UNSW Course Outline

CVEN4202 Advanced Topics in Geotechnical Engineering - 2024

Published on the 27 May 2024

General Course Information

Course Code : CVEN4202
Year : 2024
Term : Term 2
Teaching Period : T2
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : School of Civil and Environmental Engineering
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Postgraduate, Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

This course will be delivered in two parts. Part one 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 covers the basic principles of critical state soil mechanics and soil plasticity, and the use of elastic-plastic constitutive models to simulate soil stress-strain behaviour. Students will learn to use elastic-plastic soil models to solve geotechnical engineering problems.

Course Aims

Part 1) To understand the principles of geothermal systems, energy geotechnics and the fundamentals of heat and mass transfer in the subsurface via learning relevant analytical solutions and FE modelling.

Part 2) To 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. Apply stress field analysis in solving simple geotechnical problems. Identify fractal patterns in soils and apply them to understand soil mechanics.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Explain the concept and applications of ground energy systems. Design and evaluate of these systems via hand calculations and computational modelling.
CLO2 : Explain the basic principles of critical state soil mechanics and soil plasticity, and use elastic-plastic constitutive models to simulate soil stress-strain behaviour.
CLO3 : Use finite element method to solve geo-energy problems, including geothermal energy systems and their interaction with the ground.

Course Learning Outcomes	Assessment Item
CLO1 : Explain the concept and applications of ground energy systems. Design and evaluate of these systems via hand calculations and computational modelling.	• Energy Geotechnics Concept • Geothermal systems modelling and optimisation • Modelling soil stress- strain
CLO2 : Explain the basic principles of critical state soil mechanics and soil plasticity, and use elastic-plastic constitutive models to simulate soil stress-strain behaviour.	• Energy Geotechnics Concept • Geothermal systems modelling and optimisation • Modelling soil stress- strain
CLO3 : Use finite element method to solve geo-energy problems, including geothermal energy systems and their interaction with the ground.	• Energy Geotechnics Concept • Geothermal systems modelling and optimisation • Modelling soil stress- strain

Learning and Teaching Technologies

Moodle - Learning Management System

Other Professional Outcomes

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

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.*

2. Understand the basic principles of critical state soil mechanics and soil plasticity,and use elastic-plastic constitutive models to simulate soil stress-strain behaviour.

3. *Using finite element method to solve geo-energy problems, including geothermal energy systems and their interaction with the ground.*

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Energy Geotechnics Concept Assessment Format: Individual	10%	Due Date: 20 June 2024
Geothermal systems modelling and optimisation Assessment Format: Group	30%	Due Date: 14 July 2024
Modelling soil stress- strain Assessment Format: Individual	60%	Due Date: 8 August 2024

Assessment Details

Energy Geotechnics Concept

Assessment Overview

Assignment 1 is a simple multiple-choice quiz covering the first three weeks of the course—marks to be out before the census date.

Course Learning Outcomes

- CLO1 : Explain the concept and applications of ground energy systems. Design and evaluate of these systems via hand calculations and computational modelling.
- CLO2 : Explain the basic principles of critical state soil mechanics and soil plasticity, and use elastic-plastic constitutive models to simulate soil stress-strain behaviour.
- CLO3 : Use finite element method to solve geo-energy problems, including geothermal energy systems and their interaction with the ground.

Detailed Assessment Description

Assignment 2 is a group 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).

Assignment submission Turnitin type

This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

Geothermal systems modelling and optimisation

Assessment Overview

Assignment 2 is a group 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).

Course Learning Outcomes

- CLO1 : Explain the concept and applications of ground energy systems. Design and evaluate of these systems via hand calculations and computational modelling.
- CLO2 : Explain the basic principles of critical state soil mechanics and soil plasticity, and use elastic-plastic constitutive models to simulate soil stress-strain behaviour.
- CLO3 : Use finite element method to solve geo-energy problems, including geothermal energy systems and their interaction with the ground.

Detailed Assessment Description

Assignment 1 is a simple multiple-choice quiz covering the first three weeks of the course—marks to be out before the census date (23rd June).

Assignment submission Turnitin type

Not Applicable

Modelling soil stress- strain

Assessment Overview

Assignment 3 is an individual assignment for which the students will model the stress-strain behavior of soils using commercial coding software to implement soil models.

Course Learning Outcomes

- CLO1 : Explain the concept and applications of ground energy systems. Design and evaluate of these systems via hand calculations and computational modelling.
- CLO2 : Explain the basic principles of critical state soil mechanics and soil plasticity, and use elastic-plastic constitutive models to simulate soil stress-strain behaviour.
- CLO3 : Use finite element method to solve geo-energy problems, including geothermal energy systems and their interaction with the ground.

Detailed Assessment Description

Assignment 3 is an individual assignment for which the students will model the stress-strain behaviour of soils.

Assignment submission Turnitin type

Not Applicable

General Assessment Information

- 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**).

Grading Basis

Standard

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 0 : 20 May - 26 May	Other	
Week 1 : 27 May - 2 June	Lecture	Introduction to shallow geothermal systems (no workshop)
Week 2 : 3 June - 9 June	Blended	week 2 - session 1:Common design approaches for shallow geothermal systems - analytical methods. week 2 - session 2: Heat and mass transfer mechanisms in the context of shallow geothermal systems - analytical solutions
Week 3 : 10 June - 16 June	Blended	week 3 - session 1: Introduction to finite element package COMSOL Multiphysics (General heat and mass transfer modelling and analysis, FEM – computer lab, level 2, 6) week 3 - session 2: Introduction to finite element package COMSOL Multiphysics (General heat and mass transfer modelling and analysis, FEM – computer lab, level 2, 6)
Week 4 : 17 June - 23 June	Assessment	week 4 - session 1: Assignment 1 brieifing week 4 - session 2: Assignment 1 consulting
Week 5 : 24 June - 30 June	Lecture	week 5 - session 1: Soil elasticity and yielding. Modelling the elastic-plastic behaviour of soils and critical state soil mechanics. week 5- session 1: Finlaising assignment 1 and submission.
Week 6 : 1 July - 7 July	Other	no teaching week.
Week 7 : 8 July - 14 July	Blended	week 7 - session 1: Constitutive models, solving differential equations as an initial value problem and simulating the stress-strain behaviour of soils week 7 - session 2: Continued.
Week 8 : 15 July - 21 July	Blended	week 8 - session 1: The Mohr-Coulomb, Cam-clay and Bounding surface plasticity constitutive models. week 8 - session 2: continued.
Week 9 : 22 July - 28 July	Blended	week 9 - session 1: Cam-clay implmentation in Maple (coding program). week 9 - session 2: Continued.
Week 10 : 29 July - 4 August	Group Activity	week 10 - session 1: Assignement 2 week 10 - session 2: Assignment 2

Attendance Requirements

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

Course Resources

Recommended 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.

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

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Lecturer	Asal Bidar maghz		Civil Engineering Building (H20) Level 5, Room CE502	+61 (2) 9385 5942	Email to make an appointment	No	No
Convenor	Asal Bidar maghz		Civil Engineering Building (H20) Level 5, Room CE502	61430755050	Email to make an appointment	No	Yes

Other Useful Information

Academic Information

I. Special consideration and supplementary assessment

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to, or within 3 working days of, submitting an assessment or sitting an exam.

Please note that UNSW has a Fit to Sit rule, which means that if you sit an exam, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

II. Administrative matters and links

All students are expected to read and be familiar with UNSW guidelines and polices. In particular, students should be familiar with the following:

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Equitable Learning Services

III. Equity and diversity

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equitable Learning Services. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

IV. Professional Outcomes and Program Design

Students are able to review the relevant professional outcomes and program designs for their streams by going to the following link: https://www.unsw.edu.au/engineering/student-life/student-resources/program-design.

Note: This course outline sets out the 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 or your primary learning management system (LMS) 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/Moodle/LMS, the description in the Course Outline/Moodle/LMS applies.

Academic Honesty and Plagarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism, visit: student.unsw.edu.au/plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis or contract cheating) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Submission of Assessment Tasks

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of five percent (5%) of the maximum mark possible for that assessment item, per calendar day.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day. This is for all assessments where a penalty applies.

Work submitted after five days (120 hours) will not be accepted and a mark of zero will be awarded for that assessment item.

For some assessment items, a late penalty may not be appropriate. These will be clearly indicated in the course outline, and such assessments will receive a mark of zero if not completed by the specified date. Examples include:

- Weekly online tests or laboratory work worth a small proportion of the subject mark;
- Exams, peer feedback and team evaluation surveys;
- Online quizzes where answers are released to students on completion;
- Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date; and,
- Pass/Fail assessment tasks.

Faculty-specific 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)

School-specific Information

Final Examinations

Final Exams in T2 2024 will be held on campus between the 9th - 22nd August, and Supplementary Exams between the 2nd - 6th September 2024. You are required to be available on these dates. Please do not to make any personal or travel arrangements during this period.

School Contact Information

For assistance with enrolment, class registration, progression checks and other administrative matters, please see the Nucleus: Student Hub. They are located inside the Library – first right as you enter the main library entrance. You can also contact them via http://unsw.to/webforms or reserve a place in the face-to-face queue using the UniVerse app.

For course administration matters, please contact the Course Coordinator.

Questions about the this course should normally be asked during the scheduled class so that everyone can benefit from the answer and discussion.