

ELEC 3115

Electromagnetic Engineering

COURSE INTRODUCTION – Session 1, 2009

Course Staff

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Course Details

Credits

The course is a 6 UoC course jointly operated with the School of Physics and EE&T; expected workload is 10-12 hours per week throughout the 12 week session.

The **School of Physics** conducts lectures during **weeks 1-4**. These lectures are given by Dr. Maria Cunningham. The School of Physics also conducts the laboratory for the course. The laboratory starts from week 1. All information in relation to these components of the course can be found from a WebCT Vista site maintained by the School of Physics.

The **School of EE&T** conducts lectures during **weeks 5-12**. These lectures are equally shared between and Professor Faz Rahman (Part A in weeks 5-12) and A/Professor Rodica Ramer (Part B in weeks 5-12). All information about lecture notes, tutorials and mid-session examination for the course from weeks 5-12 can be found from the webpage on Lecture Notes in ELEC3115, which is maintained by the School of EE&T.

Contact hours

The course consists of 3 hours of lectures per week, 1 hour of tutorials per fortnight, and 3 hours of laboratory session per fortnight. Details are given below.

Week 1-4

Lectures:

Mon 2 - 4 pm, EEG25

Wed 2 - 3 pm, EEG25

Tutorials:

Wed 3 - 4 pm, EEG25

Week 5, 7, 9, 11

Lectures:

Mon 2 - 4 pm, EEG25 (Part A)

Wed 2 - 4 pm, EEG25 (Part B)

Week 6, 8, 10, 12

Lectures and Tutorials:

Mon 2 - 4 pm, EEG25 (Part A)

Wed 2 - 4 pm, EEG25 (Part B)

Tutorials (repeat):

Wed 4 - 5 pm, Red C 4034 (Part A)

Wed 5 - 6 pm, Red C 4034 (Part B)

Lab Sessions:

Thursdays, 1 pm - 4 pm, School of Physics...
Thursdays, 3 pm - 5 pm, School of Physics...

Tutorial classes start in week 2 and laboratory classes start in week 1.

Consultation

Weeks 1-4 TBA

Weeks 5-12: Wed 5 - 7 pm, EEG25.

Students are encouraged to use the open consultation time rather than contact by email.

COURSE INFORMATION

Context and Aims

Electromagnetics is of fundamental importance to physicists and to electrical and computer engineers. Electromagnetic theory is indispensable in understanding electromechanical energy conversion, communication systems, RF/microwave devices, optical fibre communication, antennas, remote sensing, radio astronomy, and electromagnetic compatibility.

The course will start introducing the electromagnetic theory as a general theory that includes the standard low frequency circuit theory. Then, the relationships between the electric and magnetic field, and their link expressed through Maxwell's equations become the basis for the introduction of the wave propagation. Finally, the course will cover several aspects of the electromagnetic applications such as capacitors, inductors, transformers, transmission lines, Smith charts, impedance matching circuits, waveguides, and antennas.

This course aims to convey to students an understanding of background for both the design and analysis of low frequency electrical devices and high frequency electronic components. Assumed knowledge of this course include undergraduate physics and basic circuit theory techniques.

Aims

The goal of Elec 3115 is to introduce basic electromagnetics and to establish the fundamentals of distributed transmission media as required by students in energy systems, telecommunications, computing and other engineering based technologies.

The course aims to make the student familiar with electromagnetic applications such as capacitors, inductors, transformers, transmission lines, Smith charts, impedance matching circuits, waveguides and antennas, that are used in the designs and implementations of electrical power systems and modern wireless communications systems.

Relations to other courses

The course is a third year subject offered to students in a BEE course at the University of New South Wales. The course gives the foundation for electrical power systems and all conventional electronic communications (RF, mobile, microwave and optical communications). The course offers the background for students that plan to design building blocks of electrical power systems and communication systems.

Pre-Requisites:

Students taking the course ELEC3115 will have successfully completed the Stage 1 courses PHYS1131 Higher Physics 1A and PHYS1231 Higher Physics 1B. The higher level mathematics needed for electromagnetism is covered in the course MATH2 111 Higher Several Variable Calculus. Students who have not previously undertaken MATH 2111 will find it necessary to put in extra work to learn this basic mathematical material.

Assumed knowledge:

It is further assumed that the students are familiar with SPICE-like circuit simulators, MATLAB, have good computer literacy and are able to operate electronics equipment.

Following Courses:

The course will provide essential basic understanding to attempt the course ELEC 4611 Electrical Energy Systems, ELEC 4613 Electrical Drive Systems, ELEC 9604 RF Electronics and TELE 4652 Mobile and Satellite Communications which are core courses in the Microsystems and Microelectronics, Telecommunications and Master of Engineering Science post-graduate specialisation coursework program, offered by the School.

Learning Outcomes

After the successful completion of the course, the student will be able to

1. Analyse and design low frequency components such as capacitors, inductors and transformers.
2. Understand the limitations of standard low frequency circuits and RF circuits; apply the distributed circuits concepts needed at high frequency.

3. Analyse and design high frequency components such as waveguides and antennas.

The course delivery methods and course content address a number of core UNSW *graduate attributes*; they include:

1. The capacity for analytical and critical thinking and for creative problem-solving, which is addressed by the design task and tutorial exercises.
2. The ability to engage in independent and reflective learning, which is addressed by the design task.
3. Information literacy, which is addressed by the homework.
4. The skills of effective communication, which are addressed by the reports.

Please refer to <http://www.ltu.unsw.edu.au/content/userDocs/GradAttEng.pdf> for more information about the graduate attributes.

Teaching Strategies

The course consists of the following elements: lectures, laboratory work, home work and tutorial work.

Lectures

The lectures, delivered in the class, will cover a range of engineering electromagnetics. There are four hours of lectures/tutorials per week. Scheduled Lecture periods will include Tutorial sessions; approx 1 hour per week on average.

Weeks 1 to 4 (Physics Component)

General field properties; Review of vector calculus and coordinate systems; static electric fields, static magnetic fields. Coulomb, Gauss, Bio-Savat and Ampere's laws. Time-varying fields and Maxwell's equations in differential, integral and phasor forms. Wave equation. Magnetic vector potential.

Weeks 5 to 12 (EE&T Component)

Part A. Boundary value problems and method of images. Materials: dielectric and magnetic materials, their properties, capacitance and inductance, applications. Electromagnetic spectrum: uses, health and regulatory considerations. Transformers and electrical machines: rotating magnetic fields, coupling in magnetic circuits, energy conversion, electrodynamic forces. Skin effect and skin depth, hysteresis and eddy current losses, dielectric losses.

Part B. Transmission lines fundamentals. Smith Charts. Impedance matching. Waveguides: modal analysis of rectangular metallic waveguides. Antennas: antenna patterns and parameters, ideal dipoles, special cases of arbitrary linear antenna. Friis transmission. Antenna arrays. XXXXXXXXXX

Tutorial Information

Weeks 1 to 4 (Physics Component)

The aim of the tutorials is to help students learn problem solving, using the tools of the subject: vector calculus, and field and wave electromagnetics. There will be a one hour tutorial every week from 3 to 4pm, following the lecture. Tutorial sheets will be distributed and the tutor will discuss the problems. The tutorials are also available on the ELEC3115 WebCT vista site. It is important that students participate

actively in the tutorials, as simply sitting and watching someone solve problems will not help students learn to solve problems by themselves - students need to attempt the problems themselves.

Weeks 5-12 4 (EE&T Component)

The aim of the tutorials is to help students learn problem solving. There will be a total of one hour tutorial every fortnight for both part A and B held in even weeks. Repeats of this tutorial will be Wednesday (even weeks) from 4 - 5 (Part B) and 5-6 (Part A). Students will be attending either one.

Laboratory work

The laboratory work provides the student with opportunity to measure and characterize basic electromagnetic applications. There are 5 labs over the session, one every second week, starting in week 1. The students will choose their laboratory time when enrol in the subject. The experiments are listed in the course timetable (below). All laboratory work must be recorded in lab Book and not in loose sheets of paper. The lab work will be marked by the demonstrator during the lab session.

Home work

The lectures can only cover the course material to a certain depth; students must read the textbook and reflect on its content as preparation for the lectures to fully appreciate the course material. Students are encouraged to read the text book and reference materials. Home preparation for laboratory exercises provides the student with quantitative understanding of the experiment.

Self-guided tutorials

The self guided tutorials provide the student with in-depth quantitative understanding of basics of electromagnetic engineering. The tutorials take the student through all critical course topics and aim to exercise the students' skills. The students are strongly encouraged to complete all the tutorials; the problems may be discussed in the tutorial sessions.

Assignments

Two assignments will be set for this course. Assignments will allow the students to explore the subject in great depth and would consume more effort and time than the normal tutorial questions. Deadline for the submission of assignment are in the course schedule.

Assessment

Theory Weeks 1 to 4

The major assessment for the work done in weeks 1 to 4 will be an **exam of 1 hours** duration held in the tutorial time in week 4 (Monday March 31st 2009, 3 to 4pm). **This exam will be worth 20% of your final mark for the subject.** The material will not be examined again in the final exam. However, you will get an option to repeat this exam during the final exam (as with First Year physics). Your final mark for the exam will be the greater of your two attempts, if you choose to re-sit the paper. Whether you take this supplementary exam or not, you will still be expected to follow the final exam time-table for the course stipulated by the examination unit.

First Mid session/Final exam (1 hour) on 31 March, 2009 20%

Theory Weeks 5-12 Parts A & B.

The major assessment for the work done in weeks 5 to 12 will consist of two mid-session exams of 1+1 hours duration held in the tutorial time in week 4. School of EE&T maintains a webpage on Lecture Notes for ELEC3115. You should access this webpage **REGULARLY** for information about lectures, tutorials and assessments in weeks 5-12.

Final mark will be calculated as follows:

First Mid session/Final exam (1 hour) on 31 March, 2009	20%
Second Mid-session exam (=1+1) hour exam in week 11	20%
End of session Exam (3 hour):	40%
Laboratory	20%
Total	100%

Final examination:

The exam in this course is an closed book 3 hours written examination. University approved calculators are allowed. The examination test analytical and critical thinking and general understanding of the course material in a controlled fashion. Assessment is a graded mark according the correct fraction of the answers to the exam questions.

Mid-Term Exams:

There is three mid term exams held through the semester, which are provided in order to give early feedback on student performance and general understanding of the course material in a controlled fashion.

Laboratory work:

Laboratory work must be documented in brief reports which are due one week after the laboratory session at 5pm. Assessment is grade only mark based on lab work and reports.

Course Contents

Handbook entry:

COURSE SCHEDULE

Week	Lecture/Tutorial Mon 2-3pm	Lecture/Tutorial Mon 3-4pm	Lecture/Tutorial Wed 2-3pm	Lecture/Tutorial Wed 3-4pm	Laboratory
1	Introduction	Vector calculus; coordinate systems	Electric fields: Coulomb's Law Gauss' law	Vector calculus; coordinate systems	Hall Effect
2	Electric fields: Maxwell Equations	Electric Potential Laplace's equation Poisson's equation; Conductors	Magnetic Fields; Biot-Savart Law Ampere's Law	Electric fields: Maxwell Equations	Hall Effect
3	Vector Potential	Maxwell's Equations	Maxwell's Equations	Maxwell's Equations	e/m ratio of electrons
4	The wave equation	Revision	Revision	Mid-session Exam (worth 20% of Assessment)	e/m ratio of electrons
5	LEC/TUT F. Rahman	LEC/TUT F. Rahman	LEC/TUT R. Ramer	LEC/TUT R. Ramer	Dielectric constant and capacitance
6	LEC/TUT F. Rahman	LEC/TUT F. Rahman	LEC/TUT R. Ramer	LEC/TUT R. Ramer	Dielectric constant and capacitance
7	LEC/TUT F. Rahman	LEC/TUT F. Rahman	LEC/TUT R. Ramer	LEC/TUT R. Ramer	Magnetic hysteresis
8	LEC/TUT F. Rahman	LEC/TUT F. Rahman	LEC/TUT R. Ramer	LEC/TUT R. Ramer	Magnetic hysteresis
9	LEC/TUT F. Rahman	LEC/TUT F. Rahman	LEC/TUT R. Ramer	LEC/TUT R. Ramer	RLC circuits
10	LEC/TUT F. Rahman	LEC/TUT F. Rahman	LEC/TUT R. Ramer	LEC/TUT R. Ramer	RLC circuits
11	LEC/TUT F. Rahman	LEC/TUT F. Rahman	LEC/TUT R. Ramer	LEC/TUT R. Ramer	
12	LEC/TUT F. Rahman	LEC/TUT F. Rahman	LEC/TUT R. Ramer	LEC/TUT R. Ramer	

Resources for Students

Textbooks: Prescribed textbook

The following textbook is prescribed for the course:

Field and Wave Electromagnetics - D. K. Cheng; Second Edition, AddisonWesley; 1992.

The lecturer may specify other titles in class.

Reference books

The following books are good additional resources for topics on Electromagnetics Engineering

1. Electromagnetics - J. D. Kraus & D. A. Fleisch; McGraw Hill, 5th Edition
2. Elements of Electromagnetics - M. N. O. Sadiku; Sanders

On-line Resources

Some additional on-line resources relevant to the course:

Resources: course website: <http://subjects.ee.unsw.edu.au/elec3115>

library resources: <http://info.library.unsw.edu/web/services/teaching>

Other Matters

Academic Honesty and Plagiarism

Plagiarism is the unacknowledged use of others peoples work, including the copying of assignment works and laboratory results form other students. Plagiarism is considered a serious offence by the University and severe penalties may apply. For more information on plagiarism, please refer to: <http://www.lc.unsw.edu.au/plagiarism>

Continual Course Improvement

Students are advised that the course is under constant revision in order to improve the learning outcomes of its students. Please forward any feedback on the course to the course convenor.

Administrative Matters

On issues and procedures regarding such matters as special needs, equity and diversity, occupational health and safety, enrolment, rights and general expectation of students, please refer to the School policies, see <http://scoff.ee.unsw.edu.au/>.