School of Civil and Environmental Engineering

Term 2, 2020

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
	Thursday,	15:00 – 17:00	online

Lecturer	Dr Asal Bidarmaghz email: a.bidarmaghz@unsw.edu.au office: CVEN, Room 502
Lecturer and Course Coordinator	Prof Adrian Russell email: a.russell@unsw.edu.au office: CVEN, Room 504

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/2020/CVEN4202/

OBJECTIVES

This course will be delivered in two parts. Part one (weeks 1-5) 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 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.

The second part of the course (weeks 7-10) is mainly on understanding the basic principles of critical state soil mechanics and soil plasticity, and use elastic-plastic constitutive models (Mohr-Coulomb, Cam-Clay, Bounding Surface Plasticity) to simulate soil stress-strain behaviour. To use the finite element method, along with elastic-plastic soil models, to solve geotechnical engineering problems. Model soil-structure interaction using simple hand calculations and the commercial finite element software PLAXIS through case studies of high-profile geotechnical engineering failures (Leaning Tower of Pisa in Italy, the Nicoll Highway braced excavation collapse in Singapore).

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 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 critical state soil mechanics and soil plasticity, and use elastic-plastic constitutive models (Mohr-Coulomb, Cam-Clay, Bounding Surface Plasticity) to simulate soil stress-strain behaviour.*	*1.1, 1.3, 1.4, 1.5, 2.1, 2.2*
3.	*Using the finite element method, along with elastic-plastic soil models, to solve geotechnical engineering problems including soil-structure interactions.*	*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 2020

Week 1	Introduction to ground energy and geothermal systems. AB
Week 2	Analytical solutions and common design approach for ground heat exchangers. AB
Week 3	Introduction to thermal response testing (TRT) and energy geo-structures (Wednesday), Introduction to computational modelling of ground-energy systems (Thursday). AB
Week 4	Computational modelling of ground energy systems – Vertical GHEs and energy geo-structures. AB
Week 5	Sensitivity analysis of ground energy systems and Assignment 2 briefing (Wednesday), Computational modelling of ground energy systems – The importance of groundwater flow and underground heat sources on ground temperature elevation (Thursday). AB
Week 6	Flexibility week for all courses (non-teaching)
Week 7	Soil elasticity and yielding. Modelling the elastic-plastic behaviour of soils and critical state soil mechanics. AR
Week 8	Constitutive models and Maple demonstration: solving differential equations as an initial value problem and simulating the stress-strain behaviour of soils. AR
Week 9	The Mohr-Coulomb, Cam-clay and Bounding surface plasticity constitutive models. Soil-structure interaction using simple hand calculations. AR
Week 10	Soil-structure interaction using PLAXIS analysis. AR.

ASSESSMENT

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

- Assignments (3) **100%**
  - Assignment 1 5%
  - Assignment 2 45%
  - Assignment 3 50%
  - **There is no exam for this course**

Notes:

- 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)**. If you have a good reason for being unable to submit your work on time, it is important that you let your lecturer know promptly and formally apply for Special Consideration through myUNSW.

Supplementary Examinations for Term 2 2020 will be held on Monday 7th September – Friday 11th 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	5%	1, 3	Weeks 1,2 and 3	24 June 2020 11:59 pm	NA	27 June 2020
Assignment 2	Ground Energy Systems Design and Modelling	45%	1, 3	Weeks 1-5	27th July 2020 11:59 pm	30th July 2020 11:59 pm	13 Aug 2020
Assignment 3	Covers content from weeks 7-10	50%			Sunday 17th August 2020 11:59 pm	Sunday 27th August 2020 11:59 pm	3 Sep 2020

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.

Part 2:

No textbook is prescribed although the first four books listed below are very good investments for any geotechnical engineer.

1. Muir Wood, D. “Soil Behaviour and Critical State Soil Mechanics”, Cambridge University Press, 1992.
2. Muir Wood, D. “Geotechnical modelling”, Spon Press, 2004.
3. Puzrin, A.M., Alonso, E.E. and Pinyol, N.M. “Geomechanics of failures”. Springer. 2010.
4. Alonso, E.E., Pinyol, N.M. and Puzrin, A.M. “Geomechanics of failures: Advanced Topics”. Springer. 2010.
5. Lambe and R.V. Whitman, "Soil mechanics", John Wiley & Sons, 1969.
6. Atkinson and P.L. Bransby, "The mechanics of soils: An introduction to critical state soil mechanics", McGraw-Hill, 1978.
7. Holtz, Kovacs and Sheahan, "An introduction to geotechnical engineering", Pearson, 2011.
8. Reddy J.N. An Introduction to the Finite Element Method, 3rd ed., McGraw-Hill, New York, 2006.
9. Potts D.M., Zdravkovic L. Finite Element Analysis in Geotechnical Engineering - Theory, Thomas Telford Publishing, London, 2001.
10. Potts D.M., Zdravkovic L. Finite Element Analysis in Geotechnical Engineering - Application, Thomas Telford Publishing, London, 2001.

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 Academic Advice on the School website available at:

https://www.engineering.unsw.edu.au/civil-engineering/student-resources/policies-procedures-and-forms/academic-advice

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