MINE8940

Mine Slope Monitoring Technologies

Term 3, 2022

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Alison McQuillan	mere.teaching@unsw.edu.au	by appointment	alison.mcquillan@rocscience.com	0418285089
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Lecturers

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School Contact Information

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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

This course delivers the current state of knowledge regarding the conventional and advanced mine slope monitoring technologies. It includes the techniques for the measurement of mine slopes; types of measurement techniques, including surface and subsurface methods; design of mine slope monitoring programs; measurement continuity; the advantages and disadvantages of different technologies; the identification of cost-efficient monitoring techniques for different purposes.

Course Aims

This course aims to equip the student with the knowledge and skills to design appropriate mine slope monitoring techniques and evaluation of the monitoring data.

Course Learning Outcomes

1. Describe the principles of mine slope monitoring and identify the conventional and advanced mine slope monitoring technologies that are currently in use.
2. Summarise and compare the appropriateness and effectiveness of different monitoring techniques.
3. Design a most efficient monitoring technique for any particular surface mining application
4. Determine the role and importance of these techniques in a comprehensive range of surface mining applications, both from a technical perspective, and from the risk and operational management perspective.

Teaching Strategies

The course is presented in the form of lectures, interactive discussions related to slope monitoring technologies. The course will be presented by a number of specialists from both within the university and from external specialist consultants.

Completion of this course usually requires around 150 hrs of work. Course delivery accounts for around 40 hrs, hence 110 hrs of additional online and assessment work is required. The formal lectures are delivered in a Short Course at UNSW. Attendance at all Short Course sessions is a compulsory.
Most course materials and assessment activities will be provided through Moodle. Access to Moodle is gained for enrolled students through the Moodle icon on the MyUNSW homepage.

Additional Course Information

This course assumes a student has knowledge of:

- Basic open pit mining sequence;
- Basic geological and geotechnical terms;
- Fundamental understanding of mining geomechanics;
- Fundamental understanding of basic mathematics and physics.

Assessment

Assignments and examination	% MARK
Assignment 1	
Answer includes reference and justification to at least four of the following monitoring tools: visual inspections, piezometers, inclinometers, prisms, terrestrial radar, satellite radar. Monitoring tool to be linked to the potential geotechnical hazard identified from the provided information.	50%
At a minimum, TARP includes responsibility of the geotechnical engineer and inspection frequency for three TARP levels (e.g. normal conditions, elevated conditions, extreme conditions).	30%
TARP includes additional controls (e.g. exclusion zones, modified mining methods, re-design) for defined TARP levels.	20%
Assignment 2	
Answer includes at a minimum visual inspections, extos (or tell tales), survey pick up.	30%
Answer includes example document (e.g. hazard alert) to communicate identified cracking. Document communicating hazard includes reference to location of hazard, risk rating, current controls, monitoring requirements and frequency.	70%
Deduct if answer includes communication of the hazard and monitoring requirements in body of an email, even if contains all information listed in the section above.	-10%
Assignment 3	
Answer includes at least three advantages and limitations of RAR, SAR, LiDAR, Doppler and satellite monitoring tools.	75%
Answer includes at least one scenario where the monitoring tool should be deployed (e.g. broad scanning or targeted monitoring of potential or identified hazard).	25%
Deduct for incorrect application.	Up to 50%

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Monitoring Strategy	35%	25/11/2022 11:59 PM	4
2. Inspection and Communication	30%	25/11/2022 11:59 PM	1, 2, 3, 4
3. Monitoring Types and Applications	35%	25/11/2022 11:59 PM	1, 2

Assessment 1: Monitoring Strategy

Due date: 25/11/2022 11:59 PM

A new mine is being developed in a high rainfall environment. The pit has a planned depth of 400 m

through highly weathered strata at the crest of the slope (top 50 m), and competent hard rock (bottom 350 m). Bedding, with varying degrees of weathering, are modelled to dip into the excavated pit. Shearing is possible along bedding planes. Photographs of a neighbouring excavation are below. The new pit is expected to have similar rock mass conditions. What monitoring devices should be implemented prior to and during operations, and why.? Develop a TARP for each monitoring instrument. At a minimum include inspection frequency and responsibilities of the geotechnical engineer for three TARP levels in the TARP.

Details see assignments.

This assignment will be conducted by individual students.

Assessment 2: Inspection and Communication

Due date: 25/11/2022 11:59 PM

During a routine field inspection, surficial cracks are observed along an active haul road. The haul road is the main route for heavy and light vehicles in and out of the pit. Identified cracking is situated 250 m above the current operating level (i.e. current pit is 250 m deep pit). See photo below. What monitoring devices should be installed.? Should this be communicated.? If yes, provide an example of how this cracking should be communicated.? How regularly should these cracks be inspected and how should they be monitored.?

This assignment will be conducted by individual students.

Assessment 3: Monitoring Types and Applications

Due date: 25/11/2022 11:59 PM

The assessments will be based on current monitoring techniques that the participants are using on their mine sites.

There are many different types of radar monitoring available. List the advantages and limitations of RAR, SAR, LiDAR, Doppler and satellite monitoring data. For each radar type, list an application of where such monitoring should be deployed.

This assignment will be conducted by individual students.

Attendance Requirements

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

Course Schedule

Day	Date	Theme(s)	Time	Topic	Presenter
1	Mon 10 Oct	Lectures	08:30 – 10:30	**Introduction** Why Monitor Failure mechanisms / Warning Signs Types of slope movement Types of monitoring / Monitoring methods	Binghao Li/ Alison McQuillan
			10:30 – 11:00	**Morning Tea**	
			11:00 – 13:30	**Prisms** Prisms and GNSS - What is the difference Advantages and Limitations Interpreting Data - including Important Considerations, Corrections and Maintenance Alarming Physical demonstration of Prisms **Intro to Quikslope**	Clint van der Loon
			13:30 – 14:30	**Lunch Break**	
			14:30 – 17:00	**GNSS** History Positioning Applications Practical Demonstration - Real Time Kinematics	Binghao Li
2	Tue 11 Oct	Lectures	08:30 – 10:30	**Satellite** What is the technology	Jessica Morgan

				Advantages and Limitations Applications and Case Studies	
			10:30 – 11:00	**Morning Tea**	
			11:00 – 13:30	**Radars** The use and abuse of radar technology in slope monitoring **Synthetic Aperture Radars (SAR)** What is the technology Advantages and Limitations Applications and Case Studies **Doppler Radars** What is the technology Advantages and Limitations Applications and Case Studies	Neal Harries
			13:30 – 14:30	**Lunch Break**	
			14:30 – 17:00	**Geosensors** Interpretation and Corrections Advantages and Limitations Applications and Case Studies	PSM
3	Wed 12 Oct	Lectures	08:30 – 10:30	**LiDAR** What is the technology Advantages and Limitations Applications and Case Studies	Lance Steel
			10:30 - 11:00	**Morning Tea**	
			11:00 – 13:30	**Real Aperture Radar (RAR) - 2D and 3D** What is the technology Advantages and	Albert Cabrejo

				Limitations Applications and Case Studies Deformation, Amplitude, Range, Coherence Atmospheric Corrections **Inverse Velocity**	
			13:30 – 14:30	**Lunch Break**	
			14:30 – 17:00	Piezometers Instrumentation / Advantages and Limitations / Applications and Case Studies Physical demonstration Pit Slope Monitoring - Case study Applications Success stories Learnings	PSM
4	Thu 12 Oct	Lectures	08:30 – 10:30	**Accompanying Systems and Processes for Safe Mining** Databases Communication TARPs Risk Matrices Controls	Glen Guy
			10:30 - 11:00	**Morning Tea**	
			11:00 – 13:30	Integration of Monitoring Data and Modelling Software Applications and Case Studies	Neil Bar Alison McQuillan
			13:30 – 14:30	**Lunch Break**	
			14:30 – 17:00	Practical demonstration using 3D software and monitoring data	Davide Colombo

Resources

Recommended Resources

There are no prescribed texts for this course. However, the following references may be of assistance, as are a range of industry and professional journals.

- Guidelines for Open Pit Slope Design. J Read & P Stacey CSIRO (2008)
- Guidelines for Slope Performance Monitoring. R Sharon & E Eberhardt (2020)
- Geotechnical Instrumentation and Monitoring in Open Pit and Underground Mining. T Szwedzicki (ed.), AA Balkema (1993).

(Note: This is not intended to be a complete list, but a guide only.)

Other resources

- *Report Writing Guide for Mining Engineers,* 2011. P Hagan & P Mort (Mining Education Australia (MEA) ISBN 978 0 7334 3032 9. Available on-line on course homepage.
- *Guide to Authors,* 2008. (Australasian Institute of Mining and Metallurgy; Melbourne).

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.

Late Submission of an Assignment

Full marks for an assessment are only possible when an assessment is received by the due date. 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. 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 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, or
- Online quizzes where answers are released to students on completion, or Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date, or Pass/Fail assessment tasks.

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.

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 MERE 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

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.

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

Synergies in Sound 2016

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.

School of Minerals and Energy Resources Engineering

Assessment Cover Sheet

Course Convenor: _____

Course Code: _____ Course Title: _____

Assignment: _____

Due Date: _____

Student Name: _____ Student ID: _____

ACADEMIC REQUIREMENTS

Before submitting this assignment, the student is advised to review:

- the assessment requirements contained in the briefing document for the assignment;
- the various matters related to assessment in the relevant Course Outline; and
- the *Plagiarism and Academic Integrity* website at < http:/www.lc.unsw.edu.au/plagiarism/pintro.html > to ensure they are familiar with the requirements to provide appropriate acknowledgement of source materials.

If after reviewing this material there is any doubt about assessment requirements, then in the first instance the student should consult with the Course Convenor and then if necessary with the Director – Undergraduate Studies.

While students are generally encouraged to work with other students to enhance learning, all assignments submitted for assessment must be their entire own work and duly acknowledge the use of other person's work or material. The student may be required to explain any or all parts of the assignment to the Course Convenor or other authorised persons. *Plagiarism* is using the work of others in whole or part without appropriate acknowledgement within the assignment in the required form. *Collusion* is where another person(s) assists in the preparation of a student's assignment without the consent or knowledge of the Course Convenor.

Plagiarism and *Collusion* are considered as Academic Misconduct and will be dealt with according to University Policy.

STUDENT DECLARATION OF ACADEMIC INTEGRITY

I declare that:

- This assessment item is entirely my own original work, except where I have acknowledged use of source material [such as books, journal articles, other published material, the Internet, and the work of other student/s or any other person/s].
- This assessment item has not been submitted for assessment for academic credit in this, or any other course, at UNSW or elsewhere.

I understand that:

- The assessor of this assessment item may, for the purpose of assessing this item, reproduce this assessment item and provide a copy to another member of the University.
- The assessor may communicate a copy of this assessment item to a plagiarism checking service (which may then retain a copy of the assessment item on its database for the purpose of future plagiarism checking).

Student Signature: Date:

Students are advised to retain a copy of this assessment for their records and submission should be made in accordance to the assessment details available on the course Moodle site.