MINE5010

Fundamentals of Rock Behaviour for Underground Mining

Term 1, 2022

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Ismet Canbulat	i.canbulat@unsw.edu.au	Appointment or emails	School of Minerals and Energy Resources Engineering OMB 164	0432003064

School Contact Information

School of Minerals and Energy Resources
Old Main Building, Level 1, 159 (K15)
UNSW SYDNEY NSW 2052 AUSTRALIA

Engineering Student Services
E: mere.teaching@unsw.edu.au
W: www.engineering.unsw.edu.au/minerals-energy-resources

Course Details

Units of Credit 6

Summary of the Course

Introduction to mining rock mechanics and the rock mechanics context within new and operating underground mines. Basic physical principles applied to rock mechanics and geotechnical engineering in an underground mining environment. Elasticity and stress; rock properties and methods of determination; rock response to load; failure modes; time-dependency; stiffness; energy release; rock mass characterisation; geological environment and structure; stress environment and methods of determination; hydro-geological environment; soft rock/soil mechanics considerations.

Course Aims

This course aims to equip the student with knowledge and skills to design and select appropriate Geomechanics techniques for different mining applications.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Basic knowledge of mining rock mechanics and the rock mechanics context within new and operating underground mines.	PE1.1
2. Principles applied to rock mechanics and geotechnical engineering in an underground mining environment.	PE1.3
3. Knowledge of elasticity and stress; rock properties and methods; rock mass failure modes; as well as behaviour of rock under loading.	PE1.5
4. Geotechnical laboratory testing and interpretation of test results.	PE1.4

It is intended that students will be able to:

1. Understand the basic mechanical properties of rock and how these are applied to analyse problems in mining geomechanics.
2. Have a sound working knowledge of fundamental mechanisms and geotechnical principles within the context of practical coal mining applications;
3. Recognise the role and importance of these principles in a comprehensive range of coal mining applications, both from a technical perspective, and from the risk and operational management perspective.
4. Have a broad knowledge of key numerical methods used in mining rock mechanics

Teaching Strategies

This course will contribute to the development of the following Graduate Attributes:

1. The skills involved in scholarly enquiry

2. An in-depth engagement with the relevant disciplinary knowledge in its interdisciplinary context

3. The ability to engage in independent and reflective learning

4. The skills required for collaborative and multidisciplinary work

5. The skills of effective communication

Additional Course Information

Welcome to MINE5010 Fundamentals of Rock Behaviour. This course is designed to introduce engineers and geologists to the major geomechanics components associated with coal mining operations, from resource evaluation and mine design to daily operations. It is, therefore, ideally suited to open cut and underground coal engineers or geologists who have an understanding and experience in the coal mining industry but are seeking to develop more specialist skills in the geomechanics field.

The course content will include the following components:

- Fundamental of rock mechanics
- Intact rock characterisation
- Discontinuities characterisation and modelling
- Rock mass classification
- Fundamental of coal geology
- Mine Design issues
- Ground control management and environmental geomechanics.

The course is structured to provide an initial overview of basic principles and terminology plus the major geomechanical properties and behavioural characteristics of rock material.

An important component will be an emphasis on the interdependencies between geotechnical parameters and coal mine design/operational decisions and requirements. The link between geological and engineering disciplines is an important component in successfully managing these dependencies.

This course assumes a student has knowledge of

- as this is a technical course in a postgraduate program, a fundamental understanding of both Mathematics and Physics to a standard at least equivalent to a first year course in a university engineering program
- basic mining and geological terms and descriptions
- mining systems.

Total student effort hours: Approximately 150 hours

Assessment

All the course materials and assignments will be available online through Moodle. Access to the Moodle site is via the Moodle icon on the MyUNSW homepage, or at https://moodle.telt.unsw.edu.au

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Laboratory Assignment	35%	27/03/2022 11:59 PM	1, 4
2. Geology Assignment	35%	17/04/2022 12:00 AM	2
3. Quizzes	15%	02/03/2022 05:00 PM	1, 2, 3, 4
4. Team-based activities	15%	03/03/2022 12:00 AM	1, 2, 3, 4

Assessment 1: Laboratory Assignment

Due date: 27/03/2022 11:59 PM

Rock testing laboratory report

Assessment criteria

Assessment 1 will be assessed based on the quality of the research proposal; marking rubrics can be found in Moodle.

Assessment 2: Geology Assignment

Due date: 17/04/2022 12:00 AM

Assess overall understanding of students on basic coal geology

Assessment criteria

Assessment 2 will be assessed based on the quality of the research proposal; marking rubrics can be found in Moodle.

Assessment 3: Quizzes

Due date: 02/03/2022 05:00 PM

Basic questions on the course content to asses overall understanding of students.

Assessment 4: Team-based activities

Start date: 28/02/2022 12:00 AM
Due date: 03/03/2022 12:00 AM

Team-based activities in the class

Attendance Requirements

All students will need to attend the class/online delivery during the time of delivery.

Course Schedule

UNSW Days	Day	Hrs.	Topic	Content/Activities	Presenter
1	28th Feb	8	Introduction to the Course and the Fundamentals of Rock Behaviour	Introduction to the program and the course	IC/CZ
				Minerals and Energy Resources Eng student OHS induction and assessment	
				Introduction to Moodle/Library Access	
				Fundamental of Geomechanics	
				Intact Rock, Discontinuity and Rock Mass	
2	1st March	8	Fundamentals of Rock Behaviour	Intact Rock, Discontinuity and Rock Mass (Cont'd)	CZ
				Rock mechanics lab inspection/induction	
				Assignments discussion	
3	2nd March	8	Coal Mine Geology	Mine geology investigations	HR/SC
				Mine geophysical investigations	
4	3rd March	8	Mine Geology Investigations	Impact of geology on mining – case studies	IC

Resources

Prescribed Resources

- MEA Report Writing Guide for Mining Engineers. P Hagan and P Mort (Mining Education Australia (MEA)). (Latest edition available for download from the School website or a hardcopy version is available from the UNSW Bookshop)
- Galvin, JM. (2016). Ground Engineering - Principles and Practices for Underground Coal Mining (Springer).
- Rock Mechanics for Underground Mining GHG Brady & ET Brown, 3rd edition, Kluwer Academic Press, 2004.
- Rock Mechanics and the Design of Structures in Rock. L Obert & WI Duvall, John Wiley & Sons (1967)
- Fundamentals of Rock Mechanics, JC Jaeger & NGW Cook, Chapman & Hall (1979).
- Rock Fracture Mechanics. BN Whittaker, RN Singh & G Sun, Elsevier (1992).
- Coal Mine Ground Control. SS Peng, John Wiley & Sons (1986).
- Geotechnical Instrumentation and Monitoring in Open Pit and Underground Mining. T Szwedzicki (ed.), AA Balkema (1993).
- Rock Support in Mining and Underground Construction. PK Kaiser & DR McCreath (eds.), AA Balkema (1992).
- Rock Slope Engineering. E Hoek & JW Bray, Inst. of Mining & Metallurgy, London (1994).
- Rockbursts in Coal Mines and their Prevention. G Brauner, AA Balkema (1994).
- Australian Coal Mining Practice – Monograph 12. AJ Hargraves, CH Martin (eds.), AusIMM (1975).
- Subsidence Engineers' Handbook. National Coal Board (1975).
- Rock Support and Reinforcement Practice in Mining. E Villaescusa, C Windsor & A Thompson (eds.), AA Balkema (1999).
- Cablebolting in Underground Mines. D Hutchinson & M Diederichs, BiTech Publishers (1996).
- Diederichs, M., Lato, M., Hammah, R., Quinn, P. 2007. Shear Strength Reduction (SSR) approach for slope stability analyses. Proceedings of the 1st Canada-US Rock Mechanics Symposium, Vancouver. pp. 319-327.
- Duncan, J., Wright, S. 2005. Soil Strength and Slope Stability, John Wiley & Sons Inc.
- Harrison, J., Hudson, J. 2000. Engineering Rock Mechanics: Illustrative Worked Examples. Elsevier Science, Oxford. 530 pp.
- Hatherly, P., Medhurst, T., MacGregor, S. 2008. Geophysical Strata Rating. ACARP project C15019. https://www.acarp.com.au/
- Hatherly, P., Medhurst, T., Zhou, B. 2013. Investigations for open pit geomechanics using geophysical logs, ACARP project C20025. https://www.acarp.com.au/
- Hoek, E. 2007. Practical Rock Engineering, Rocscience (online): https://www.rocscience.com/learning/hoek-s-corner.
- Hoek, E., Brown, E. 1980. Empirical strength criterion for rock masses. Journal of The Geotechnical Engineering Division. ASCE 106 (GT9), pp. 1013-1035.
- Hoek, E., Brown, E. 1988. The Hoek-Brown failure criterion – a 1988 update. Proceedings 15th Canadian Rock Mech. Symp. Toronto.
- Hoek, E., Marinos, P. 2007. A brief history of the development of the Hoek-Brown failure criterion. Soils and Rocks. No. 2.
- International Society for Rock Mechanics (ISRM) Commission on Standardization of Laboratory and Field Tests, 1978. Suggested methods for the quantitative description of discontinuities in rock masses. Int J Rock Mech Min Sci & Geomech Abstr. 15, pp. 319-368.
- Jaeger, J., Cook, N., Zimmerman, R. 2007. Fundamentals of Rock Mechanics (Fourth Edition). Blackwell Publishing, Oxford, UK.

- Mark, C., Molinda, G. 2005. The Coal Mine Roof Rating (CMRR) – A decade of experience. Intl J of Coal Geology. 64, pp. 85-103.
- Priest, S., Brown, E. 1983. Probabilistic stability analysis of variable rock slopes. Institution of Mining and Metallurgy Transactions. 92, pp. A1-A12.
- Sjoberg, J. 1999. Analysis of Large Scale Rock Slopes, Doctoral Thesis, Lulea University of Technology Department of Civil and Mining Engineering Division of Rock Mechanics, Sweden.
- Zhai, H., Canbulat, I., Hebblewhite, B., Zhang, C. 2017. Review of current empirical approaches for determination of the weak rock mass properties. Procedia Engineering. 191, pp. 908-917.

Other Resources

- *Guide to Authors,* 2008. (Australasian Institute of Mining and Metallurgy; Melbourne).

- *Style Manual for authors, editors and printers.* 6th edition, (John Wiley & Sons).

Online Resources

Selected readings as well as other supporting material (e.g. course outline and lecture notes will be made available on Moodle.

Course Evaluation and Development

The student feedback will be recieved through myExperience.

Submission of Assessment Tasks

The School has developed a guideline to help you when submitting a course assignment.

We encourage you to retain a copy of every assignment submitted for assessment for your own record either in hardcopy or electronic form.

All assessments must have an assessment cover sheet attached.

Course completion

Course completion requires submission of all assessment items. Failure to submit all assessment items may result in the award of an Unsatisfactory Failure (UF) grade for the Course unless special consideration has been submitted and approved. Please note, a competency hurdle of 50% is applied to the final assessment.

Late Submission of an Assignment

Full marks for an assignment are only possible when an assignment is received by the due date.

We understand that at times you may not be able to submit an assignment on time, and the School will accommodate any fair and reasonable extension. We would recommend you review the UNSW Special Consideration guidelines – see section below.

Late submission will not be accepted and will be considered as no submission.

Special Consideration

You can apply for special consideration through The Nucleus Student Hub when illness or other circumstances interfere with your assessment performance. Sickness, misadventure or other circumstances beyond your control may:

- Prevent you from completing a course requirement
- Keep you from attending an assessable activity
- Stop you submitting assessable work for a course
- Significantly affect your performance in assessable work, be it a formal end-of-semester examination, a class test, a laboratory test, a seminar presentation or any other form of assessment

We ask that you please contact the Course Convenor immediately once you have completed the special consideration application, no later than one week from submission.

More details on special consideration can be found at: www.student.unsw.edu.au/special-consideration

Student Support

The University and the Faculty provide a wide range of support services for students, including:

- Library training and support services - www.library.unsw.edu.au

- UNSW Learning Centre - www.lc.unsw.edu.au
- Counselling support - www.counselling.unsw.edu.au

Equitable Learning Services aims to provide all students with a free and confidential service that provides practical support to ensure that your health condition doesn't adversely affect your studies. https://student.unsw.edu.au/els

Academic Honesty and Plagiarism

Your lecturer and the University will expect your submitted assignments are truly your own work. UNSW has very clear guidelines on what plagiarism is and how to avoid it. Plagiarism is using the words or ideas of others and presenting them 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. The University has adopted an educative approach to plagiarism and has developed a range of resources to support students. All the details on plagiarism, including some useful resources, can be found at www.student.unsw.edu.au/plagiarism.

All Mining Engineering students are required to complete a student declaration for academic integrity which is outlined in the assignment cover sheets. By signing this declaration, you agree that your work is your own original work.

If you need some additional support with your writing skills, please contact the Learning Centre or view some of the resources on their website: www.lc.unsw.edu.au. The Learning Centre is designed to help you improve your academic writing and communication skills. Some students use the Centre services because they are finding their assignments a challenge, others because they want to improve an already successful academic performance.

Academic Information

Course Results

For details on UNSW assessment policy, please visit: www.student.unsw.edu.au/assessment

In some instances your final course result may be withheld and not released on the UNSW planned date. This is indicated by a course grade result of either:

- LE – indicates you have not completed one or more items of assessment; or
- WD – indicates there is an issue with one or more assignment; or
- WC – which indicates you have applied for Special Consideration due to illness or misadventure and the course results have not been finalised.

In either event it would be your responsibility to contact the Course Convener as soon as practicable but no later than five (5) days after release of the course result. If you don't contact the convener on time, you may be required to re-submit an assignment or re-sit the final exam and may result in you failing the course. You would also have a NC (course not completed) mark on your transcript and would need to re-enroll in the course.

Studying a course in the School of Minerals and Energy Resources Engineering at UNSW

Report writing guide

The School has a Report Writing Guide (RWG) available. A copy of this is available on the course Moodle site.

Computing Resources and Internet Access Requirements

UNSW Minerals and Energy Resources Engineering provides blended learning using the on-line Moodle LMS (Learning Management System). Also see - Transitioning to Online Learning: www.covid19studyonline.unsw.edu.au

It is essential that you have access to a PC or notebook computer. Mobile devices such as smart phones and tablets may compliment learning, but access to a PC or notebook computer is also required. Note that some specialist engineering software is not available for Mac computers.

- Mining Engineering Students: OMB G48
- Petroleum Engineering Students: TETB LG34 & LG 35

It is recommended that you have regular internet access to participate in forum discussion and group work. To run Moodle most effectively, you should have:

- broadband connection (256 kbit/sec or faster)
- ability to view streaming video (high or low definition UNSW TV options)

More information about system requirements is available at www.student.unsw.edu.au/moodle-system-requirements

Accessing Course Materials Through Moodle

Course outlines, support materials are uploaded to Moodle, the university standard Learning Management System (**LMS**). In addition, on-line assignment submissions are made using the assignment dropbox facility provided in Moodle. All enrolled students are automatically included in Moodle for each course. To access these documents and other course resources, please visit: www.moodle.telt.unsw.edu.au

How We Contact You

At times, the School or your course convenors may need to contact you about your course or your enrolment. Your course convenors will use the email function within Moodle or we will contact you on your @student.unsw.edu.au email address.

We understand that you may have an existing email account and would prefer for your UNSW emails to be redirected to your preferred account. Please see instructions on how to redirect your UNSW emails: "How can I forward my emails to another account?"

How You Can Contact Us

We are always ready to assist you with your inquiries. To ensure your question is directed to the correct person, please use the email address below for:

- Enrolment or other admin questions regarding your program: https://unswinsight.microsoftcrmportals.com/web-forms/
- Course inquiries should be directed to the Course Convenor

Image Credit

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