

MINE3230

Mine Planning

Term 2, 2022



Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Professor Serkan Saydam	s.saydam@unsw.edu.au		Room 159	+61 2 9385 4525

Lecturers

Name	Email	Availability	Location	Phone
Adj. A/Professor Carlos Tapia	carlos.tapia@unsw.edu.au			+61 2 9385 5006

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

This course deals with the theoretical principles and practical methodologies associated with mine planning and project evaluation techniques. Mine planning is an iterative process entailing elements of design, scheduling and project evaluation. As part of the planning process a range of issues has to be considered including, short and long term planning, mine optimisation, cut-off grade analysis and mining valuation. The course presents principles of surface and underground mine planning and valuation for metalliferous and coal mining projects.

This course covers the following broad topics:

- Holistic Mine Planning Process: Review
- Mining Strategy: Block economic value; Ultimate pit optimisation; Mining sequence and scheduling; Project scheduling; Cutoff grade theory; Linear programming
- General Project Risks: Identifying project risks
- Mine Project Evaluation: Financial Technical Modeling; Construction of FTM; Project financing
- Mine Planning & Evaluation Case Studies: Metalliferous case studies; Coal case studies

Course Aims

This course aims to introduce the principles and practical methodologies of mine planning and mine valuation. The mine planning project provides students with the opportunity to get involved in the planning process for a real mining project. The knowledge and skills you acquire in this course will be useful not only in your mine design and feasibility courses in 4th year but also when you work as a mining engineer in industry

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Explain how economic and technological factors impact on mining method selection	PE1.1
2. Design an optimal pit outline and develop the long/short term mine plans with cut-off grade optimisation	PE1.3, PE1.5, PE2.2, PE2.3
3. Explain engineering aspects of surface coal mine planning, development and operation	PE1.3
4. Explain the factors considered in underground mine planning for coal and metaliferous mines	PE1.3
5. Construct mine schedules and compare different alternatives based on sequencing, timing and costs	PE1.1, PE1.2, PE2.1, PE2.2

Learning Outcome	EA Stage 1 Competencies
6. Create realistic, properly integrated financial/technical discounted cash flow models of mining projects	PE1.1, PE1.6, PE2.3
7. Function effectively as a member of a mine planning team	PE3.1, PE3.3, PE3.5, PE3.6

Learning Outcomes

By the end of this course, it is intended that the student will be able to understand:

1. The technical aspects of mining, financial math and optimisation tools for the effective development of accurate mine plans
2. The value chain of the mining business and strategies to maximise its value
3. All aspects of the optimisation processes into mine planning form technical and financial points of view
4. The role of finance in the mining business and effectively use it to develop technical-financial models to assess the value and risk of mine plans and determine the bankable feasibility of mining projects
5. The multi-disciplinary nature of the mining engineering and how to consider, integrate and model all those aspects within an optimal - precise and accurate - mine plan

Teaching Strategies

This course uses a number of different teaching and learning approaches including:

- Problem/Project-based Learning
- Lectures and Tutorials
- Industry Guest Lectures
- Question/Answer Sessions
- Software Demonstrations / Trainings
- Self-directed Activities
- Group Activities
- Examinations

1. Project-based Learning: This course utilises project-based learning methods. Students will be given two group projects to work on. Students are required to work in groups, share the project workload, and have weekly meetings and discussions.
2. Lectures and Tutorials: Project work will be supported with weekly consultative and information-sharing session. The content of these are aligned with the projects to help students. Although this is an activity-based course, it is a requirement that all work is conducted within the School.
3. Group Work: Members of a group may elect to work on a topic of the project they feel more comfortable with, but should integrate their work into the whole project. This should be reported back at their team meetings. Some marks will be taken from the underperforming students and allocated to the other group members. If a student makes no contribution to the project, he/she will receive zero for that project.
4. Effective Communication: One of the most effective means of learning is to effectively communicate what has been learned. Part of the assessment in this course will be determined by how effectively the results are communicated. There are a number of opportunities for this in the form of presentations and final reports. The process of writing reports, brainstorming within a design team, preparation and presentation of report both in front of an audience and in report

form, requires clarity of thinking, defending and revising a design and analysing the risks inherent in a project.

5. Quiz: Two quizzes will be conducted in a controlled environment. The details are given under Assessment Section.
6. Final Exam: A Final Exam will be conducted during the exam term. The details are given under Assessment Section.

Assessment

Detailed Information on Assessment Tasks

Quiz (10% each): Tests will constitute multiple choice, true-false, short-answer, and/or relatively short computations based questions. The questions will be derived from the theoretical background and computations discussed during lectures and tutorials. Students must present computational steps, if necessary. Marks will be deducted for missing steps or incomplete solutions. Parameters and variables along with units and applicable assumptions must be clearly defined in computations. Or each test, right answers, procedures and solutions of questions involving calculations will be disclosure immediately after marking release.

Mine Planning Project (40%): The mine planning project constitutes two parts.

Assignment 2 (A2) □ Manual Procedure (20%): This part will be based on a small-scale (hypothetical) ore body model and relevant economic/technical parameters. Students will develop an economic valuation model and its respective economic evaluation (manually using MS Excel) including: 1) mining method selection, 2) cut-off grade, processing and logistics strategists, 3) either ultimate pit limit or footprint, 4) production schedule, 5) Capex and Opex, 6) evaluation and recommendations. Students will be required to work in groups/teams. A formal report along with the softcopy of calculations is expected for grading, and the detailed marks distribution for each task will be provided as part of the project statement.

Assignment 3 (A3) □ Mining Software Assistance (20%): This part will be based on a full-scale actual ore body block model and relevant economic/technical parameters. Assisted by mining software, students will generate an appropriated technical/economic model to determine: 1) ultimate pit, 2) eventual transition level between Open Pit and Underground operations, 3) economic footprint (if proceed), 4) production and development schedule. Students will also include a detailed economic evaluation that has to include: 1) economic valuation, 2) financial & technical model, 3) risk assessment, and 4) recommendations. The assessment includes 15 min interview weighing 40% of the Assignment mark (8%). A formal report is expected for grading, and the detailed marks distribution for each task will be provided as part of the project statement, weighting 60% of the Assignment mark (12%).

Group Composition: Given the expected number of students and project requirements, the students are required to form a group of 3 to 4 members. Students are encouraged to form multi-cultural teams. Group formation must be completed with the submission of members' names and IDs by July 6th, 2022.

Final Examination (40%): The final examination will be comprehensive in nature, as it will cover all topics (lectures and tutorials). It will constitute major computations-based questions. However, it may include multiple-choice, true-false, short-answer, and/or relatively short computations-based questions. The details on the final exam structure will be provided as part of the unit review in Week 10. Students must present all computational steps, if necessary. Marks will be deducted for missing steps or incomplete solutions. Parameters and variables along with units and applicable assumptions must be clearly defined in computations. If required, formulae will be provided in the final examination.

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Quiz 1 & 2	20%	28/06/2022 08:00 PM	1, 2, 3, 4, 5, 6, 7
2. Strategic Mine Planning	20%	13/07/2022 11:59 PM	1, 2, 3, 4, 5, 6, 7

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
Project Part A Manual Procedure			
3. Strategic Mine Planning Project Part B Whittle Project	20%	03/08/2022 11:59 PM	1, 2, 3, 4, 5, 6, 7
4. Final Examination	40%	Not Applicable	1, 2, 3, 4, 5, 6, 7

Assessment 1: Quiz 1 & 2

Start date: 21/06/2022 06:00 PM

Due date: 28/06/2022 08:00 PM

Deadline for absolute fail: Quiz 01: 28/06/2022 08:00 PM. Quiz 02: 20/07/2022 08:00 PM.

These two quiz will consist of 20 multiple choice questions each to be completed within two hours. Questions will test a combination of theoretical knowledge and the application of this via questions that require you to perform calculations. This will be based on topics that are discussed and addressed in the first few weeks of the course in the lead up to the quiz.

Each quiz has a weight of 10%

Quiz 01: 21/06/2022 06:00 PM

Quiz 02 20/07/2022 06:00 PM

Assessment criteria

The weight of each question will be determined based on the type and complexity of the question and will be noted on each one of the questions of the quiz. Each multiple selection or true or false question will be marked as correct (full mark) or incorrect (no mark). In the case of calculation questions, partial marks will be established based on the procedure and partial results obtained. Open questions might also be partially marked if they address the key points asked.

Assessment 2: Strategic Mine Planning Project Part A Manual Procedure

Start date: 22/06/2022 06:00 PM

Due date: 13/07/2022 11:59 PM

This task requires you to work in groups of two to develop your ability to create value from an ore deposit by using the key levers for value creation as part of the strategic mine planning process.

Assessment criteria

A detailed task sheet, criteria and electronic files of the block model of a hypothetical deposit will be handed out to groups in week 3 to work on the project as each of the weekly topics is discussed and presented.

The task requires the development of accurate economic/technical modelling for a comprehensive economic evaluation of a hypothetical mining project. All works must be conducted without the assistance of any mining software, and all assumptions and calculation must be backed up by reliable sources and auditable records of calculations.

Assignments to be submitted through the Turnitin portal

Assessment 3: Strategic Mine Planning Project Part B Whittle Project

Start date: 12/07/2022 06:00 PM

Due date: 03/08/2022 11:59 PM

This project will consist of an activity requiring the use of the Whittle 4X Software Package.

Assessment criteria

The task requires the development of an appropriate mining optimisation of an Open-pit or Underground project or a mix of both. The task should be developed using any of the mining software available at UNSW.

All assumptions and calculations must be backed up by reliable sources and auditable records of calculations.

The full project (database) used for the optimisation process through the mining software must be provided

Assignments to be submitted through the Turnitin portal

Assessment 4: Final Examination

This will be a comprehensive two-hour exam on all topics addressed in this course throughout the semester. Questions will assess your theoretical knowledge and the application of this on practical problem based questions that will require you to draw meaningful conclusions from calculations.

Attendance Requirements

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

Course Schedule

Week	Date	h	Topic	Content/Activity	Marked Activity
1A	May 31	2	Introduction	Course Introduction + QA	
			Tech. Concepts (Geology/Engineering)	Block Model, Mineral Resources and Ore Reserves	
1B	June 1	2	Technical Concepts (Engineering)	Mining Method Selection	
				Mine Planning	
2A	June 7	2	Technical/Economic Strategies	Maintenance	
				Cut-off Grade (CoG), Eq. Ore Grade	
2B	June 8	2		Mineral Processing (MP)	
				Tutorial MP & CoG	
3A	June 14	2	Optimisation I	Math concepts of Min and Max	
				Linear Programming (LP)	
				Operations Research (OR)	
3B	June 15	2		Floating Cone (FC)	
				Tutorial (LP + FC)	
4A	June 21	2	Quiz	Tech Concepts, Strategy and Optimisation	A1.1 - Quiz 01
4B	June 22	2	Optimisation II	Lerch & Grossman (L&G)	
				Economic Footprint (EFP)	
5A	June 28	2	Optimisation II	Tutorial (L&G + EFP)	A2.0 - Release
5B	June 29	2	Mine Planning & Scheduling	OP and UG Planning	
6A	July 5	2	Mine Planning & Scheduling	OP and UG Tutorial	
6B	July 6	2	Fundamentals of Geomechanics	Guest Lecturer	
7A	July 12	2	Mining Software Training	Demonstration and training with Whittle 4X (software demonstration)	A3.0 - Release
7B	July 13	2	Economic Aspects of Mining	Mineral Economics	A2.0 - Due
				Economic Theory Overview	
				Scale of Operation	
				Cost Structure	
				Economic Evaluation	
8A	July 19	2	Coal Mining	Guest Lecturer	
8B	July 20	2	Quiz	Mine Planning & Scheduling	A1.2 - Quiz 02
9A	July 26	2		A1 Interview	
9B	July 27	2	Financial & Technical Model	Valuation Strategies	
				Financial Instruments	
				Financial Maths	

10A	<i>August 2</i>	1	<i>Financial & Technical Model</i>	Depreciation & Amortisation	
10A	<i>August 2</i>	1	<i>Project Assessment</i>	Risk and Sensitivity Analysis	
10B	<i>August 3</i>	2	<i>Course Review</i>	Course Review	A3.0 - Due

[View class timetable](#)

Timetable

Date	Type	Content
Week 5: 27 June - 1 July	Assessment	Quiz 1 & 2
Week 7: 11 July - 15 July	Assessment	Strategic Mine Planning Project Part A Manual Procedure
Week 10: 1 August - 5 August	Assessment	Strategic Mine Planning Project Part B Whittle Project

Resources

Recommended Resources

Reference Material

- Camus, J P, 2002. *Management of Mineral Resources Creating Value in the Mining Business*, (Society for Mining, Metallurgy, and Exploration, Inc.: Littleton, CO, USA).
- Card, P, (2011) *Guidelines for economic evaluation of projects*, METPLANT 2011 - Metallurgical Plant Design and Operating Strategies, , pp. 1-11.
- Darling, P, 2011. *SME Mining Engineering Handbook*, 3Edition, (Society for Mining, Metallurgy, and Exploration, Inc.: Littleton, CO, USA).
- Dewhirst, R F and Knight Merz, S, 2013. Monograph 27 - Cost Estimation Handbook, 2Edition (The Australian Institute of Mining and Metallurgy: Australia).
- Gordon, R.L., Tilton, J.E., 2008. *Mineral economics: Overview of a discipline*. Resour. Policy 33, 4–11.
- Hall, B, 2014. *Cut-off Grades and Optimising the Strategic Mine Plan*, 300 p (The Australian Institute of Mining and Metallurgy: Australia).
- Hustrulid, W A, and Kuchta, M, 2006. *Open Pit Mine Planning & Design*, Volume 1 – Fundamentals, Edition (Taylor and Francis: London).
- InfoMine, 2015. Industry Standard for Mining Cost Estimating [online], Available from: < <http://costs.infomine.com/>>
- Lane, K F, 1988. *The Economic Definition of Ore - Cut-Off Grades in Theory and Practice*, (Mining Journal Books Limited, London).
- Pindyck, R.S., Rubinfeld, D.L., 2009. *Microeconomics*. Pearson/Prentice Hall.
- Rendu, J M, 2014. *Introduction to Cut-off Grade Estimation*, Edition, (Society for Mining, Metallurgy, and Exploration, Inc.: Littleton, CO, USA).
- Rudenno, V, 2004. *The Mining Valuation Handbook – Australian Mining and Energy Valuation for Investors and management*, 430 p (Wright Books: Victoria).
- Runge, I C, 1998. *Mining Economics and Strategy*, (Society for Mining, Metallurgy, and Exploration, Inc.: Littleton, CO, USA).
- US Federal Reserve. *FRB: H.10 Release--Foreign Exchange Rates--Nominal/Real Indexes* [online] Available from: < https://www.federalreserve.gov/releases/h10/summary/indexb_m.htm>
- World Bank, *Global Economic Monitor (GEM) Commodities| World DataBank* [on-line]. <[http://databank.worldbank.org/data/reports.aspx?source=Global-Economic-Monitor-\(GEM\)-Commodities](http://databank.worldbank.org/data/reports.aspx?source=Global-Economic-Monitor-(GEM)-Commodities)>

Other Resources

Selected readings as well as other supporting material (e.g. course outline and lecture notes will be made available on LMS. Videos are often provided to students as a webstream within the Moodle learning management system. Videos are not available for download by students, unless approved by the Course Convenor and either the Undergraduate or Postgraduate Coursework Director. Special consideration can be provided for students to access videos off-line (e.g. working remotely). Please contact the Course Convenor for more information. Note that UNSW reserves the right to deliver videos as a webstream rather than off-line and cannot provide videos that are copyright by other providers.

On-line Resources

There are numerous articles/information sources on reservoir engineering on the web. Many of them are sound, but many are either very lightweight or contain errors. Be very careful in your choice of web

sources. Remember, UNSW librarians are usually happy to help you locate articles or make suggestions regarding possible material to help you in your academic work. You can also access basic on-line help at <http://www.library.unsw.edu.au/>

Software and Hardware

- GEOVIA Whittle 4.5 [or 4.6 recently resealed version
- Maptek Vulcan 2022.1
- Microsoft Excel - Solver

Course Evaluation and Development

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:

- WD – which usually indicates you have not completed one or more items of assessment or 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-enrol in the course.

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 Assessment

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.microsoftcrmpartals.com/web-forms/>
- Course inquiries should be directed to the Course Convenor.

Image Credit

<https://portal.engineersaustralia.org.au/event/2021/05/infrastructure-thought-leaders-series-design-construction-and-maintenance-mining>

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	✓