School of Civil and Environmental Engineering
Term 2, 2021
CVEN4202 ADVANCED TOPICS IN GEOTECHNICAL ENGINEERING

COURSE DETAILS

<table>
<thead>
<tr>
<th>Units of Credit</th>
<th>6</th>
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</thead>
<tbody>
<tr>
<td>Contact hours</td>
<td>5 hours per week</td>
</tr>
<tr>
<td>Class</td>
<td>Wednesday, 11:00 – 14:00; Friday, 10:00 – 12:00</td>
</tr>
<tr>
<td></td>
<td>Online (weeks 1-4) and Online and Face to Face (weeks 5, 7-10)</td>
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<tr>
<td></td>
<td>Online (weeks 1-4) and Online and Face to Face (CE 201) (weeks 5, 7-10)</td>
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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:

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:

<table>
<thead>
<tr>
<th>Learning Outcome</th>
<th>EA Stage 1 Competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td>1.1, 1.3, 1.4, 1.5, 2.1, 2.2</td>
</tr>
<tr>
<td>2. Understand the basic principles of heat and mass transfer in porous medium, to simulate soil systems hydro-thermal behaviour.</td>
<td>1.1, 1.3, 1.4, 1.5, 2.1, 2.2</td>
</tr>
<tr>
<td>3. Using finite element method to solve geo-energy problems, including geothermal energy systems and their interaction with the ground.</td>
<td>1.1, 1.3, 1.4, 1.5, 2.1, 2.2</td>
</tr>
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</table>

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.
<table>
<thead>
<tr>
<th>Item</th>
<th>Topics</th>
<th>Weight</th>
<th>Learning outcomes assessed</th>
<th>Learning outcomes assessed</th>
<th>Due date</th>
<th>Deadline for absolute fail</th>
<th>Marks returned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment 1</td>
<td>Energy Geotechnics Concept</td>
<td>10%</td>
<td>1, 3</td>
<td>Weeks 1, 2 and 3</td>
<td>23 June 2021 11:59 pm</td>
<td>NA</td>
<td>26th June 2021</td>
</tr>
<tr>
<td>Presentation</td>
<td>Energy Geo-structures</td>
<td>30%</td>
<td>1, 3</td>
<td>Weeks 1-7</td>
<td>23rd July 2021</td>
<td>23rd July 2021</td>
<td>30th Aug 2021</td>
</tr>
<tr>
<td>Assignment 2</td>
<td>Geothermal systems modelling and optimisation</td>
<td>60%</td>
<td>1, 3</td>
<td>Weeks 1-10</td>
<td>Sunday 15th August 2021 11:59 pm</td>
<td>Sunday 15th August 2021 11:59 pm</td>
<td>29th August 2021</td>
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(Laloui and Loria, 2019)
RELEVANT RESOURCES

Part 1:


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

<table>
<thead>
<tr>
<th>PE1: Knowledge and Skill Base</th>
<th>Program Intended Learning Outcomes</th>
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<tbody>
<tr>
<td>PE1.1</td>
<td>Comprehensive, theory-based understanding of underpinning fundamentals</td>
</tr>
<tr>
<td>PE1.2</td>
<td>Conceptual understanding of underpinning maths, analysis, statistics, computing</td>
</tr>
<tr>
<td>PE1.3</td>
<td>In-depth understanding of specialist bodies of Knowledge</td>
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<tr>
<td>PE1.4</td>
<td>Discernment of knowledge development and research directions</td>
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<tr>
<td>PE1.5</td>
<td>Knowledge of engineering design practice</td>
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<tr>
<td>PE1.6</td>
<td>Understanding of scope, principles, norms, accountabilities of sustainable engineering practice</td>
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<thead>
<tr>
<th>PE2: Engineering Application Ability</th>
<th>Program Intended Learning Outcomes</th>
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<tbody>
<tr>
<td>PE2.1</td>
<td>Application of established engineering methods to complex problem solving</td>
</tr>
<tr>
<td>PE2.2</td>
<td>Fluent application of engineering techniques, tools and resources</td>
</tr>
<tr>
<td>PE2.3</td>
<td>Application of systematic engineering synthesis and design processes</td>
</tr>
<tr>
<td>PE2.4</td>
<td>Application of systematic approaches to the conduct and management of engineering projects</td>
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<thead>
<tr>
<th>PE3: Professional and Personal Attributes</th>
<th>Program Intended Learning Outcomes</th>
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<tbody>
<tr>
<td>PE3.1</td>
<td>Ethical conduct and professional accountability</td>
</tr>
<tr>
<td>PE3.2</td>
<td>Effective oral and written communication (professional and lay domains)</td>
</tr>
<tr>
<td>PE3.3</td>
<td>Creative, innovative and pro-active demeanour</td>
</tr>
<tr>
<td>PE3.4</td>
<td>Professional use and management of information</td>
</tr>
<tr>
<td>PE3.5</td>
<td>Orderly management of self, and professional conduct</td>
</tr>
<tr>
<td>PE3.6</td>
<td>Effective team membership and team leadership</td>
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