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	+61430755 050

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	• Review lecture material and textbook • Do set problems and assignments • Join Moodle discussions of problems • Reflect on class problems and assignments • Download materials from Moodle • Keep up with notices and find out marks via Moodle
Lectures	• Find out what you must learn • See methods that are not in the textbook • Follow worked examples • Hear announcements on course changes • Ask questions
Workshops	• Be guided by Demonstrators/Lecturers • Practice solving set problems • Ask questions
Assessments	• Demonstrate your knowledge and skills • Demonstrate higher understanding and problem solving
Laboratory Work	• Hands-on work, to set studies in the context

Additional Course Information

This course is designed based on face to face learning, given that **the course heavily relies on computational modelling of geothermal systems as the primary tool and method for designing and optimising such systems; hence, more than half of the course will be held in the computer lab, working on various models and scenarios.**

Therefore, studetns are expected to attend the class (Thursdays and Fridays) **in person in CivEng 101 and computer lab level 2 unless currently not located in Sydney, or self-isolating on the day.**

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

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

Course Schedule

View class timetable

Timetable

Date	Type	Content
Week 1: 30 May - 3 June	Lecture	02/06/2022 Introduction to shallow geothermal systems (CivEng 101)
Week 2: 6 June - 10 June	Lecture	09/06/2022 Common design approaches for shallow geothermal systems - analytical methods (CivEng 101) 10/06/2022 Common design approaches for shallow geothermal systems - analytical methods (CivEng 101)
Week 3: 13 June - 17 June	Lecture	16/06/2022 Heat and mass transfer mechanisms in the context of shallow geothermal systems - analytical solutions (CivEng 101) 17/06/2022 Heat and mass transfer mechanisms in the context of shallow geothermal systems - analytical solutions (CivEng 101)
Week 4: 20 June - 24 June	Lecture	23/06/2022 Scaling methodologies in the context of shallow geothermal systems (CivEng 101) 24/06/2022 Scaling methodologies in the context of shallow geothermal systems (CivEng 101)
	Assessment	Multiple choice quiz
Week 5: 27 June - 1 July	Lecture	30/06/2022 Introduction to finite element package COMSOL Multiphysics (General heat and mass transfer modelling and analysis, FEM – computer lab, level 2) 01/07/2022 Introduction to finite element package COMSOL Multiphysics (General heat and mass transfer modelling and analysis, FEM – computer lab, level 2)

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

More than 50% of the course will be held in the computer lab working with a FE software to build and solve geothermal energy extraction models. Students are required to attend the lab sessions in person unless currently located outside Sydney or self-isolating.

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 are and where you found them (giving the complete reference details, including page number(s)). The Learning Centre provides further information on what constitutes Plagiarism at:

https://student.unsw.edu.au/plagiarism

Academic Information

Final Examinations:

Final exams in T2 2022 will be held online between 12th - 25th August 2022 inclusive, and supplementary exams between 5th - 9th September 2022 inclusive. You are required to be available on these dates. Please do not to make any personal or travel arrangements during this period.

ACADEMIC ADVICE

- Key Staff to Contact for Academic Advice (log in with your zID and password): https://intranet.civeng.unsw.edu.au/key-staff-to-contact-during-your-studies-at-unsw
- Key UNSW Dates - eg. Census Date, exam dates, last day to drop a course without academic/financial liability etc.
- CVEN Student Intranet (log in with your zID and password): https://intranet.civeng.unsw.edu.au/student-intranet
- Student Life at CVEN, including Student Societies: https://www.unsw.edu.au/engineering/civil-and-environmental-engineering/student-life
- Special Consideration: https://student.unsw.edu.au/special-consideration
- General and Program-Specific Questions: The Nucleus: Student Hub
- Book an Academic Advising session: https://app.acuityscheduling.com/schedule.php?owner=19024765

Disclaimer

This course outline sets out description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle should be consulted for the up to date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline (as updated in Moodle), the description in the Course Outline/Moodle applies.

Image Credit

Mike Gal.

CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	✓
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	✓
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	✓
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	✓
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering problem solving	✓
PE2.2 Fluent application of engineering techniques, tools and resources	✓
PE2.3 Application of systematic engineering synthesis and design processes	
PE2.4 Application of systematic approaches to the conduct and management of engineering projects	
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	
PE3.2 Effective oral and written communication in professional and lay domains	
PE3.3 Creative, innovative and pro-active demeanour	
PE3.4 Professional use and management of information	
PE3.5 Orderly management of self, and professional conduct	
PE3.6 Effective team membership and team leadership	