School of Electrical Engineering and Telecommunications

Term 3, 2020
Course Outline

ELEC4123
Electrical Design Proficiency

COURSE STAFF

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Consultations: You are encouraged to ask questions on the course material, during the practical lab sessions as well as open labs rather than via email. Lecturer consultation times will be advised. You are welcome to email the lecturer, 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 ELEC4123 in the subject line; otherwise they will not be answered. You are encourage to activity participate in Moodle Forums as a way of consulting your enquiries with the lecturer and benefit from your peer responses and contribution.

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.

Safe Return to Campus (Covid-Safe message from the University)

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.

COURSE SUMMARY

Contact Hours

This course involves

- **Two 3-hour** of scheduled **laboratory** contacts per week running in two streams, morning session and afternoon session (total **6 hours per week** per session shown as **TLB** is timetable),
- **Three 3-hour open labs** per fortnight (total **9 hours** per fortnight shown as **OTH** in timetable), plus a **catch-up lab** (the **last open lab** every fortnight is the catch-up lab),
- **One-hour introductory lecture in Week 1** (there will no other lectures),

as detailed on the next page.

Attendance at the scheduled **laboratories** (TLB) is **mandatory**. These are the primary assessed components of the course. All laboratories are assessment opportunities. Attending **open labs** is **optional**. Attending catch-up labs is buy the approval of the course coordinator. More details on open labs and catch-up labs are provided in TEACHING STRATEGIES and ASSESSMENT sections.

Session	Day	Time	Location
Lecture:	Mon of Week 1	9am – 10am	Synchronous lecture online via Blackboard Collaborate
Scheduled Laboratories*:	Mon – Wed morning Mon – Wed afternoon	10am – 1pm 4pm – 7pm	Labs 201, 224, 225, 214, and 119 in EE&T Building G17.
Open labs and catch-up labs:**	Tue – Fri morning Tue – Fri afternoon	9am – 12pm 5pm – 8pm	Seating allocation will be released on Moodle

* There will be no scheduled labs in **Week 5 Wed** and **Week 9**. Week 11 is the makeup lab for a public holiday on Mon of Week 4, which will be the final assessment of the Elective topic.
** Every fortnight, the **Friday session** is reserved for **catch-up lab** for the corresponding topic on that week.

Context and Aims

This is a rather unusual course, in that there is no final or mid-term examination and most of your contact hours are spent in the laboratory. The course is organized around **4 proficiency topics**, each of which has **four/4 formal lab sessions** each lasting **3 hours,** plus **three open labs**, and **a catch-up lab** included in the course schedule. The **first three topics** cover the **core disciplines** of **Electronics**, **Signal Processing** and **Control Systems**, while the **fourth topic** involves an **elective** choice of two or three different projects. With some exceptions for the elective topic, all formal lab sessions are assessment opportunities. To accommodate the 10-week term and covid-19 outbreak, a new schedule has been devised to incorporate open labs and catch-up lab into the course schedule.

The **principle purpose** of this course is to test your **design proficiency**, through a sequence of design challenges. Some of the challenges are very basic, but there is also plenty of scope for you to demonstrate superior skills. The design challenges within each of the **core** (non-elective) **topics** are organized into **4 or 5 tasks** that can be undertaken and **assessed progressively**. Your designs, implementation and **assessment** for the **core topics** are to be undertaken on an **individual basis**, not as group work. Moreover, you are expected to regard the laboratory sessions as **miniature examinations**.

A **secondary aim** of the course is to **fill in any major holes** in your **fundamental design knowledge**, to ensure that all graduating students have at least a **minimum level of proficiency**. Although some of you might initially feel uncomfortable about this, it is important to realise that prospective employers will be very pleased indeed to know that you are able to demonstrate your proficiency. You should expect that this course will **reinforce** your **existing knowledge** and **increase** your **confidence in design** and some of the fundamental disciplines you have been studying. Opportunities to **correct misunderstandings** mostly occur between laboratory sessions, including within the course lectures.

Final objective of the course is to expose you to a **healthy balance** between **teamwork** and **individual responsibility**. For practical reasons, **team-based design** is **restricted** to the **elective topic**, which takes place over **Weeks 8-10** and is **assessed differently** from the other topics (Week 9 is off due to Thesis A/C seminars/poster presentations). You will be **assigned** a **tutor** who can both help to **keep you on track** and also

keep an eye on the functioning of your team and the **level of contribution** that each team member appears to be making to the design. The **elective topic** will involve both individual and group assessment components.

Indicative Laboratory Schedule

Period	Summary of Laboratory Program (morning and afternoon sessions)			
	Monday	Tuesday	Wednesday	Friday
Week 1	Topic 1: Electronics	Open lab	Topic 1: Electronics	Open lab
Week 2	Topic 1: Electronics	Open lab	Topic 1: Electronics (Final lab)	Catch-up lab (Topic 1 **reflective task** submission **due** at **11pm**)
Week 3	Topic 2: Signal Processing	Open lab	Topic 2: Signal Processing	Open lab
Week 4	***Public Holiday***	Open lab	Topic 2: Signal Processing (Final lab)	
Week 5	Topic 2: Signal Processing	**No scheduled lab**		Catch-up lab (Topic 2 **reflective task** submission **due** at **11pm**)
Week 6	Topic 3: Control Systems	Open lab	Topic 3: Control Systems	Open lab
Week 7	Topic 3: Control Systems	Open lab	Topic 3: Control Systems (Final lab) (**Elective topic** selection **due** at **11pm**)	Catch-up lab (Topic 3 **reflective task** submission **due** at **11pm**)
Week 8	Topic 4: Elective	Open lab	Topic 4: Elective	Open lab
Week 9	**No scheduled lab** (*Thesis A/C seminars/poster presentations*)			
Week 10	Topic 4: Elective	Open lab	Topic 4: Elective	Open lab or Catch-up lab
Week 11	Topic 4: Elective Final assessment			Topic 4 **Report** submission **due** at **11pm**

Assessment

The **total mark** of **each core topic** is **24%** and the **elective topic** is worth **28%** (four/4 topics in total 100%). The marks breakdown for each aspect of the topics for this course will be assigned as follows:

Assessment Concept	Basis	Marks
Core Topics: Achievement of design requirements, as demonstrated in labs	Individual	11% per topic (33%)
Core Topics: Understanding of relevant subject material, as demonstrated in labs	Individual	11% per topic (33%)
Core Topics: Reflective task, submitted online, core topics T1-T3	Individual	2% per topic (6%)
Elective Topic: Achievement of design requirements, as demonstrated in labs	Individual	9%
Elective Topic: Understanding of relevant subject material and individual contribution	Group	9%
Elective Topic: Team performance	Group	3%
Elective Topic: Team report	Group	7%

Deadlines:

Core topics Reflective task for are due on **Friday** at **11pm** after the **end of each topic** (**Fri W2, W5, and W7**).
Elective topic selection (with optional team formation preferences): **Week 7**, **Wednesday 11pm**.
Elective topic report due: **Week 11**, **Wednesday 11pm.**

COURSE DETAILS

Credits

This is a 6 UoC course. Since this course has **no final examination**, the workload of the course is compacted into just 10 weeks, so your effort must be adjusted accordingly. The expected average workload is 16 hours per week, which includes 8 hours of scheduled formal contact and 4 to 8 hours of independent study, design and preparation, including open labs and time spent working with peers. This is not only an expectation – it is a reality that most students undertaking this course do put in at least this amount of time!!

Relationship to Other Courses

This is a 4th-year course in the School of Electrical Engineering and Telecommunications, which is a core component of the BE and BE-ME programs (Electrical and Telecommunications) offered by the School.

This course directly ties into core courses in Electronics, Signal Processing, Control, Telecommunications, Data Networks and Energy and Power Systems which you should have already taken (typically in the third year of your program). See below for more on what is expected.

Pre-requisites and Assumed Knowledge

The course has three core topics, for which the following knowledge is assumed and **crucially essential**:

- Electronics (to the level of ELEC3106 (and partly ELEC2141 and ELEC2133)
- Signal Processing (to the level of ELEC3104)
- Control Systems (to the level of ELEC3114).

Through these and other courses, it is assumed that students have also developed good computer literacy and familiarity with MATLAB/Simulink, as well as microcontroller (Arduino in particular for Control Systems topic) which is used in some topics.

Learning outcomes

After successful completion of this course, you should be able to:

1. demonstrate an ability to work both individually and within a group,
2. produce designs which draw upon a number of disciplines previously studied in other courses,
    - (the 4 design topics and scheduled laboratory sessions all reinforce and assess the outcomes 1 and 2),
3. demonstrate the ability to contribute to and learn from peers,
    - (the elective design topic reinforces this ability),
4. develop a sufficient level of understanding and engineering design skills within a range of disciplines,
5. explain, evaluate, and reflect on design decisions and well as implementing them to achieve the design requirements.
    - (the assessment methodology in laboratories together with final report on elective deign deliberately reinforces and assesses the outcomes 4 and 5).

This course is designed to provide the above learning outcomes which arise from targeted graduate capabilities listed in ***Appendix A***. The targeted graduate capabilities broadly support the UNSW and Faculty of Engineering graduate capabilities (listed in ***Appendix B***). This course also addresses the Engineers Australia (National Accreditation Body) Stage I competency standard as outlined in ***Appendix C***.

Syllabus

The course involves three core competency components, as follows:

- Electronic Circuit Design: Devices, amplifiers, tuned circuits, op-amp circuits, digital circuits, etc.

- Control System Design: Feedback and stability, linear control, data acquisition and sampling, etc.
- Signal Processing Design: Filter design, frequency response, spectrum analysis, BIBO analysis, etc.

The elective component of the course involves competency components in at least one of the following areas:

- Power System Design: Transformer, motor, power electronic converter, power factor, harmonics, etc.
- Networked Communications: Computer programming, socket programming, network protocols, distributed asynchronous systems, estimation and exploitation of local and system-wide timing information, etc.
- Physical Communications: Modulation schemes, robust detection of signals in noise, multiplexing and interference suppression, efficient bandwidth utilization, error control, etc.
- Analog Design: Power amplifiers for audio systems, analog filters, linear system design, etc.

Laboratory assessment requires the design, construction and understanding of working solutions to specified problems.

TEACHING STRATEGIES

Delivery Mode

The teaching in this subject is heavily focused on laboratories. Each of **4 design topics** has **4 assigned laboratories**, each **3 hours** in duration, plus **three optional open labs**. The laboratories are designed to develop and assess proficiency in each discipline of electrical engineering. The majority of the assessment is individual, with a focus on objectively working solutions, in addition to understanding.

Open labs are intended to provide an opportunity both to address knowledge gaps and also to reinforce an approach to design with more practical lab time, which focusses on **the need to identify early what is most problematic about a design problem**. Through this process, students are expected to be better prepared to approach the larger design problem that they will face as a team during the fourth (elective) design topic.

At the end of each topic, there will be a **catch-up lab** for those who have been granted remarking a task or tasks of that topic due to legitimate reasons.

A very important aspect of the teaching in this course is the allocation of **12 hours** schedule lab time in total to **each topic** for assessing the designs and their implementations plus plenty of open lab times, which allows students to attempt design tasks multiple times and to learn from their mistakes between attempts. This strategy facilitates a reflective learning cycle as well as an opportunity to contribute and learn from peers, noting that the rigorous and strict marking process prevents students form copying designs from each other.

Through these mechanisms, the course aims to build and ensure proficiency in the core areas of your program of study.

Due to the intensity and time pressure in this course for 10-week teaching system, as well as its coincidence with public holidays and Thesis A/C seminars/poster presentations, **cool-off periods** are incorporated into the course schedule (see the **Indicative Laboratory Schedule** on page 3). This allows for students to have less stress about preparing for their thesis, and the selected team for the elective topic can work in parallel on the design and testing during possibly arranged open labs in that week.

Design Topics

The course is divided into a sequence of **three** "**core design topics**" and **one** "**elective design topic**," each of which is assigned **four/4** formal laboratory sessions of **3 hours** each.

The **core design topics** are:
Topic 1: Electronic Circuits;
Topic 2: Signal Processing; and
Topic 3: Control Systems.

The **elective topics** are:
Topic 4a: Energy Systems;
Topic 4b: Data Networks; and
Topic 4c: Telecommunications.
Topic 4d: Analog Design

Each of the core topics consists of a sequence of design tasks, with progressively higher complexity. Design tasks for the core topics must be completed individually, although you are encouraged to discuss the topics with your fellow students **outside the formal laboratory hours**.

The elective design is performed in **groups** of **at most 4 students**. You must **nominate** which of the **elective topics** you intend to pursue by **before the end of Week 7** (see the **Indicative Laboratory Schedule** on page 3), at which point you will also have an opportunity to propose a design team. If you are not part of a proposed team, or if unavoidable circumstances require it, you will be assigned to a team at the Course Convener's discretion. You will be provided with further instructions on how to submit elective topic and team nominations. Unlike the first three design topics, the elective design is assessed only in the final week, however, the progressive observation of the team performance and individual contribution to the project is carried out by the lab demonstrators acting as tutors to help them better assess the teams in the final week.

Individual Learning

Preparation for labs is essential to success in this course. You should find yourself revising material from previous courses, discussing problems with your peers, raising questions in lectures, and perhaps struggling to find and solve problems you encounter with your design or implementation in the laboratory. All of these are outstanding learning opportunities.

Group Learning

You are strongly encouraged to discuss the design tasks with your classmates outside the laboratory sessions – laboratories themselves, however, are not the place for helping your friends or discussing design solutions, except during the elective topic.

The elective topic is a team effort, having larger scope and less incremental objectives than the first three design topics. To succeed in this topic, you will need to work effectively as a team member or leader. Moreover, each team is required to submit a report describing the design principles, implementation, outcomes and final reflections. The report will also need to be a team effort.

Laboratory Exemption

There is no laboratory exemption for this course. Regardless of whether equivalent labs have been completed in previous courses, all students enrolled in this course must take the labs. If, for medical reasons, (note that a valid medical certificate must be provided) you are unable to attend a lab, you will need to **seek permission from the course convener** to be assessed in a subsequent week.

ASSESSMENT

Assessment of core design tasks

All completed tasks for the three core design topics are to be **assessed during the scheduled laboratory sessions** by one of the laboratory demonstrators. Once you have completed a task, you should add your name to a list maintained by the demonstrators, so that you can be assessed as quickly as possible. You cannot expect to be assessed for all of the tasks you have completed during the final laboratory session of the topic, since this can place an unacceptable burden on the demonstrators' time. As a result, we devised a plan for task assessment as follows:

- For each lab session, it is recommended that **at least one task** to be completed and assessed, but **no more than two tasks will be marked**.
- Open lab sessions: **No assessments** will be done during open labs. It is recommended that you work on your designs for at least two tasks during each open lab so that you can quickly get assessed in the next scheduled lab.
- Final assessment lab session: **No more than two tasks will be assessed**. So please make sure to ***not leave your tasks pile up for the final lab sessions***.

Important note: You must **at least** complete **three/3 tasks** from each **topic** with **"satisfactory"** grade to achieve a **passing mark** from that topic. The task grading system will be explained in the introductory lecture.

Below is the breakdown of the marking strategy for **core topics**,

- Out of the **24%** of the overall course assessment that is associated with each core design topic, **11%** is awarded based on **actual outcomes**. This will be known as ***Requirement mark*** (***Req***). You **cannot expect** to **obtain** any of these **marks** for a **solution** which **does not actually work** or achieve the task objectives to some extent.
- **11%** of the topic mark is awarded for your **understanding** of the **design problem** and your own design. This is known as ***Understanding mark*** (***Und***) To obtain these marks, you will need to **convince** the **marker** (one of the lab demonstrators) that you **thoroughly understand** your design and why you have selected it. Please note that your understanding mark will be usually capped by the requirements mark, but in some exceptional cases, it could be higher by only one mark.
    - For example, you might have a fully functioning design that satisfies all the given requirements in a task, but you may not be able to explain the main reasons behind your design decisions or demonstrate that you have understood the background knowledge required to come up with selected design or not being able to answer to some specialized understanding questions around the relevant topic to the task. Under these circumstances, you could get either equal mark for both Req and Und or with Req being only one mark higher than Und.
    - The opposite case is also applicable. That means if you do NOT have a functioning design, you should not expect to receive a mark for Und higher than your Req mark.

- At the end of each topic, you must submit a short **reflective task** worth **2%** by answering to some questions to reflect on your work and learning gained from that topic.
    - The submission of this task is through Moodle (see the Indicative Laboratory Schedule on page 3 for the deadlines).
    - The mark is awarded for your **genuine effort** in providing your **reflections** on your work on each topic (there is no right or wrong answer to the question).

Assessment is **individual**. You may not present a group design or implementation for assessment within the core design topics. You **MUST maintain a lab book** for **recording** your **observations** as your **marks** will be **written** in **your lab book** and **signed off** by the **marker**. A lab book could be a paper or a digital notebook.

Assessment of the elective design tasks

The elective design topic is a **group activity**, for which **all final assessment** will take place on **Monday of week 11**, but your **team performance** and **individual contribution** will be observed and assessed continuously by an **allocated lab demonstrator** to your group in the lab sessions. Below is the breakdown of the marking strategy for the elective topic,

- Out of **28%** of the overall course mark is allocated to the elective topic, **18%** of which is awarded by the lab demonstrators in **Week 10**.
    - **9%** is awarded based on an **individual interview** of **each team member**, to determine their level of **understanding** (Und) of both the overall design and their individual contribution to it.
    - **9%** is awarded based on the **achievement of the requirements** in the **final design** (Req), a component of which will be competitive, meaning that teams will be ranked within each topic, based on the objective performance of their designs.
- Your team's **final report** for the elective topic is an essential part of the reflective process worth **7%**.
    - You will be expected to have a **preliminary** version of the **report** available during the laboratory assessment exercise in **Week 11**. However, the report should be finalized afterwards, including a reflection on the design process that you followed, in light of your design's performance. The report submission is **due** in **Week 11**.

- Your **team performance** mark worth **3%**
    - Each team will have a dedicated tutor/mentor. They will be circulating between their assigned teams to **observe** their **interaction** and **thought processes**, and to **offer suggestions where appropriate**. Your tutor will be especially interested in the way in which you approach the design problem, how you ensure that you focus on the most challenging parts of the problem first, how you reach an overall design that is likely to work, and how your team manages the resources at its disposal. Your tutor will also **observe** how **individuals contribute** to the **team's deliberations**, **design,** and **interaction** during **elective topic scheduled lab sessions**. Based on **these observations**, the tutor will award **team performance mark** as well as your **individual contribution** with **understanding** which is a continuous assessment process.

Relationship of Assessment Methods to Learning Outcomes

	Learning outcomes				
Assessment	**1**	**2**	**3**	**4**	**5**
Core design tasks	✓	✓	-	✓	✓
Elective design topic	✓	✓	✓	✓	✓
Elective design team performance and report	✓	✓	✓	-	-

Mid-Semester Exam and Final Exam

There is no Mid-Semester exam or Final exam in this course.

COURSE RESOURCES

Textbooks

There are no specific texts for this course, but you should consider your lecture notes and text books from earlier classes in Electronics, Signal Processing, Control, Telecommunications, Data Networks and/or Energy Systems to be useful resources.

On-line resources

Moodle

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

Mailing list

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

OTHER MATTERS

Dates to note

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

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.

Student Responsibilities and Conduct

Students are expected to be familiar with and adhere to all UNSW policies (see https://student.unsw.edu.au/guide), 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 face-to-face classes and *independent, self-directed study*. In periods where you need to 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.

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.

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.

Continual Course Improvement

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 online student survey myExperience. 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 continued to evaluate and modify our delivery and assessment methods.

New Changes: In this current version of the course, the assessment weights have been modified to put equal emphasis on understanding behind their design decisions as well as achieving the given design requirements in a fully functioning design in the practical implementation phase. Also, the open labs have been officially scheduled in the course timetable so students can better manage their working time in the labs.

Previous improvements since Term 3 2019 which still exists in this offering: Adding **reflective task** as both formative and summative assessment to better support the learning outcome in core topics. Also, the **qualitative grading system** has been introduced for marking to remove the stress from students and eliminate mark-driven assessment style. The mapping to numerical marks is then carried out by the course coordinator according to the rubric. Finally, a new schedule has been devised for the course due to the feedback from students on the intensity and time pressure in the course fooling the trimester teaching system. In this new schedule, there will be **4 official 3-hour lab sessions** for every topic in two weeks (one hour less from previous offering of this course) plus **open lab every week** (of which the last acts as catch-up lab). This new plan allows to accommodate two no-lab weeks as cooling off weeks, one in Week 5 for preparation for the next upcoming topics and one in Week 9 for Thesis A/C seminar/poster presentations which is usually scheduled in in that week. These no-lab weeks provide students with less stress about their Thesis as well as helping them with their mental health and wellbeing.

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

APPENDICES

Appendix A: 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.

Appendix B: 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. These will be achieved by the laboratory experiments and interactive checkpoint assessments and lab exams during the labs.
- Developing ethical practitioners who are collaborative and effective team workers, through group activities, seminars and tutorials.
- Developing independent, self-directed professionals who are enterprising, innovative, creative and responsive to change, through challenging design and project tasks.

Appendix C: Engineers Australia (EA) Professional Engineer Competency Standard

	Program Intended Learning Outcomes	
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals	
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing	
	PE1.3 In-depth understanding of specialist bodies of knowledge	✓
	PE1.4 Discernment of knowledge development and research directions	
	PE1.5 Knowledge of engineering design practice	✓
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice	
PE2 ..	PE2.1 Application of established engineering methods to complex 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	✓
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability	
	PE3.2 Effective oral and written communication (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	✓