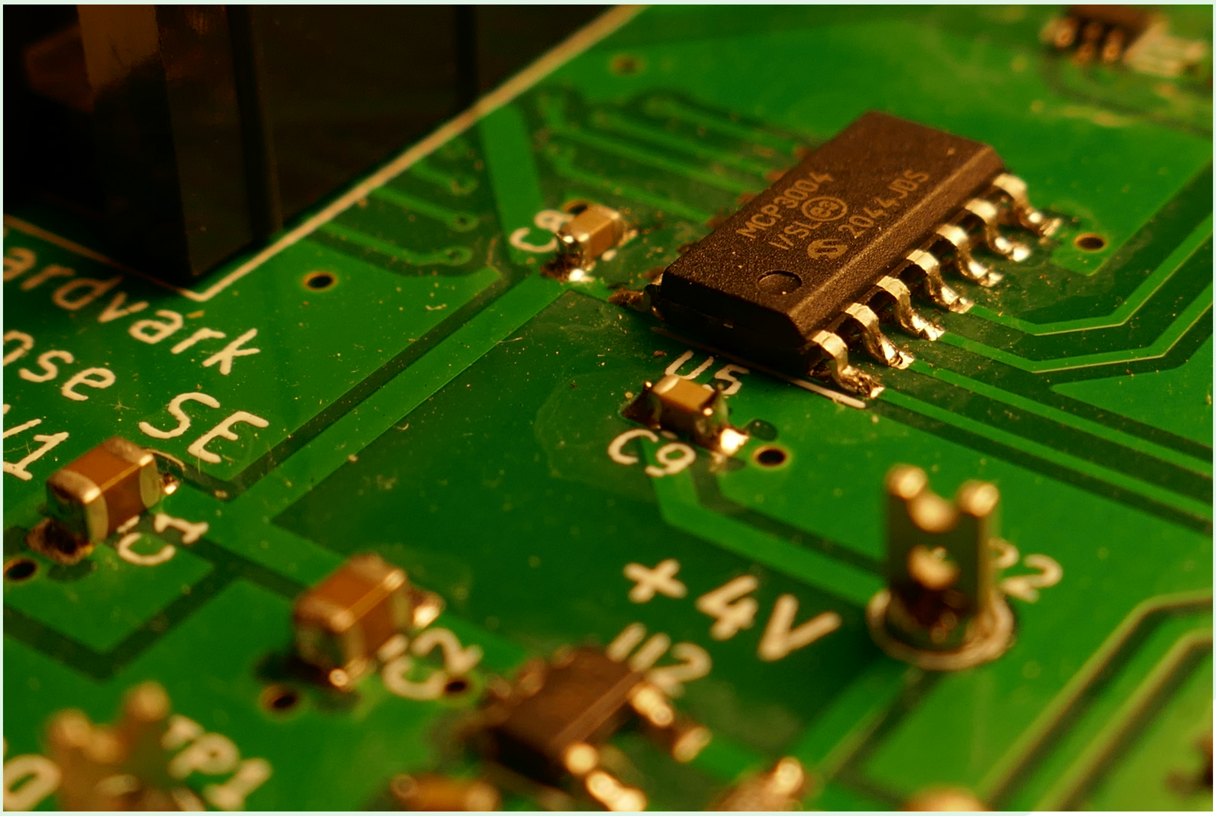
School of Electrical Engineering & Telecommunications

UNSW Engineering

ELEC3106

Electronics

Term 1, 2022



Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Torsten Lehmann	t.lehmann@unsw.edu.au	Wednesdays 4-5pm, Thursdays 5-6pm.	G17-343	93855374

Demonstrators

Name	Email	Availability	Location	Phone
Julian Keledjian	julian.keledjian@unsw.edu.au			

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 6

Summary of the Course

Non-ideal effects in electronic circuits and systems: Noise; device noise, external noise, CMRR, PSRR, mixed A/D. Distortion; non-linearity, dynamic range, saturation. Stability and performance sensitivity to parameter variations. Some simple design for stability and performance. Design optimisation. Power-supply distribution and decoupling. Mixed analogue/digital system design, including grounding and shielding. Device modelling in SPICE. Data sheet interpretation. Design of analogue and digital circuits and system components: Non-linear circuits; oscillators, PLLs, multipliers, AGCs, schmitt triggers. Introduction to filter design; active filters; op-amp. Sensors and actuators, PTAT; instrumentation amplifiers and signal conditioning. Low-level design and optimisation of digital CMOS gates. Gate delay, power dissipation, noise margins, fan-out. Introduction to integrated circuit design.Thermal consideration, power supplies, reliability, uC watchdongs

Course Aims

Background

Physical electronic circuits and systems are plagued by a number of undesired effects that the designer need be aware of in order to implement operational electronics. Electrical noise and non-linearity, for instance, limit signal dynamic range; dynamic power supply currents can lead to corruption of digital data; electromagnetic interference (EMI) can cause system malfunction; parasitic components limit the operating frequencies of all circuits. Modern electronic systems, such as laptops and mobile phones, are actually extraordinarily difficult to implement. The *Electronics* course introduces you to a number of important undesired effects of electronic systems and ways to deal with these; also, it introduces some more advanced circuit functions.

Aims

The course aims to make the student familiar with critical non-ideal effects in electronic devices and systems, thus enabling the student to design and construct physical electronic circuits that operate as desired.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Identify critical non-ideal effects in analogue and digital electronic circuits	PE1.1, PE1.3
2. Appreciate the wealth of electronic circuit functions available	PE1.3
3. Appropriately design for EMC	PE1.1, PE1.3, PE1.5, PE2.2, PE3.2
4. Design simple power supplies and circuits	PE1.1, PE1.3, PE1.5

Learning Outcome	EA Stage 1 Competencies
5. Interface analogue circuits and digital circuits	PE1.1, PE1.3, PE1.5, PE2.2
6. Design for failure protection in firmware and hardware	PE1.1, PE1.2, PE1.3, PE1.5
7. Design electronic circuits that work reliably	PE1.2, PE1.3, PE1.5, PE2.1, PE2.2, PE3.2, PE3.3, PE3.4, PE3.5

Targeted Graduate Capabilities

Electrical Engineering and Telecommunications programs are designed to address the following targeted capabilities which were developed by the school in conjunction with the requirements of professional and industry bodies:

- The ability to apply knowledge of basic science and fundamental technologies;
- The skills to communicate effectively, not only with engineers but also with the wider community;
- The capability to undertake challenging analysis and design problems and find optimal solutions;
- Expertise in decomposing a problem into its constituent parts, and in defining the scope of each part;
- A working knowledge of how to locate required information and use information resources to their maximum advantage;
- Proficiency in developing and implementing project plans, investigating alternative solutions, and critically evaluating differing strategies;
- An understanding of the social, cultural and global responsibilities of the professional engineer;
- The ability to work effectively as an individual or in a team;
- An understanding of professional and ethical responsibilities;
- The ability to engage in lifelong independent and reflective learning.

UNSW Graduate Capabilities

The course delivery methods and course content directly or indirectly addresses a number of core UNSW graduate capabilities, as follows:

- Developing rigorous analysis, critique, and reflection, and ability to apply knowledge and skills to solving problems, through laboratory experiments and tutorial exercises.
- Developing capable independent and collaborative enquiry, through tutorials exercises.
- Developing digital and information literacy and lifelong learning skills, through lectures, class preparations and report writing.
- Developing the capability of effective communication, through report writing.
- Developing independent, self-directed professionals who are enterprising, innovative, creative and responsive to change, through the design task.

Teaching Strategies

Delivery Mode

- Formal face-to-face lectures, which provide you with a focus on the core analytical material in the course, together with qualitative, alternative explanations and individually targeted illustrations to aid your understanding.
- Tutorials, which allow for exercises in problem solving and allow time for you to resolve in-depth

problems for quantitative understanding of the lecture material and applying your engineering skills in electronics context.
- Laboratory sessions, which experimentally support the formal lecture material and also provide you with practical design, construction, measurement and debugging skills.
- Design labs, which support creativity set in the course context solving an open-ended design problem with experimental or simulated verification.

Learning in this Course

You are expected to attend all lectures, tutorials, labs, and quizzes in order to maximise learning. You must prepare well for your laboratory classes and your lab work will be assessed. You should read relevant sections of the recommended texts. For most topics, lecture notes will not be given: reading and reflecting on the recommended texts and identify critical parts with the aid of the lectures is an essential component of this course. Reading additional texts will further enhance your learning experience. Group learning is also encouraged. UNSW assumes that self-directed study of this kind is undertaken in addition to attending face-to-face classes throughout the course.

Lectures

During the lectures technology capabilities and design issues are discussed and theoretical aspects of electronics design and technology are presented. Numerous examples of analogue and digital electronic circuit functions are discussed in order to convey a qualitative understanding of circuit operations, non-idealities, and EMI. You are encouraged to actively engage in the lectures to facilitate two-way communication and enhance learning. The lectures aim to support you in identifying and analysing non-ideal effects in circuits, to aid in learning how to mitigate such effects, and finally to help you appreciate the capabilities and limitations of the technology.

Tutorial Classes

You should attempt all of your problem sheet questions in advance of attending the tutorial classes. The importance of adequate preparation prior to each tutorial cannot be overemphasised, as the effectiveness and usefulness of the tutorial depends to a large extent on this preparation. Group learning is encouraged. Answers for these questions will be discussed during the tutorial class and the tutor will cover the more complex questions in the tutorial class.

Laboratory Program

The laboratory work provides you with hands-on experience in measuring non-ideal effects and EMI in electronic circuits, and thus helps to re-enforce the central topics in the course. Most of the laboratory work being carried out on bread boards constructed by you, also exercises your ability to set up measurements and locating circuit errors. The laboratory work will be carried out in groups of two students.

Laboratory Design Task

The design laboratory exercise is a small design task which aims to draw together theoretical and practical design aspects in a small open-ended design problem. You will design a circuit meeting given specifications during ther term and debug and characterise the circuit during the design laboratory sessions. The design task provide and test engineering creativity, open-ended problem solving skills, communication skills and general understanding of the course content.

Additional Course Information

Relationship to Other Courses

This is a 3rd year course in the School of Electrical Engineering and Telecommunications. It is a core course for students following a BE (Electrical) or (Telecommunications) or (Quantum) program and other combined degree programs, and an elective for Computer Engineering students.

Pre-requisites and Assumed Knowledge

The pre-requisites for this course are ELEC2133, Analogue Electronics, and ELEC2141, Digital Circuit Design. ELEC2133 may be taken as a co-requisite. It is also required that you have good working knowledge of circuit theory and some basic signal analysis as covered in the courses ELEC1111, Electrical Circuit Fundamentals, and ELEC2134 Circuits and Signals. It is finally assumed that you are proficient in the use of personal computers, and are able to operate electronics laboratory equipment independently.

Following Courses

The course is a pre-requisite for the fourth-year professional elective courses in the electronics area: ELEC4601, Digital and Embedded Systems Design, ELEC4602, Microelectronics Design and Technology, and ELEC4604, RF Electronics. These courses are again pre-requisites for post-graduate level courses in electronics.

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Laboratory Work and Reporting	15%		3, 5
2. Quizzes	10%		3, 5
3. Project design task and report	15%		4, 7
4. Final Examination	60%		1, 2, 3, 5, 6

Assessment 1: Laboratory Work and Reporting

Submission notes: See Moodle for laboratory submission dates.
Deadline for absolute fail: One week after each laboratory submission deadline.

While laboratory work is primarily about learning, it is assessed to ensure that you understand the material in this essential course component. This assessment test that you can use the lab equipment, understand circuit models and non-idealities, carry out measurements, and can design simple circuits.

You are required to maintain a lab book for recording your observations and you must bring a camera or USB stick to capture CRO images of your observations for documentation. After completing each lab component, your work will be assessed by the laboratory demonstrator, so make sure that your demonstrator notice your work. Laboratory work must be documented in *brief* reports which are due Monday the week after the laboratory session ending each exercise. Late submissions carry a 50% penalty for the first week and will not be accepted beyond one week delay. Delays on medical grounds are accepted. Each report must be uploaded as a .pdf file (no other format accepted) on the course Moodle site.

Assessment criteria

Assessment marks (grade only) will be awarded according to how much of the lab you were able to complete, your understanding of the experiments conducted during the lab, and your ability to concisely express lab findings in your report. A HD mark is given only for exceptional performance that includes an attempt to complete any optional laboratory extensions; a serious attempt at completing the problems is required for a PS mark.

Assessment 2: Quizzes

Submission notes: See Moodle for quiz dates and times.

There are two quizzes held during the lecture time through the semester. These are designed to give early feed-back on your progress through the theoretical components of the course and test your general understanding of the course material. Questions will be drawn from course material covered in the three weeks prior to each quiz.

Assessment criteria

Assessment marks are given according the correct fraction of the answers to the quiz questions.

Assessment 3: Project design task and report

Submission notes: See Moodle for design report submission date.

The design task is assessed to test your ability to design a simple electronic circuit, thus also demonstrating the your appreciation of the technology, and ability to use appropriate components and conduct suitable analysis to aid the design.

As for the other laboratory work, you are required to maintain a lab book and bring a camera or USB stick for recording your observations. Again, your work will be assessed by the laboratory demonstrator, so make sure that your demonstrator notice your work. The design and experimentation work must be documented in a *brief* report which is due Monday the week after the last design laboratory session. Late submissions carry a 50% penalty for the first week and will not be accepted beyond one week delay. Delays on medical grounds are accepted. Each report must be uploaded as a .pdf file (no other format accepted) on the course Moodle site.

Assessment criteria

Assessment marks (grade only) will be awarded according to your understanding of the design problem and experiments conducted during the lab, the quality and innovativeness of your design, and your ability to concisely explain and characterise your design in your report. A HD mark is given only for exceptional performance that includes functions exceeding the design requirements; a serious attempt at completing the problem is required for a PS mark.

Assessment 4: Final Examination

The exam in this course is an open-book two-hour (nominal) written examination. University approved calculators are allowed. The examination tests analytical and critical thinking and general understanding of the course material in a controlled fashion. Questions may be drawn from any aspect of the course (including laboratories and design task), unless specifically indicated otherwise by the lecturer.

Assessment criteria

Assessment marks will be assigned according to the correctness of the responses.

Hurdle requirement

An examination mark of at least 45% is required to pass the course.

Attendance Requirements

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

Course Schedule

View class timetable

Timetable

Date	Type	Content
Week 1: 14 February - 18 February	Lecture	Op-amp voltage/current limitations, offsets, biasing. CMRR, PSRR, parameter variation. Slew-rate, bandwidth, compensation. Distortion, saturation.
	Reading	PW ch. 5, notes, datasheets.
	Laboratory	Lab 1: op-amp measurements.
	Tutorial	Tute 1: op-amps.
Week 2: 21 February - 25 February	Lecture	Electrical noise. Dynamic range. Digital fan-out, noise margins.Logic families, VTC, I/O characteristics.
	Reading	SS Ch. 15, PW ch. 6, notes, datasheets.
	Laboratory	Lab 1 cont.
	Tutorial	Tute: Ex-2016-Q1.
	Presentation	**Guest**.
Week 3: 28 February - 4 March	Lecture	Gate delays, timing. Interfacing to logic, opto-coupling. Level-shifting, ESD. Driving transmission lines, human interfaces.
	Reading	SS ch. 15, PW ch. 6+9, videos, datasheets.
	Laboratory	Lab 2: logic gate measurements.
	Tutorial	Tute 2: logic.
	Assessment	**Lab 1 report** due.
Week 4: 7 March - 11 March	Lecture	Grounding, decoupling. Noise coupling, shielding. EMC, mixed A/D.

	Reading	PW ch. 1+8.
	Laboratory	Lab 2 cont.
	Tutorial	Tute: Ex-2016-Q2.
	Assessment	**Quiz 1**.
Week 5: 14 March - 18 March	Lecture	Power supplies, linear regulators, rectification. Switch-mode supplies, start-up. Batteries, solar cells. Thermal modelling.
	Reading	PW ch. 7, ch. 9.
	Laboratory	Lab 3: PCB EMI measurements.
	Tutorial	Tute 3: power supplies.
	Assessment	**Lab 2 report** due.
Week 6: 21 March - 25 March	Workshop	Surface-mount soldering practice or PCB layout.
	Laboratory	Design task.
Week 7: 28 March - 1 April	Lecture	SPICE simulations, models, functions. Simulation types and limitations. Power stages (A, B, AB, D). Protection, biasing.
	Reading	Notes, SS ch. 11.
	Laboratory	Lab 4: EMI simulations with SPICE.
	Tutorial	Tute: Ex-2016-Q3.
	Assessment	**Lab 3 report** due.
Week 8: 4 April - 8 April	Lecture	Filtering. Passive and active filters. Filter design, sensitivity.
	Reading	SS ch. 13.
	Laboratory	Design task.
	Tutorial	Tute 4: power amps.
	Assessment	**Quiz 2**.
Week 9: 11 April - 15 April	Lecture	Oscillators. Multipliers, Schmitt triggers, PLL. AGC, sensors, interfaces.
	Reading	SS ch. 2+14.
	Laboratory	Design task (Tue, Wed, Thurs labs).
	Tutorial	Tute 5: filters & non-lin.
	Assessment	**Lab 4 report** due.

Week 10: 18 April - 22 April	Lecture	Electronic failure mechanisms. Reliability. FMEA, watchdogs, defensive programming.
	Reading	PW ch. 6+9, notes.
	Laboratory	**Design demonstration**.
	Tutorial	Tute Ex-2016-Q4.
Study Week: 25 April - 28 April	Assessment	**Design task report** due.

Resources

Prescribed Resources

Textbooks

- A. S. Sedra & K. C. Smith, Microelectronic Circuits. Oxford University Press, 7th ed., 2016.
- P. Wilson, The Circuit Designer's Companion. Elsevier, 3rd ed. 2012.

Note, if you use the 6th edition of SS, subtract 1 from the chapter references in the lecture schedule (except for chapter 2).

On-line resources

Moodle: As a part of the teaching component, Moodle will be used to upload lab reports and host forums. Assessment marks will also be made available via Moodle: https://moodle.telt.unsw.edu.au/login/index.php.

Course webpage: The course webpage is used to disseminate course material, including laboratory notes and design brief, past assessment and examination papers, and some lecture notes: https://subjects.ee.unsw.edu.au/elec3106.

Teams: MS Teams (accessed using your University zpass credentials) will be used for on-line real-time communications. Q&A sessions will be held via Teams and students doing laboratory classes remotely will need to use Teams to communicate with their laboratory demonstrator during classes: https://teams.microsoft.com/. Teams will also be used to deliver on-line lectures and tutorials.

Recommended Resources

Reference books

- P. Horowitz & W. Hill, The Art of Electronics. Cambridge University Press, 3rd ed., 2015.
- E. Bogatin, Signal and Power Integrity — Simplified. Pearson, 2nd ed., 2009.

Course Evaluation and Development

This course is under constant revision in order to improve the learning outcomes for all students. Please forward any feedback (positive or negative) on the course to the course convener or via the myExperience process. You can also provide feedback to ELSOC who will raise your concerns at student focus group meetings. As a result of previous feedback obtained for this course, and in our efforts to provide a rich and meaningful learning experience, we have changed the weighting of in-semester assessments, increased the number of tutorial exercises, commenced use of the LTSpice simulator program, provided supplementary lecture notes on selected topics, released lecture summary slides, and provided lecture video recordings.

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. Current alerts and a list of hotspots can be found here. **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.engineering.unsw.edu.au/electrical-engineering/resources

Image Credit

Close-up of PCB with SMT components (c) 2021 Torsten Lehmann

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	