

# ELEC9452

Masters Project B

Term 1, 2023



## Course Overview

### Staff Contact Details

#### Convenors

Name	Email	Availability	Location	Phone
Aron Michael	<a href="mailto:a.michael@unsw.edu.au">a.michael@unsw.edu.au</a>	Monday 4:00pm-4:30pm	G17, 316	02 93855663

### School Contact Information

**Consultations:** Lecturer consultation times will be advised during the first lecture. You are welcome to email the tutor or laboratory demonstrator, who can answer your questions on this course and can also provide you with consultation times. **ALL email enquiries should be made from your student email address with ELEC/TELExxxx in the subject line; otherwise they will not be answered.**

**Keeping Informed:** Announcements may be made during classes, via email (to your student email address) and/or via online learning and teaching platforms – in this course, we will use Moodle <https://moodle.telt.unsw.edu.au/login/index.php>. Please note that you will be deemed to have received this information, so you should take careful note of all announcements.

### Student Support Enquiries

[For enrolment and progression enquiries please contact Student Services](#)

### Web

[Electrical Engineering Homepage](#)

[Engineering Student Support Services](#)

[Engineering Industrial Training](#)

[UNSW Study Abroad and Exchange](#) (for inbound students)

[UNSW Future Students](#)

## 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)

## Email

[Engineering Student Support Services](#) – current student enquiries

- e.g. enrolment, progression, 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

## Course Details

### Units of Credit 4

### Summary of the Course

#### Contact Hours

The project consists of regular online meetings with the supervisor, typically about 30 minutes weekly. In addition, the project usually involves experimental work and thus requires laboratory assistance from the supervisor and/or technical staff.

#### Context

This course is normally undertaken in the second term of the last year of the ME (BE-ME) degree program. Its purpose is for students to undertake directed laboratory and research work on an approved topic under the guidance of an academic supervisor.

### Course Aims

The thesis provides an opportunity for the student to bring together engineering principles learned over their previous years of study and apply these principles to innovatively solve problems such as the development of a specific design, process and/or the investigation of a hypothesis. Thesis projects must be complex, open-ended problems that allow room for student creativity, and the acquisition, analysis and interpretation of results. There must be multiple possible solutions or conclusions at the outset and sufficient complexity to require a degree of project planning from the student. The thesis requires the student to formulate problems in engineering terms, manage an engineering project and find solutions by applying engineering methods. Students also develop their ability to work in a research and development environment.

The project provides a good introduction to work in industry and research and serves as an important indicator of how well students are able to utilize and integrate the knowledge and skills they have learnt throughout their program.

### Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Develop a design or a process or investigate a hypothesis following industry and professional engineering standards.	PE1.2, PE1.3, PE1.5, PE1.6, PE2.1, PE2.2, PE2.3, PE2.4, PE3.1, PE3.3, PE3.6
2. Critically reflect on a specialist body of knowledge related to their thesis topic.	PE2.3, PE2.4, PE3.1, PE3.2
3. Apply scientific and engineering methods to solve an engineering problem.	PE1.2, PE1.3, PE1.5, PE1.6, PE2.1, PE2.2, PE2.3, PE2.4, PE3.3

Learning Outcome	EA Stage 1 Competencies
4. Analyse data objectively using quantitative and mathematical methods.	PE1.2, PE1.3, PE2.1, PE2.2
5. Demonstrate oral and written communication in professional and lay domains.	PE1.3, PE1.4, PE3.1, PE3.2, PE3.3, PE3.4, PE3.5, PE3.6

## Teaching Strategies

The course is taught as an individual research project, to develop a level of research skills and autonomy.

## Delivery Mode

- Regular weekly online meetings between supervisor and student – to discuss and advise on the Project work.
- Laboratory access throughout the semester – for students to carry out practical design and development work with some assistance from technical staff

## Learning in this course

The project gives you the opportunity to take on a project on your own, to produce a self-contained and rounded piece of work and write it up for others to assess and use. While the project is yours alone, you will need to obtain advice, information and assistance from others, for example your supervisor, technical officers responsible for laboratories, or computing and workshop staff. While a majority of the design and synthesis tasks will be carried out in the third term (Project C), it is important that you take full advantage of time in the second term to complete preliminary works, refine your solution, formulate detailed plan, and begin the design and synthesis tasks. Regular online meetings with your supervisor are important not only because one of the assessments in this course is participation effort but also to check what you are doing is indeed what is required. If you want to contact your supervisor outside a regular online meeting time, leave a message arranging a time to meet. Pre-arranged consultations are often more effective, check contact details on the School website. Having completed Project Part A, at this stage you should have preliminary idea what you are going to do, and what tasks have got to be performed on the way to achieving your goal. In this Project part B, you will further develop the preliminary idea into a clear idea and refine the research tasks to set achievable milestones and solid plan towards accomplishing your objectives. Moreover, you will be expected to begin executing the main task of the project in this Project part B.

Once the research tasks are refined, careful and detailed planning is an important task in this course. The time duration of each task should be carefully checked to ensure if it is realistic and, in particular, allows sufficient time for tasks that are critical for the success of the project. For example, ordering components or equipment construction by the workshop, access to state-of-the art research facilities may have particularly time implications you need to be well aware of. There may be significant lead time with component delivery. Workshop time is always limited and long delays are frequently experienced and therefore it is important to get drawings to the workshop as soon as possible. Access to research facility often requires laboratory inductions and extensive training. Discuss these issues with your supervisor to draw up realistic and time efficient plan

## Additional Course Information

## **Credits**

This is a 4 UOC, level 4 course. The expected workload is 10 hours per week throughout the 10-week term. It is important to note that the weighting applied to the course is equivalent to 1.2 UOC from the available overall 12 UOC for the Project course.

## **Relationship to Other Courses**

This is a postgraduate core course for students following a ME or BE ME in Electrical or Telecommunications program in the EE&T School and other combined degree programs. This course constitutes the second part (Project B) of the three-part project work (Project A, B and C). It involves completing preliminary work, producing initial results from the execution of the main task, acquiring high level of skills in using software and hardware (tools or equipment) relevant to the project, and revising research plan in the context of preliminary work. This prepares the student for the detailed project work that will be undertaken in Project C in the following subsequent term.

## **Pre-requisites and Assumed knowledge**

The pre-requisite for this course is ELEC9451.

## **Following Courses**

The course can be a pre-requisite or a co-requisite for ELEC9453. When it is a pre-requisite, ELEC9453 must be taken in the immediate following term. When it is also a co-requisite, ELEC9453 will be taken in the same term.

# Assessment

## If Things Go Wrong

If you start having serious problems, don't ignore them or stop working; the problems won't go away. Talk over your worries with your supervisor to see what you can do to get going again. If you are still not able to resolve the problems, then see the Thesis Coordinator, the Director of Academic Studies in EE&T or the Student Counselling and Careers Unit. The Learning Centre also offers advice and support on these matters. Often some advice or perhaps reducing the scope of the project can get you working effectively for the rest of the year.

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Progress report	50%	16/03/2023 12:00 PM	1, 2, 3, 4, 5
2. Participation	50%	20/04/2023 12:00 PM	1, 2, 3, 4, 5

## Assessment 1: Progress report

**Assessment length:** 7-10 pages

**Submission notes:** Students first submit their report for the Turnitin check. Once the similarity is below 15%, they then submit their report using the "PART B REPORT ASSESSMENT" workshop tool.

**Due date:** 16/03/2023 12:00 PM

A written report is to be submitted in week 5 (Thursday 12 pm), by uploading the report as one single pdf formatted file. For those who are doing Project B and C together, the due date for submitting the report will be in week 3 (Thursday 12pm). The report will have three key aspects: (i) 5-6 pages of progress – progress made on the project since Thesis A; (ii) 1-2 pages of reflection; (iii) 1-2 pages of updated planning.

This assignment is submitted through Turnitin and students can see Turnitin similarity report

This assignment is submitted through Turnitin and students can see Turnitin similarity reports.

## Assessment criteria

The assessment is based on 4 criteria: completed preliminary results, discussion of results, and refined solutions(60%); detailed and revised project planning (15%); reflection on progress (15%); document presentation (10%).

## Additional details

Description	Wt	Accomplished	Distinguished	Solid	Adequate	Deficient
<b>Mark bands</b>		<b>85-100</b>	<b>75-84</b>	<b>65-74</b>	<b>50-64</b>	<b>0-49</b>
<b>Progress (5-6 pages)</b>	60%	Achievement is beyond expectations with respect to plan. If any complexities	Highly satisfactory achievement against the plan. If complexities or	Mostly satisfactory achievement against the plan. If complexities	Marginal achievement compared to the plan. If complexities	Achievement is not satisfactory with respect to the plan.

<b>Description</b>	<b>Wt</b>	<b>Accomplished</b>	<b>Distinguished</b>	<b>Solid</b>	<b>Adequate</b>	<b>Deficient</b>
<b>Mark bands</b>		<b>85-100</b>	<b>75-84</b>	<b>65-74</b>	<b>50-64</b>	<b>0-49</b>
		<p>or challenges have been encountered, a plan for equivalent work has been developed with significant progress made. Highly detailed discussions on work completed. The student is clearly on track to demonstrate a sophisticated understanding of the meaning and implications of their research findings.</p>	<p>challenges have been encountered, a plan for equivalent work has been developed with satisfactory progress made. Detailed discussions on the work completed. The student clearly on their way to demonstrating a good understanding of the meaning and implications of their research findings.</p>	<p>have been encountered a plan for equivalent work has been developed and a good start has been made. Some discussion of the work completed. The student looks to be developing a reasonable understanding of the meaning of their research findings.</p>	<p>have been encountered a plan for equivalent work has been developed but with little progress. Only superficial discussions of the work completed. The student will probably be able to demonstrate some understanding of the meaning of their results.</p>	<p>Little work has been done to address any complexities or challenges encountered . Little or no discussion of the work completed. It is unclear that the student understands what their results mean.</p>
<b>Reflection</b>	15%	<p>Compares and contrasts the thesis, with industrial and other academic experiences, illuminating the differences and similarities between them. The student also demonstrates a deep understanding of their field(s) of study and broadening perspective through the research experience. Evaluates changes in learning through the thesis, recognizing</p>	<p>Compares and contrasts the thesis, with industrial and other academic experiences, illuminating the differences and similarities between them. The student also demonstrates a growing understanding of their field(s) of study and developing perspective through the research experience. Evaluates changes in learning through either</p>	<p>Compares and contrasts the thesis, with industrial and/or other academic experiences, illuminating the differences and similarities between them. Evaluates changes in learning through the thesis, recognizing complex contextual factors (e.g. works with ambiguity and risk, deals with frustration).</p>	<p>Compares and contrasts the thesis, with industrial or other academic experiences, inferring differences and similarities between them. Articulates strengths and challenges during the thesis, with contexts.</p>	<p>Identifies superficial connections between the thesis, and industrial or other academic experiences . Describes own performances during the thesis with general descriptors of success and failure at a superficial level.</p>



Description	Wt	Accomplished	Distinguished	Solid	Adequate	Deficient
<b>Mark bands</b>		<b>85-100</b>	<b>75-84</b>	<b>65-74</b>	<b>50-64</b>	<b>0-49</b>
		complex contextual factors (e.g. works with ambiguity and risk, deals with frustration), demonstrating self-awareness, and envisions a future self or develops plans that build on the research experience.	recognizing complex contextual factors (e.g. works with ambiguity and risk, deals with frustration), demonstrating self-awareness, and/or envisioning a future self / developing plans that build on the research experience.			
<b>Revised project plan</b>	15%	Highly thoughtful and incisive discussions on future project plan and expected results. A reasonable strategy to ensure progress is stated, explained in detail and innovative.	Quality discussion of the future project plan and expected results. A reasonable strategy to ensure progress is stated and explained in detail.	Some discussions of future project plan and outcomes. A reasonable strategy to ensure progress is stated and briefly explained.	Superficial discussion of future project plan &/or outcomes. A reasonable strategy to ensure progress is stated.	Little or no discussion of future project plan or outcomes. No reasonable strategy to ensure progress in stated.
<b>Document presentation</b>	10%	The document follows a clear and logical structure indicated using headings and other conventions. The report is very easy to read: well-written, with good spelling and grammar, and appropriate language style. Text spacing aids readability. All aspects of formatting are consistent	The document makes good use headings, sub-headings and other stylistic conventions to indicate document structure. The report is easy to read: writing is clear enough, with good spelling and grammar, and reasonable choice of language style. Graphical	The document makes some use headings and other stylistic conventions to indicate document structure. The report is reasonably easy to read: there may be some issues with spelling, grammar or style but it doesn't affect comprehension.	Document is not at a professional level but does make use of headings and sub-headings to indicate document structure. The report is may be difficult to read: writing is just ok, broad idea comes across; spelling and grammar have some flaws, not quite appropriate language style.	The document is poorly structured, does not cohere or shows a lack of understanding of the purpose of its sections. Much effort is required to read and understand the report: writing is poor, many

Description	Wt	Accomplished	Distinguished	Solid	Adequate	Deficient
<b>Mark bands</b>		<b>85-100</b>	<b>75-84</b>	<b>65-74</b>	<b>50-64</b>	<b>0-49</b>
		throughout the document. Graphical and tabular presentation of data is appropriate, clear, consistent and economical. Discernment is shown in the placement of graphical elements (figures, tables, etc.), whether in the body of the work or in the appendices. References in text match reference list (and vice versa) and are cited properly.	elements (figures, tables, etc.) are labelled, largely formatted consistently and cited correctly. References in text match reference list (and vice versa) and are cited properly.	Figures and diagrams are generally fine, although there may be some issues with the graphical presentation of data - poor choice of axes, overcrowding, poor use of chart space, etc. References in text match reference list (and vice versa) and are cited properly.	Although figures and tables are labelled, the formatting is unclear and/or inconsistent to the extent that the reader can lose track of the context when reading. References in text match reference list (and vice versa) and are mostly cited correctly.	mistakes with spelling and grammar, and possibly inappropriate language style (e.g. too informal) Presentation is poor to the extent that it impedes reading of the document. Examples include inconsistent formatting, and unlabelled figures or tables. References are either not cited or cited inconsistently.

## Assessment 2: Participation

**Submission notes:** Submit executive summary on Moodle using "PART B PARTICIPATION REPORT" workshop tool

**Due date:** 20/04/2023 12:00 PM

A three-page executive summary should be submitted on Thursday 12pm in week 10 by uploading a pdf formatted file. The file should also include a meeting log sheet as an additional attachment. This applies to those who are doing Project B and C together. There are no any particular formats for the three-page executive summary and meeting log sheet. The report should be able to summarize the progress that has been made since the beginning of the term. The executive summary must be submitted individually even for a group project. Submission is via Moodle

### Assessment criteria

The assessment criteria are: (i) initiative and engagement; (ii) sustained activity; (iii) diligence and competence in performing the task. They are equally weighted.

### **Additional details**

#### **Initiative and engagement:**

Did the student actively engage in the thesis work, take ownership of the task with enthusiasm, initiate own ideas to overcome various roadblocks along the journey?

Marking guide:

0-49: Deficient – none or minimal effort across all areas, need a lot of pushing from supervisor to make things happen

50-64: Satisfactory – some evidence of student driving the project; student put in some effort but considerable need for improvement

65-74: Good – above satisfactory effort, clear evidence of student driving the project

75-84: Very good – student showed genuine interest and enthusiasm in the work, initiated many own ideas during the process

85-100: Excellent – superior evidence of effort; student intellectually and practically led the project all the way, went beyond what was expected of a student

#### **Sustained activity:**

For example, based on student's attendance in lab, regular meetings/contacts with supervisor throughout the semester, etc.

Marking guide:

0-49: Deficient – irregular, sporadic engagement in the project

50-64: Satisfactory – regular engagement but only just adequate

65-74: Good – regular engagement; project progressing smoothly as planned

75-84: Very good – high level of sustained effort throughout the whole project

85-100: Excellent – superior evidence of effort, student attended all meetings or had regular weekly contact with the supervisor.

#### **Diligence and competence in performing the task:**

For example, based on examination of relevant documentation (project diary, student's lab book detailing experiment activities or measurement records). Did the student put in serious effort? Was it meticulous, professional?

Marking guide:

0-49: Deficient – careless or technically incompetent in doing the work

50-64: Satisfactory – you are fairly sure results from project are useable and trustworthy

65-74: Good – you closely monitored the work and are confident with student's results

75-84: Very good – work is professionally, meticulously performed and recorded

85-100: Excellent – very persistent and unrelenting in performing the task, demonstrate superior level of knowledge and applied thinking to solving an engineering problem.

## Attendance Requirements

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

## Course Schedule

Period	Activity
	<ul style="list-style-type: none"> <li>▪ Student will continue working on the same Project topic as in Project A with the same supervisor</li> <li>▪ Weekly online meetings during the term with supervisor for technical guidance on Project work</li> <li>▪ Laboratory work during the term subject to arrangement with technical staff</li> </ul>
Week 1	<ul style="list-style-type: none"> <li>▪ Online meeting with supervisor to discuss plan and update progress</li> </ul>
Week 1-4 (Week 1-2)*	<ul style="list-style-type: none"> <li>▪ Provide Project details for each assessment via Moodle course page 'T3 2023 ELEC4952/9452 Research Thesis B/Masters Project B'               <ul style="list-style-type: none"> <li>◦ For start, provide general Project topic, your name and supervisor's name. Project topic has already been finalised in Project A.</li> <li>◦ The details should be provided for each assessment. In this course, the assessments are PART B REPORT ASSESSMENT and PART B PARTICIPATION EFFORT</li> <li>◦ To provide the details for PART B REPORT ASSESSMENT, follow the steps below                   <ul style="list-style-type: none"> <li>▪ Go to Project B REPORT (click to expand the section)</li> <li>▪ Click on PART B REPORT ASSESSMENT and follow the prompt</li> </ul> </li> <li>◦ To provide the details for PART B PARTICIPATION EFFORT, follow the steps below                   <ul style="list-style-type: none"> <li>▪ Go to Project B Report (click to expand the section)</li> <li>▪ Click on PART B PARTICIPATION EFFORT and follow the prompt</li> </ul> </li> </ul> </li> </ul>
Week 5 (Week 3) *	<ul style="list-style-type: none"> <li>▪ Submit progress report by Thursday 12pm week 5 (week 3) *</li> </ul>
Week 6-10	<ul style="list-style-type: none"> <li>▪ Meet with supervisor and keep a meeting log sheet</li> </ul>
Week 10	<ul style="list-style-type: none"> <li>▪ Submit a three-page executive summary and a meeting log sheet by Thursday 5pm. <b>The executive summary is a condensation of the whole thesis to date (part A and B).</b> To submit, follow the steps below           <ul style="list-style-type: none"> <li>▪ Go to Project B Report (click to expand the section)</li> <li>▪ Click on PART B PARTICIPATION EFFORT and follow the prompt</li> </ul> </li> </ul>

[View class timetable](#)

## Timetable

Date	Type	Content

Week 5: 13 March - 17 March	Assessment	Progress report: Students first submit their report for the Turnitin check. Once the similarity is below 15%, they then submit their report using the "PART B REPORT ASSESSMENT" workshop tool.
Week 10: 17 April - 21 April	Assessment	Participation: Submit executive summary on Moodle using "PART B PARTICIPATION REPORT" workshop tool

# Resources

## Prescribed Resources

### Recommended texts(s)

Reading materials are specified by the supervisor (related to particular Project topic).

### On-line Resources

#### Moodle

As a part of the teaching component, Moodle will be used to disseminate materials, host forums: <https://moodle.telt.unsw.edu.au/login/index.php>. All information about this course is available from this link which is regularly updated.

#### Mailing list

Announcements concerning course information will be given on Moodle and/or via email (which will be sent to your student email address).

## **Academic Honesty and Plagiarism**

### **Academic Honesty and Plagiarism**

Plagiarism is the unacknowledged use of other people's work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a form of academic misconduct, and the University has very strict rules that include some severe penalties. For UNSW policies, penalties and information to help you avoid plagiarism, see <https://student.unsw.edu.au/plagiarism>. To find out if you understand plagiarism correctly, try this short quiz: <https://student.unsw.edu.au/plagiarism-quiz>.

### **General Conduct and Behaviour**

Consideration and respect for the needs of your fellow students and teaching staff is an expectation. Conduct which unduly disrupts or interferes with a class is not acceptable and students may be asked to leave the class.



## Academic Information

### COVID19 - Important Health Related Notice

Your health and the health of those in your class is critically important. You must stay at home if you are sick or have been advised to self-isolate by [NSW health](#) or government authorities. **You will not be penalised for missing a face-to-face activity due to illness or a requirement to self-isolate.** We will work with you to ensure continuity of learning during your isolation and have plans in place for you to catch up on any content or learning activities you may miss. Where this might not be possible, an application for fee remission may be discussed.

If you are required to self-isolate and/or need emotional or financial support, please contact the [Nucleus: Student Hub](#). If you are unable to complete an assessment, or attend a class with an attendance or participation requirement, please let your teacher know and apply for [special consideration](#) through the [Special Consideration portal](#). To advise the University of a positive COVID-19 test result or if you suspect you have COVID-19 and are being tested, please fill in this [form](#).

UNSW requires all staff and students to follow NSW Health advice. Any failure to act in accordance with that advice may amount to a breach of the Student Code of Conduct. Please refer to the [Safe Return to Campus](#) guide for students for more information on safe practices.

### Dates to note

Important Dates available at: <https://student.unsw.edu.au/dates>

## Student Responsibilities and Conduct

Students are expected to be familiar with and adhere to all UNSW policies (see <https://student.unsw.edu.au/policy>), and particular attention is drawn to the following:

### Workload

It is expected that you will spend at least **15 hours per week** studying a 6 UoC course, from Week 1 until the final assessment, including both formal classes and *independent, self-directed study*. In periods where you need to complete assignments or prepare for examinations, the workload may be greater. Over-commitment has been a common source of failure for many students. You should take the required workload into account when planning how to balance study with employment and other activities.

### Attendance

Regular and punctual attendance at all classes is expected. UNSW regulations state that if students attend less than 80% of scheduled classes they may be refused final assessment.

### Work Health and Safety

UNSW policy requires each person to work safely and responsibly, in order to avoid personal injury and to protect the safety of others.

## Special Consideration and Supplementary Examinations

You must submit all assignments and attend all examinations scheduled for your course. You can apply for special consideration when illness or other circumstances beyond your control interfere with an assessment performance. If you need to submit an application for special consideration for an exam or assessment, you must submit the application **prior to the start** of the exam or before the assessment is submitted, except where illness or misadventure prevent you from doing so. Be aware of the “fit to sit/submit” rule which means that if you sit an exam or submit an assignment, you are declaring yourself well enough to do so and cannot later apply for Special Consideration. For more information and how to apply, see <https://student.unsw.edu.au/special-consideration>.

## Administrative Matters

On issues and procedures regarding such matters as special needs, equity and diversity, occupational health and safety, enrolment, rights, and general expectations of students, please refer to the School and UNSW policies:

<https://student.unsw.edu.au/guide>

<https://www.unsw.edu.au/engineering/our-schools/electrical-engineering-telecommunications/student-life/resources>

## 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

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.

## 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	✓