School of Electrical Engineering and Telecommunications

Term 1, 2019
Course Outline

ELEC3115
Electromagnetic Engineering

COURSE STAFF

Course Convener/Lecturer: Dr Rukmi Dutta, Room EE406, rukmi.dutta@unsw.edu.au
Dr King Yuk Chan (Eric), Room EE 320, kyc@unsw.edu.au

Tutor: As above
Laboratory Contact: TBA

Consultations: You are encouraged to ask questions on the course material, after the lecture class times in the first instance, rather than via email. You are also encouraged to post your questions on the Discussion forum that will be set up on the Moodle page. Asking questions either during class or via the Moodle forum has the advantage of giving everyone the opportunity to hear the answer.
Lecturer consultation times will be advised during lectures. 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 ELEC3115 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.

COURSE SUMMARY

Contact Hours

The course consists of 4 hours of lectures, a 1-2 hours of tutorial per week and a 3-hour laboratory session in each fortnight.
Lectures (weeks 1-10) – 4 hr/wk, Tutorials – 1 hr/wk except for wk 5 and 11*. Laboratory classes (start from week 5 for odd weeks and from week 6 for even weeks) – 3 hrs /fortnight. You should enrol in a tute and a lab-class.
You must attend this same class in T1, 2019.

Lectures	Day	Time	Location
	Tuesday	15:00-17:00	CLB8
	Thursday**	14:00-16:00	ChemScM17
Tutorials			
	Monday Monday (wk 5, 11*)	10:00-11:00 10:00-12:00	TETB G17 TETB G17
	Monday Monday (wk 5, 11*)	14:00 - 15:00 14:00 - 16:00	OMB G32 OMB G32
	Thursday Thursday (wk 5*) Tuesday (wk 11*)	16:00 - 17:00 16:00 - 18:00 16:00 - 18:00	TETB LG05 Macauley Th Macauley Th
Lab**	As per your time table		EE 205

*2hrs tutorial on week 5 and 11.
**Week 10, Thursday being a holiday, a catchup lecture is scheduled in week 11, Tuesday.
**Week 9, Friday being a holiday, a catch-up lab will be held for the affected lab groups in week 11.

Context and Aims

Electromagnetism is of fundamental importance to electrical and computer engineers. Electromagnetic theory is indispensable in understanding electro-mechanical energy conversion, transmission & electric power utilization 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.

Aims

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

Students will become familiar with electromagnetic applications such as capacitors, inductors, 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.

Indicative Lecture Schedule

Course has two components:

Part A: Field electromagnetics

Part B: Wave electromagnetics

Period	Summary of Lecture Program
Week 1	Part A commences, offered by Dr Rukmi Dutta
Week 2	Part A, Tutorial classes start
Week 3	Part A
Week 4	**Class test of Part A on Tuesday** (12/03/2019) Part A
Week 5	Part A,
Week 6	Part A finishes on Tuesday Part B commences, offered by Dr K. Y. Chan (Eric) on Thursday
Week 7	Part B
Week 8	Part B
Week 9	**Class test of Part B on Tuesday** (16/04/2019) Part B
Week 10	Part B
Week 11	Part B finishes on Tuesday

Indicative Laboratory Schedule

There are 3 labs to be completed during the session and students will do one every second week. Students choose a laboratory time when they enroll and will do experiments in pairs. The laboratory starts from week 5 for the students enrolled to odd weeks and from week 6 for the students enrolled to even weeks schedule.

Assessment

Laboratory Practical Experiments	15%
Class test -A	12.5%
Class test -B	12.5%
Final Exam (2 hours)	60%

COURSE DETAILS

Credits

This is a 6 UoC course and the expected workload is 15 hours per week throughout the 10-week term.

Relationship to Other Courses

This is a third-year course offered to students in a BE (Elect and Tele) 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 courses 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 specialization in Power Engineering. It also provides essential background to ELEC4604 RF Electronics, TELE4652 Mobile and Satellite Communications, and PHTN4661 Optical Circuits & Fibres.

Learning outcomes

For this course, we have identified the following specific **Learning Outcomes**:
After successful completion of this course, you should be able to:

Part A

1. use Gauss', Ampere's and Faraday's Laws in the context of electrical devices
2. design capacitors & inductors and analyse their characteristics; understand the impact of dielectric and magnetic materials in their design
3. solve simple boundary value problems, using the method of images and Poisson's equation
4. calculate the forces that develop in electromagnetic actuators used in energy conversion and energy storage devices
5. understand and calculate mutual coupling between magnetic circuits and the basic principle of transformers
6. understand and calculate electromotive forces in motional devices and define core loss in an electromagnetic device, and recognise & describe its effect

Part B

1. describe the engineering uses of electromagnetic waves, by frequency band, and the respective hazards associated with them
2. understand the causes and remedies of reflections in HF transmission lines
3. understand why lumped element models break down at HF
4. apply the distributed circuit concepts needed at HF, specifically to match impedances and design HF components
5. use and interpret a Smith chart

6. describe & recognise fundamental properties of waveguide modes

Additionally, students are expected to develop their communication skills by correctly using the appropriate terminology, and to demonstrate suitably professional skill and conduct in the context of an engineering laboratory.

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

A detailed syllabus for each part will be provided in the first class of each section.

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 characterize 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 <u>not on</u> 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.

<u>Laboratory Exemption</u>

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 for T1, 2019 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 overemphasized, 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 activities

All course documents, laboratory support material, etc., will be available on Moodle, as well as discussions and revision activities.

Learning in this course

You are expected to attend all lectures, tutorials, labs, and mid-term exams in order to maximize 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.

ASSESSMENT

The assessment scheme in this course reflects the intention to align the learning outcomes to the assessment methods. Ongoing assessment occurs through the lab checkpoints (see lab manual). The assessments are specifically designed to stimulate and direct your learning progression towards the achievement of the stipulated learning outcomes of this course.

Laboratory Assessment: 15% worth

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.

Test -A: 12.5% worth

A closed-book mid-term test will be held for part A of the course on Tuesday 15:00-17:00hrs, week 4 (12/03/19). Further details will be announced closer to the date.

Test -B: 12.5% worth

A closed-book test will be held for part B of the course on Tuesday 15:00-17:00hrs, week 11 (16/04/19). Further details will be announced closer to the date.

Final Exam 60% worth

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

Relationship of Assessment Methods to Learning Outcomes

Part A

	Learning outcomes						
Assessment	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Laboratory practical assessments	-	-	-	✓	✓	✓	✓
Test - A	✓	✓	✓	-	-	-	-
Final exam	✓	✓	✓	✓	✓	✓	✓

Part B

	Learning outcomes						
Assessment	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Test - B	✓	✓	✓	✓	✓	-	-
Final exam	✓	✓	✓	✓	✓	✓	✓

Assessment of mid-semester tests and final exam will be carried out according marking criterial developed by the lecturers. Reassessment of these tasks will strictly follow UNSW reassessment policy (https://student.unsw.edu.au/results).

COURSE RESOURCES

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

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

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.

On-line resources

Moodle

As a part of the teaching component, Moodle will be used to disseminate teaching materials, host forums and 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

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 http://www.lc.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://my.unsw.edu.au/student/atoz/ABC.html), and particular attention is drawn to the following:

Workload
It is expected that you will spend at least **fifteen 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 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. As of Term 1 2019, assessment of applications for Special Consideration will be managed centrally and the University has introduced a “fit to sit/submit” rule. You will no longer be required to take your original documentation to The Nucleus for verification. Instead, UNSW will conduct source checks on documentation for verification purposes. 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. If you sit an exam or submit an assignment, you are declaring yourself well enough to do so.
For more detail, consult: https://my.unsw.edu.au/student/atoz/SpecialConsideration.html.

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 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 visualization of problems.

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:
http://www.engineering.unsw.edu.au/electrical-engineering/policies-and-procedures
https://my.unsw.edu.au/student/atoz/ABC.html

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 address a number of core UNSW graduate capabilities, as follows

- Developing scholars who have a deep understanding of their discipline, through lectures and solution of analytical problems in tutorials and assessed by assignments and written examinations.
- 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 during the labs.
- Developing capable independent and collaborative enquiry, through a series of tutorials spanning the duration of the course.

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: Engineering Application Ability	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	✓