School of Civil and Environmental Engineering

Term 2, 2021

CVEN4202 ADVANCED TOPICS IN GEOTECHNICAL ENGINEERING

COURSE DETAILS

Units of Credit	6		
Contact hours	5 hours per week		
Class	Wednesday,	11:00 – 14:00	Online (weeks 1-4) and Online and Face to Face (weeks 5, 7-10)
	Friday,	10:00 – 12:00	Online (weeks 1-4) and Online and Face to Face (CE 201) (weeks 5, 7-10)

Lecturer and Course Coordinator	Dr Asal Bidarmaghz email: a.bidarmaghz@unsw.edu.au office: CVEN, Room 502

INFORMATION ABOUT THE COURSE

- Students enrolling in this course are assumed to have knowledge of soil mechanics to Bachelor of Civil Engineering standard.

HANDBOOK DESCRIPTION

See link to virtual handbook:

https://www.handbook.unsw.edu.au/undergraduate/courses/2021/CVEN4202/

OBJECTIVES

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.**

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

EXPECTED LEARNING OUTCOMES

This course is designed to address the learning outcomes below and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown. The full list of Stage 1 Competency Standards may be found in Appendix A.

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.*	*1.1, 1.3, 1.4, 1.5, 2.1, 2.2*
2.	*Understand the basic principles of heat and mass transfer in porous medium, to simulate soil systems hydro-thermal behaviour.*	*1.1, 1.3, 1.4, 1.5, 2.1, 2.2*
3.	*Using finite element method to solve geo-energy problems, including geothermal energy systems and their interaction with the ground.*	*1.1, 1.3, 1.4, 1.5, 2.1, 2.2*

For each hour of contact it is expected that you will put in at least 1.5 hours of private study.

COURSE PROGRAM

Term 2 2021

Week 1	Introduction to shallow geothermal systems.
Week 2	The common design approaches for shallow geothermal systems (analytical methods).
Week 3	Heat and mass transfer mechanisms in the context of shallow geothermal systems (analytical solutions)
Week 4	Introduction to thermal response testing (TRT) and energy geo-structures Introduction to computational modelling of ground-energy systems

Week 5	Introduction to the finite element package COMSOL Multiphysics (General heat and mass transfer modelling and analysis – computer lab)
Week 6	Flexibility week for all courses (non-teaching)
Week 7	Closed-loop vertical borehole heat exchangers (FE modelling – computer lab) Assignment 2 briefing
Week 8	Heat conduction and convection in porous medium (FE modelling – computer lab) Project presentation
Week 9	Shallow vs Deep geothermal systems (concepts and FE modelling, computer lab)
Week 10	Underground urban heat island modelling (3D vs semi-3D methods) Assignment 2 discussion and problem solving

ASSESSMENT

Student assessment is based on assignments and there is no final exam for the course.

- Assignments **100%**
  - Assignment 1 10%
  - Presentation 30%
  - Assignment 2 60%
  - **There is no exam for this course**

Notes:

- Assignment 1 is a simple multiple-choice quiz covering the first three weeks of the course—marks to be out before the census date.
- The presentation will be a 15 minutes 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 current status of these systems and their applications globally.
- Assignment 2 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).
- The Coordinator reserves the right to adjust the final scores by scaling if agreed to by the Head of School.
- Assignments should be uploaded on Moodle via designated modules. Any other forms of submission will not be accepted.
- Late work will not be accepted or assessed or will be penalised **(10% per day up until the deadline for absolute fail)**.

Supplementary Examinations for Term 2 2021 will be held on Monday 6th September – Friday 10th September (inclusive) should you be required to sit one. You are required to be available during these dates. Please do not to make any personal or travel arrangements during this period.

PENALTIES

Late work will be penalised at the rate of 10% per day after the due time and date have expired.

ASSESSMENT OVERVIEW

Item	Topics	Weight	Learning outcomes assessed	Learning outcomes assessed	Due date	Deadline for absolute fail	Marks returned
Assignment 1	Energy Geotechnics Concept	10%	1, 3	Weeks 1,2 and 3	23 June 2021 11:59 pm	NA	26th June 2021
Presentation	Energy Geo-structures	30%	1, 3	Weeks 1-7	23rd July 2021	23rd July 2021	30th Aug 2021
Assignment 2	Geothermal systems modelling and optimisation	60%	1,3	Weeks 1-10	Sunday 15th August 2021 11:59 pm	Sunday 15th August 2021 11:59 pm	29th August 2021

RELEVANT RESOURCES

Part 1:

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.
5. Laloui, L. & Loria, A. F. R., “Analysis and Design of Energy Geostructures: Theoretical Essentials and Practical Application”, Academic Press, 2019.

DATES TO NOTE

Refer to MyUNSW for Important Dates available at:

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

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 ADVICE

For information about:

- Notes on assessments and plagiarism;
- Special Considerations: student.unsw.edu.au/special-consideration;
- General and Program-specific questions: The Nucleus: Student Hub
- Year Managers and Grievance Officer of Teaching and Learning Committee, and
- CEVSOC/SURVSOC/CEPCA

Refer to Key Contacts on the Faculty website available at:
https://www.unsw.edu.au/engineering/student-life/student-resources/key-contacts

Appendix A: Engineers Australia (EA) Competencies

Stage 1 Competencies for Professional Engineers

	Program Intended Learning Outcomes
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing
	PE1.3 In-depth understanding of specialist bodies of Knowledge
	PE1.4 Discernment of knowledge development and research directions
	PE1.5 Knowledge of engineering design practice
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice
PE2: Engineering Application Ability	PE2.1 Application of established engineering methods to complex 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
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability
	PE3.2 Effective oral and written communication (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