

School of Civil and Environmental Engineering UNSW Engineering

CVEN4201

Rock and Slope Engineering

Term 1, 2023



Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Dr Kurt Douglas	<u>k.douglas@unsw.edu.au</u>	TBC in class	CE 506	9385 5046

School Contact Information

<u>Engineering Student Support Services</u> – 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

Description of rock mass and discontinuities; rock strength and failure criteria. Core logging; field data collection, mapping and fracture surveys; data presentation; hemispherical projections; introductory rock slope stability; foundations on rock; excavation on rock; in-situ stress; stresses about underground openings; classification systems and tunnel support requirements; site investigations for landslides and slope stabilisation techniques; use of slope stability anlaysis programs.

Course Aims

- To teach you the basic principles related to the theory and design of rock engineering including methods for describing, recording and presenting features of rock masses.
- To enable you to be able to perform basic designs in rock including foundations, slope stability and tunnel designs.
- To study the basic principles related to the theory and design of rock and soil slopes including an examination of the different types of slope instability and different site investigation methods, methods of analysing slopes and different methods for stabilising slopes.
- To give you some experience in using computer software to assess the stability of a slope and various remediation measures.
- To give you a practical understanding of rock and slope engineering using the field trip and assignments.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Describe the basic principles related to the theory and design of rock engineering including methods for describing, recording and presenting features of rock masses	PE1.1, PE1.3, PE1.4, PE2.1, PE2.4, PE3.2, PE3.4, PE3.6
2. Perform basic design in rock engineering including foundation, slope stability and tunnel designs	PE1.1, PE1.2, PE1.3, PE1.5, PE2.1, PE2.2, PE2.3
3. Describe the basic principles related to the theory and design of rock and soil slopes	PE1.1, PE1.2, PE1.3, PE1.5, PE2.1, PE2.2, PE2.3
4. Illustrate the methods of site investigation, soil and rock slope analysis and different methods of slope stabilisation	PE1.2, PE1.3, PE1.5, PE2.1, PE2.2, PE2.3
5. Utilise software to assess the stability of a slope and various remediation measures	PE1.2, PE1.3, PE1.5, PE2.1, PE2.2, PE2.3
6. Work effectively in a team	PE3.6

Teaching Strategies

Lectures: Formal in-person lectures will be presented to discuss the basic principles of rock and slope engineering. Lectures will vary from standard PowerPoint lectures to more hands on demonstrations of various engineering techniques. You are expected to attend all the lectures as they will greatly assist in understanding what is presented in the lecture notes. The lectures will also be a primary point of communication between the class and myself. Further communication will be via your student email and Moodle. It is very important that you frequently check your messages.

Demonstrations/workshops: The demonstrations/workshops in this subject are used to teach you 'hands on' rock description and classification; plotting of defect data and use of computer programs. They will also contain opportunities for you to work on example problems. You will be expected to be present and participate at all demonstrations/workshops, as they will contain material not covered in lectures.

Assignment: Your first assignment (multi-parts) will be a group assignment. The assignment has been developed so that it covers all the aspects of rock engineering and therefore provides you with a good facility for learning the course content. The second assignment will teach you how to analyse a slope using a computer program similar to those used in industry. You may approach me for guidance when doing your assignments. This includes showing drafts of your work to me for comment prior to submission.

Private study: Your private study should include review and reflection of lecture material; workshop and assignment problems; accessing provided links and supplementary material on Moodle and generally taking notice of the characteristics of the geological environments that you travel through each day. For each hour of contact it is expected that you will put in at least 1.5 hours of private study

Additional Course Information

Up until now you have studied soil properties and geology and basic geotechnical design in soils in third year. Part of this course will teach you the basics of rock mechanics and introduce you to design techniques for rock masses. The other part of this course covers slope stability that will use your existing knowledge of soil mechanics and what you learnt about rock mechanics in the first part of this course. The geology you studied in earlier courses will be very important in this course for developing geotechnical models that can be used to develop good engineering designs.

The course begins by examining methods of describing, recording and presenting rock mass features. This will be followed by learning about methods for determining the engineering properties of rock masses. This initial work will then be used to perform basic foundation, slope stability and tunnel designs.

The second part of the course will begin by examining the different types of slope instability and how to characterise them followed by a discussion of different site investigation techniques. Methods of analysing slopes including the use of stability analysis programs will be learnt. Finally different methods for stabilising slopes will be covered.

Assessment

The final grade for this course will normally be based on the sum of the scores from each of the assessment tasks. The Final Examination is worth 55% of the Final Mark if class work is included and 100% if class work is not included. The class work is worth 45% of the Final Mark if included. A mark of at least 40% in the final examination is required before the class work is included in the final mark. The formal exam scripts will not be returned. Students who perform poorly in the assessment tasks and workshops are recommended to discuss progress with the lecturer during the semester. Note: The lecturer reserves the right to adjust the final scores by scaling if agreed by the Head of School.

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Rock Engineering 🏝	30%	In parts - See schedule	1, 2, 3, 4, 6
2. Slope Stability	15%	31/03/2022 11:59 PM	3, 4, 5, 6
3. Final exam	55%	Formal UNSW Exam Period	1, 2, 3, 4

Assessment 1: Rock Engineering (Group)

Start date: Week 2 Due date: In parts - See schedule

This assignment will be carried out in groups of three or four and will cover the entire rock engineering component of the course including: hemispherical projections and a simple rock slope design, rock core logging, a foundation design and a tunnel design. It is important that you all contribute to each part of the assignment so that you can practice applying everything you are presented with in class.

Additional details

The assignment will assess: how well you develop your geotechnical model (if required); your ability to record, plot and synthesise information; your ability to perform appropriate calculations with an appreciation of the impact of your assumptions; and how well you assess your answer/s. Quality of presentation is also important.

Students in surveys in previous years have expressed the desire for ongoing feedback. To facilitate this, the assignment will be split into components with due dates distributed throughout the session. This will allow you to complete each part as it is taught in class (similar to a workshop) so as not to overload yourselves at the end of the session and to enable me to give you some marks/feedback prior to the end of the year. It is aimed to give feedback within two weeks of submission.

Late submissions will be penalised at the standard UNSW rate of 5% per day after the due time and date have expired, capped at five days (120 hours), after which a student cannot submit an assessment for marks.

Assessment 2: Slope Stability

Start date: Week 4 Submission notes: To be submitted as a report in Moodle Due date: 31/03/2022 11:59 PM

This assignment will cover the slope stability component of the course. It will assess your ability to analyse a slope using the program Slope/W and to consider and design possible remediation measures. Geotechnical engineers often use computers to design and analyse slopes so it is important that you learn how to use them properly and also very importantly learn their limitations. Quality of presentation is also important.

Assessment criteria

The assignment will assess: how well you develop your computational model, including geometrical setup, material property selection and your analysis process/technique; your appreciation and impact assessment of your assumptions; your remediation methods and assessment; and how well you assess your answer/s. Quality of presentation is also important.

Additional details

Late submissions will be penalised at the standard UNSW rate of 5% per day after the due time and date have expired, capped at five days (120 hours), after which a student cannot submit an assessment.

Assessment 3: Final exam

Assessment length: 2 hours (plus 10 minutes reading and 20 minutes upload time) **Due date:** Formal UNSW Exam Period

The final OPEN BOOK exam will assess your understanding of the whole course with particular emphasis on your ability to synthesise data and investigate and design structures in rock masses and slopes.

Attendance Requirements

For courses with Workshops and/or Labs, attendance for those classes is a necessary part of the course. You must **attend at least 80% of the workshop/lab** in which you are enrolled for the duration of the session.

Course Schedule

View class timetable

Timetable

Date	Туре	Content
Week 1: 13 February - 17 February		Description of rock mass and discontinuities. Data collection and presentation. Core logging.
Week 2: 20 February - 24 February		Rock strength and failure criteria. Ass 1a out 23/2.
Week 3: 27 February - 3 March		Hemispherical projections, introductory rock slope stability. Ass 1a due 2/3. Ass 1b out 2/3.
Week 4: 6 March - 10 March		Site investigations for landslides. Slope stability analysis. Ass 2 out 9/3.
Week 5: 13 March - 17 March		Slope stabilisation techniques. Ass 1b due 16/3.
Week 6: 20 March - 24 March		Flexibility Week - No lecture/workshop.
Week 7: 27 March - 31 March		Foundations on rock. Ass 2 due 31/3. Ass 1c out 30/3.
Week 8: 3 April - 7 April		In-situ stress. Stresses about underground openings. Ass 1d out 6/4.
Week 9: 10 April - 14 April		Classification systems and tunnel support requirements. Ass 1c due 14/4.
Week 10: 17 April - 21 April		Review. Ass 1d due 21/4.

Resources

Prescribed Resources

No compulsory texts. Students will be provided with notes and references to explore in Moodle and during class.

Recommended Resources

The following are recommended reading.

- Hoek, E. (2007) Practical Rock Engineering. FREE DOWNLOAD: https://www.rocscience.com/learning/hoek-s-corner
- Brady, B.H.G. and Brown, E.T. (2006) Rock Mechanics for Underground Mining, 3rd Edition. [Ebook Available Online through library]
- Wyllie, D.C. and Ma, C.W. (2004) Rock Slope Engineering, 4th Edition. Spon Press:New York. [Note: continues Hoek, E. and Bray, E.W. (1981) Rock Slope Engineering, 3rd Edition. The Institute of Mining and Metallurgy, London.] [E-book Available Online through library]
- Hoek E. and Brown E.T. (1982) Underground Excavation in Rock, The Institution of Mining and Metallurgy, London.
- Hoek, E., Kaiser, P.K. and Bawden, W.F. (1995) Support of Underground Excavations in Hard Rock.
- Hudson, J.A. and Harrison, J.P. (2005) Engineering Rock Mechanics. 3rd Impression. Permagon. [E-book Available Online through library]
- Bell, F.G. (2007) Engineering Geology. Burlington : Elsevier. [E-book Available Online through library]

Websites of interest include:

- Australian Geomechanics Society:
- Australian Geomechanics Society, Sydney: https://australiangeomechanics.org/chapter/sydney-nsw/
- Int. Soc. for Soil Mechanics & Geotechnical Engineering: https://www.issmge.org/
- International Society for Rock Mechanics:
- International Association of Engineering Geology:
- The Australasian Institute of Mining and Metallurgy:
- The U.S. Geological Survey:
- Science Direct Journal Search:

More will be provided on Moodle as required.

iPhone (and other almost as smart phones)

There are numerous apps being developed for various smart phones. At the moment, there are only a handful developed for geology/geotechnical work that are free. One that may be useful for this course is:

- GeoID– works as a geological compass that can be used for basic rock mapping. It also allows for real-time plotting on a Schmidt Net or similar (useful to check your assignment).

https://australiangeomechanics.org/

https://www.isrm.net/

https://www.iaeg.info/

https://ausimm.com/

https://www.usgs.gov/

https://www.sciencedirect.com/

Computer Software

The School computer laboratories provide you access to *Rocscience* programs, *Dips* (plotting defect data) and *Examine* and *RS2* (underground stress analysis); and the *GeoStudio* program *GeoSlope* (soil slope stability analysis). Software can also be accessed via *Access Anytime Anywhere* (TIP: Using the virtual machine option is usually faster). For example for *Rocscience* software: https://www.myaccess.unsw.edu.au/applications/rocscience-suit

Course Evaluation and Development

The course is reviewed annually through the myExperience survey. All responses are considered and I make changes to the course annually in response. I am also always happy to get feedback during the course for immediate consideration. You can email me directly or use the feedback discussion tool I have placed in Moodle.

I am aware from feedback that there is a lot of content in our course. You do not have to read and watch everything you are provided with, it is there if you need it or want to explore further. It is much like solving problems in industry, where you are required to identify the information you need to solve and delve deeply into the literature where required.

Laboratory Workshop Information

Workshops and lectures are combined to allow flexibility. Generally the workshop will be in the last hour of the 3 hour session.

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 T1 2023 will be held on campus between the 28th of April and the11th of May, and Supplementary Exams between the 22nd of May and the 26th of May. 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): <u>https://intranet.civeng.unsw.edu.au/key-staff-to-contact-during-your-studies-at-unsw</u>
- <u>Key UNSW Dates</u> 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): <u>https://intranet.civeng.unsw.edu.au/student-intranet</u>
- Student Life at CVEN, including Student Societies: <u>https://www.unsw.edu.au/engineering/civil-and-environmental-engineering/student-life</u>
- Special Consideration: https://student.unsw.edu.au/special-consideration
- General and Program-Specific Questions: <u>The Nucleus: Student Hub</u>
- Book an Academic Advising session: https://unswengacademicadvising.as.me/schedule.php

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

Dr Kurt Douglas

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	4			
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	1			
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	1			
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				