ELEC3115

Electromagnetic Engineering

Term 1, 2022

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Rukmi Dutta	rukmi.dutta@unsw.edu.au		Room EE406	+61293857884

Lecturers

Name	Email	Availability	Location	Phone
Andrea Morello	a.morello@unsw.edu.au		Room Newton 103D	

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

Electromagnetism is of fundamental importance to electrical and computer engineers. Electromagnetic theory is indispensable in understanding electro-mechanical energy conversion, transmission & electric power utilisation systems and communication systems, RF/microwave devices, optical fibre systems, antennas, remote sensing, radio astronomy, and electromagnetic compatibility.

This course will consider electromagnetic theory as a general theory that includes the standard electro- and magneto-statics. The relationship between electric and magnetic fields, and their links expressed through the Maxwell equations, lead to wave propagation with associated wave behaviours. The course covers several aspects of electromagnetic applications such as capacitors, inductors, transformers, electromagnetic forces and power losses in electromagnetic systems (at low frequencies) and transmission lines, impendence matching circuits, waveguides, and antennas (at high frequencies).

This course aims to give students the necessary background for the design and analysis of both low-frequency electrical devices and high-frequency electronic components. Assumed knowledge of this course includes undergraduate physics (PHYS1231), vector calculus (MATH2069), and basic circuit theory techniques.

Course Aims

The goal of ELEC3115 is to introduce basic electromagnetism and establish the fundamentals of electromagnetic devices in engineering applications such as the energy systems, telecommunications, computing and other technologies.

Students will become familiar with electromagnetic applications such as capacitors, inductors, actuators, transformers, transmission lines, Smith charts, impendence matching circuits, waveguides and antennas, that are used in the designs and implementations of electrical power systems and modern wireless communications systems.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Use Gauss', Ampere's and Faraday's Laws in the context of design and apply them in the evaluation of electrical devices such as power cables, actuators, transformers etc.	PE1.1, PE1.2, PE1.3, PE1.5, PE2.1, PE2.2, PE3.1, PE3.2, PE3.4, PE3.5, PE3.6
2. Analyse characteristics of capacitor and inductor by evaluating the impact of dielectric and magnetic materials properties and calculate induced forces from their stored energies	PE1.1, PE1.2, PE1.3, PE1.5, PE2.1, PE2.2, PE3.1, PE3.2, PE3.4, PE3.5, PE3.6
3. Solve simple boundary value problems, using the method of	PE1.1, PE1.2, PE1.3, PE1.5,

Learning Outcome	EA Stage 1 Competencies
images, Poisson's and Laplace's Equations	PE2.1, PE2.2, PE3.1, PE3.2, PE3.4, PE3.5, PE3.6
4. Identify the conditions that make the lumped-element models of electrical circuits break down at high frequency (HF), and replace them with distributed element models	PE1.1, PE1.2, PE1.3, PE1.5, PE2.1, PE2.2, PE3.1, PE3.2, PE3.3, PE3.4, PE3.5
5. Calculate the effect of reflections in transmission lines at HF, and apply analytical and graphical methods to design reflection-free transmission lines	PE1.1, PE1.2, PE1.3, PE1.5, PE2.1, PE2.2, PE3.1, PE3.2, PE3.4, PE3.5, PE3.6
6. Describe and apply the fundamental properties of propagation modes in waveguides	PE1.1, PE1.2, PE1.3, PE1.5, PE2.1, PE2.2, PE3.1, PE3.2, PE3.3, PE3.4, PE3.5

Teaching Strategies

This course consists of lectures, laboratory work, homework and tutorial work.

Delivery Mode

Lectures

The lectures will provide the fundamental concepts and theory of engineering electromagnetics.

Laboratory work

The laboratory work provides students with opportunities to measure and characterise basic electromagnetic devices and applications. There are 3 labs to be completed during the session and students will do one lab every second week. Students choose a laboratory time when they enrol and will do experiments in pairs.

Students must comply with all H&S requirements and complete the relevant lab inductions before they may begin work. Each experiment has some required preparation, including a brief video introducing the equipment. All laboratory work must be recorded in a lab-book and not on loose sheets of paper. The lab work and the student's performance will be assessed by the demonstrator, and a mark given at the end of each lab session.

More details about the laboratory activities can be found in a separate document available on Moodle.

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 apply for a catch-up lab during another lab time, as agreed by the laboratory coordinator/course-in-charge.

Tutorial classes

Tutorial classes provide students with an opportunity to discuss problems with others, while being guided by a staff member.

You should attempt all questions of the practice tutorial-sheets published in Moodle 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 some of these questions or additional questions provided during the tutorial class will be discussed during the tutorial session. Solutions discussed during the tutorial class may not be made available on the web, so it is worthwhile for you to attend your tutorial classes to gain maximum benefit.

Out of class work

Lectures can only ever introduce the key ideas. Students must further reflect on these to fully develop their understanding. Students are encouraged to read the textbook and reference materials.

Preparation for laboratory exercises provides further understanding of the experiment.

The practice tutorial questions develop an in-depth quantitative understanding of basics of electromagnetic engineering. These problems take the student through all critical course topics and aim to develop and exercise their thinking skills. Students are expected to attempt complete all the problems, though not expected necessarily to successfully complete the harder ones.

Making serious attempts to understand and complete these problems is the proven method to succeed in ELEC3115.

On-line resources

All course documents, laboratory support material, etc., will be available on **Microsoft Teams course page**, as well as discussions and revision activities.

This year, due to COVID restrictions, the lectures will be run in hybrid mode during the scheduled time slots via Microsoft Teams.

The lectures, workshops and laboratory classes all have an option of enrollling into face-face or online. Students outside Sydney are only encouraged for the online version of the lab.

Those enrolled in the online laboratory classes will work in a group of 4 to 5, and have to appear in an oral exam after each lab class.

Learning in this course

You are expected to attend all lectures, tutorials, labs, and mid-term exams in order to maximise learning. You must prepare well for your laboratory classes and your lab work will be assessed. In addition to the lecture notes/video, you should read relevant sections of the recommended text. 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.

Additional Course Information

Relationship to Other Courses

This is a third-year course offered to students in a BE (Elec., Tele. or Quantum) program at UNSW. It gives the foundation for electrical power systems and all conventional electronic communications (RF, mobile, microwave and optical). The course provides the background for those who will design and build equipment and systems for application in electrical power or communication systems.

Pre-requisites and Assumed Knowledge

Students taking the course ELEC3115 will have successfully completed the Stage 1 course PHYS1231 - Higher Physics 1B and the mathematics course MATH2069 Mathematics 2A (Vector Calculus) or their equivalent.

It is also assumed that students have good computer literacy and are able to use basic instruments such as an oscilloscope.

Following Courses

This course provides essential basic understanding which is pre-requisite for ELEC3105 - Electrical Energy Systems, which is a core course for subsequent specialisation in Power Engineering. It also provides essential background to ELEC4604 RF Electronics, TELE4652 Mobile and Satellite Communications, and PHTN4661 Optical Circuits & Fibres.

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Feedback Quizzes	5%	Not Applicable	1, 2, 3, 4, 5, 6
2. Laboratory	15%	Not Applicable	1, 2
3. Mid-Term Test	15%	28/03/2022 07:00 PM	1, 2, 3
4. Assignment Take Home	15%	27/04/2022 11:55 PM	4, 5, 6
5. Final Exam	50%	Not Applicable	1, 2, 3, 4, 5, 6

Assessment 1: Feedback Quizzes

A set of weekly quiz designed to give feedback on how the student is doing in the course contents of each week.

Assessment 2: Laboratory

Assessment length: 3 hours

Laboratories are primarily about learning, and the laboratory assessment is designed mainly to check your knowledge as you progress through each stage of the laboratory tasks. You are required to maintain a lab book for recording your observations. A lab book is an A4 size notebook containing a mix of plain pages and graph sheets. You must purchase your own lab book from any store.

It is essential that you complete the laboratory preparation before coming to the lab. You are required to write the aim of the experiment and draw the diagram if required by the experiment in hand. This will be verified and signed by your demonstrators in the lab.

After completing each experiment, your work will be assessed by the laboratory demonstrator.

Assessment marks will be awarded according to your preparation (completing set preparation exercises and correctness of these or readiness for the lab in terms of pre-reading), how much of the lab you were able to complete, your understanding of the experiments conducted during the lab, and your understanding of the topic covered by the lab.

Assessment 3: Mid-Term Test

Assessment length: 1-2 hours
Due date: 28/03/2022 07:00 PM

A open-book mid-term test will be held for part A of the course on Monday (28/03/2022), at 7:00 pm. Further details of the course materials for the test will be announced closer to the date.

Assessment 4: Assignment Take Home

Due date: 27/04/2022 11:55 PM

The assignment allows self-directed study leading to the solution of partly structured problems. Marks will be assigned according to how completely and correctly the problems have been addressed and the understanding of the course material demonstrated by the report.

The assignment will be marked through a peer-review system managed by the Moodle platform. You will be required to scan your written assignment and upload it in pdf form to the Moodle system. After the submission deadline, the system will randomly and anonymously forward 3 assignments to each student. Each one of you will mark the 3 assignments according to the marking guidelines and the solution that will be posted on Moodle. For each assignment, 85% of your mark will be given for the assignment score itself, and 15% for the undertaking of the peer-marking activity. The marking activity is **mandatory**. Failure to mark the 3 assignments forwarded to you will result in a mark of 0 for the overall assignment.

Because of the peer-review method of marking, the solutions will be posted online immediately after the submission deadline. Therefore, there is no possibility for late submission. At exactly the time indicated on the assignment paper and in Moodle, the system will stop accepting assignment uploads. Students who have, for whatever reason (including internet problems, etc), failed to upload their assignment by the submission deadline, will receive zero marks for the assignment, and will not be included in the peer-review process.

Assessment 5: Final Exam

The exam in this course is a standard closed-book 2 hour written examination, comprising four compulsory questions. 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 laboratory), unless specifically indicated otherwise by the lecturer. Marks will be assigned according to the correctness of the responses.

Attendance Requirements

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

Course Schedule

Course has two components: Part A: Field electromagnetics,

Part B: Wave electromagnetics

View class timetable

Timetable

Date	Type	Content
Week 1: 14 February - 18 February	Lecture	Part A commences, offered by A/Prof Rukmi Dutta Topic 1: Electrostatic field and capacitance
	Online Activity	Feedback Quiz 1
Week 2: 21 February - 25 February	Lecture	Topic 1: Electrostatic field and capacitance
	Workshop	Tutorial 1 of Topic 1-A
	Online Activity	Feedback Quiz 2
Week 3: 28 February - 4 March	Lecture	Topic 2: Solving electrostatic problems
	Workshop	Tutorial 2 -Topic 1A
	Online Activity	Feedback Quiz 3
Week 4: 7 March - 11 March	Lecture	Topic 3: Magnetic field – static and time-varying and inductance
	Workshop	Tutorial 3 - Topic 2 A
	Online Activity	Feedback Quiz 4
	Laboratory	Experiment 1 for even week enrolments
Week 5: 14 March - 18 March	Lecture	Topic 3: Magnetic field – static and time-varying and inductance
	Workshop	Tutorial 4- Topic 3 A
	Online Activity	Feedback Quiz 5
	Laboratory	Experiment 1 for odd week enrolments
Week 6: 21 March - 25		

March		
Week 7: 28 March - 1 April	Lecture	Part B commences, offered by Prof Andrea Morello Topic 4: Propagation and reflection of electromagnetic waves
	Workshop	Tutorial 5 - Topic 3 A
	Assessment	Mid-term test
	Laboratory	Experiment 2 - Odd week enrolments
	Online Activity	Feedback Quiz 1 - part B
Week 8: 4 April - 8 April	Lecture	Topic 4: Propagation and reflection of electromagnetic waves
	Workshop	Tutorial 1 - part B
	Laboratory	Experiment 2 for even week enrolments
	Online Activity	Feedback Quiz 2 - part B
Week 9: 11 April - 15 April	Lecture	Topic 5: Impedance matching
	Workshop	Tutorial 2 - Part B
	Laboratory	Experiment 3 for odd week enrolment
	Online Activity	Feedback Quiz 3 - part B
Week 10: 18 April - 22 April	Lecture	Topic 6: Waveguides
	Workshop	Tutorial 3 - Part B
	Laboratory	Experiment 3 for even week enrolment
	Online Activity	Feedback Quiz 4 - part B
Study Week: 25 April - 28 April	Assessment	Assignment of part B due

Resources

Prescribed Resources

The following ***textbook*** is prescribed for the course:

Field and Wave Electromagnetics - D. K. Cheng; 2nd edn, AddisonWesley; 1989

Recommended Resources

The following books are also good additional references:

1. ***Electromagnetics*** -J. D. Kraus & D. A. Fleisch; McGraw Hill, fifth edition
2. ***Engineering Electromagnetics*** - Nathan Ida, Springer.
3. ***Introduction to Engineering Electromagnetics***- Yeon Ho Lee, Springer

Lecturers may mention other references in class for topics.

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 myExpereince 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 continued to evaluate and modify our delivery and assessment methods.

The following changes are being undertaken to improve the course based on the previous students' feedback on the course:

- A new method of assessing your lab work is being tried out, in order to give you all better feedback.
- Videos will be used to introduce the lab equipment to you. This was an explicit student suggestion.
- Part B, high-frequency wave propagation and component, will be restructured with an increased focus on basic concepts, examples and visualisation of problems.

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

Synergies in Sound 2016

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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	✓