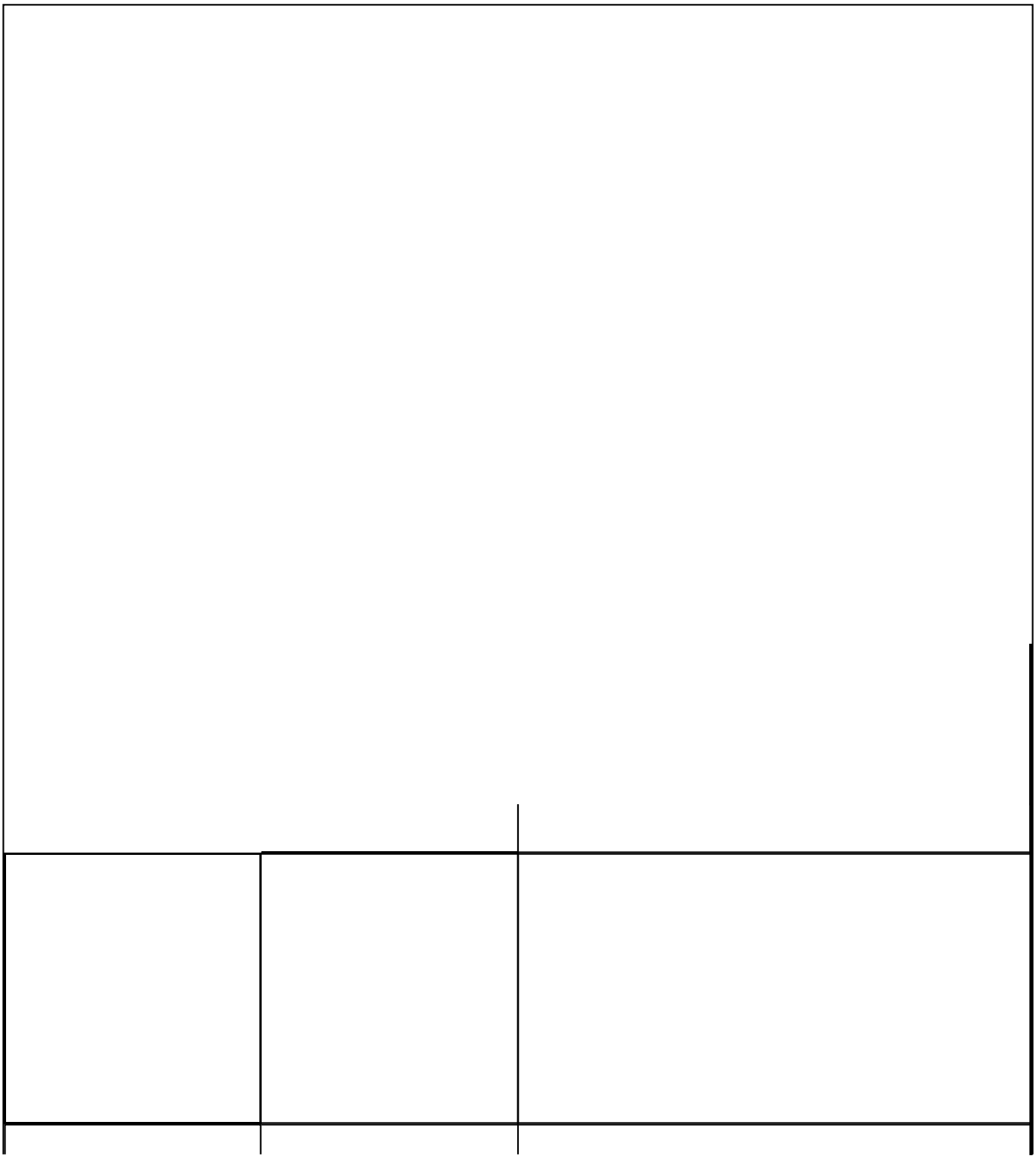
Assessment 3: Shallow Geothermal System Design

Due date: 12/08/2022 11:59 PM
Marks returned: End of Term 2

This assignment is an individual assignment for which the students will design a shallow geothermal system for specific space and thermal load using COMSOL Multiphysics (in an optimised and efficient manner).

Assessment criteria

Weeks 1-10



Week 7: 11 July - 15 July	Laboratory	14/07/2022 Closed-loop vertical borehole heat exchangers (FEM– computer lab, level 2) 15/07/2022 Heat conduction and convection in porous medium (FEM– computer lab, level 2) and Assignment 2 briefing
Week 8: 18 July - 22 July	Lecture	21/07/2022 Introduction to energy geo-structures and thermal response testing (TRT) - Guest Lecturer (CivEng 101)
Week 9: 25 July - 29 July	Blended	28/07/2022 Shallow vs Deep geothermal systems (FEM, computer lab, level 2) 29/07/2022 Project presentation (CiVEng 101)
	Assessment	Group Presentation
Week 10: 1 August - 5 August	Blended	04/08/2022 Underground urban heat island modelling - 3D vs semi-3D methods, FEM, (computer lab, level 2) 05/08/2022 Assignment 2 discussion and problem-solving (CivEng 101)

Resources

Recommended Resources

1. Banks, D. “An Introduction to Thermogeology”, Wiley and Backwell, 2012.
2. Al-Khoury, R. “Computational Modelling of Shallow Geothermal Systems”, CRC Press.
3. IGSHPA, “Ground Source Heat Pump Residential and Light Commercial Design and Installation Guide”, Oklahoma State University.
4. Laloui, L., Di Donna, A., “ Energy Geo-structures – Innovation in Underground Engineering”, Wiley, 2013.

Laboratory Workshop Information

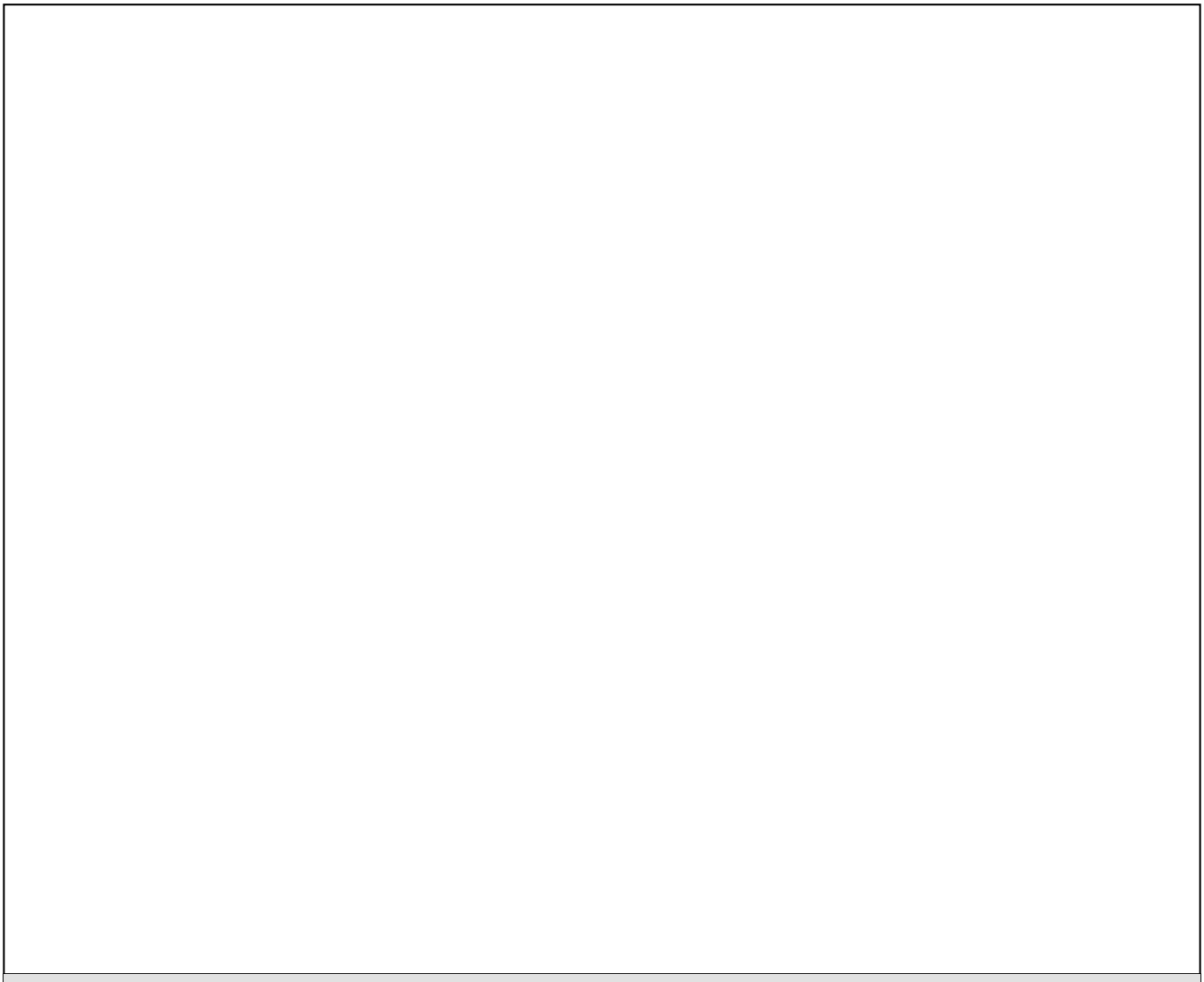
Submission of Assessment Tasks

Please refer to the Moodle page of the course for further guidance on assessment submission.

UNSW has a standard late submission penalty of:

- 5% per day, for all assessments where a penalty applies, capped at five days (120 hours), after which a student cannot submit an assessment, and no permitted variation.

Academic Honesty and Plagiarism

Beware! An assignment that includes plagiarised material will receive a 0% Fail, and students who plagiarise may fail the course. Students who plagiarise are also liable to disciplinary action, including exclusion from enrolment.

Plagiarism is the use of another person’s work or ideas as if they were your own. When it is necessary or desirable to use other people’s material you should adequately acknowledge whose words or ideas they