UNSW COURSE OUTLINE

Faculty of Engineering

School of Electrical Engineering and Telecommunications

ELEC 3115

Electromagnetic Engineering

Session 1, 2010

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2. COURSE STAFF DETAILS

Course convenor: Prof. R. Ramer, room EE 305, 9385-4759, ror@unsw.edu.au, week 5 – 12, part B
Dr. R. Dutta, room EE130, 9385-7884, rukmi.dutta@unsw.edu.au, week 5 – 12, part A
Dr. M. Cunningham, room 130 Old Main Building, 9385-5662, maria.cunningham@unsw.edu.au, week 1-4

Laboratory Demonstrators: Dr Mary Beilby, 9385-5463, mjb@newt.phys.unsw.edu.au
Tamara Reztsova, 9385-4730, rt@phys.unsw.edu.au

Web assistant: Jiong An, 9385-4001, jiongan@ee.unsw.edu.au
3. COURSE DETAILS AND COURSE INFORMATION

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 Blackboard website 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 Rodica Ramer (Part B in weeks 5-12) and Dr. Rukmi Dutta (Part A 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:

Wed 16-18, EEG25
Thu 11-13, EEG25

Tutorials (repeat):

Wed 3-4 pm, TBA

Week 5, 7, 9, 11

Lectures:

Wed 16-18, EEG25 (Part B)
Thu 11-13, EEG25 (Part A)

Week 6, 8, 10, 12

Lectures and Tutorials:

Wed 16-17(L), 17-18(Tut), EEG25 (Part B)
Thu 11-12(L), 12-13(Tut), EEG25 (Part A)
Tutorials (repeat): Wed 18-19, OMB G31 (Part B)
Thu 14-15, Civil Eng G1 (Part A)

Lab Sessions: Mondays 9-12, School of Physics OMB1,
Fridays 13-16, School of Physics OMB1,
Tutorial classes start in week 2 and laboratory classes start in week 1.

Consultation
Weeks 1-4 Wed 15-16, TBA
Weeks 5-12: Wed 15-16, TBA
Students are encouraged to use the open consultation time rather than contact by email.

Context, Summary 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.
Student 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.

Graduate Attributes
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.

4. RATIONALE FOR THE CONTENT AND 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 4604 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.

5. 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)


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 Blackboard website. 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 (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 (even weeks) on Wednesdays from 6 pm to 7 pm (Part B) and Thursdays from 1 pm to 2 pm (Part A). Students will be attending either the tutorials or the repeats.

**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.

**Mid-Term Exam**

A midterm test will be set for this course. The mid-session test will allow the students to explore the subject in great depth and would consume more effort and time than the normal tutorial questions.
6. ASSESSMENT

Mid-Term Exam:
There is one mid-term exam held through the semester, which is provided in order to give early feedback on student performance and general understanding of the course material in a controlled fashion. **This exam will be of 1 hour duration held on the tutorial time in week 4. It is worth 20% of your final mark for the subject.** The material for this test is based on the work done in weeks 1 to 4 and will not be examined in the final exam.

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

The final examination material includes questions from Part A and Part B taught by the School of EE&T.

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.

Final mark will be calculated as follows:

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<thead>
<tr>
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<tbody>
<tr>
<td><strong>Mid-Term Exam</strong></td>
<td>20%</td>
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<tr>
<td>(1 hour) in week 4:</td>
<td></td>
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<tr>
<td><strong>Final Exam</strong></td>
<td>60%</td>
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<td>(3 hours) at the end of session:</td>
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<tr>
<td><strong>Laboratory</strong></td>
<td>20%</td>
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<tr>
<td><strong>Total</strong></td>
<td>100%</td>
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7. ACADEMIC HONESTY AND PLAGIARISM

Plagiarism is the unacknowledged use of others peoples work, including the copying of assignment works and laboratory results fromm 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](http://www.lc.unsw.edu.au/plagiarism)
## 8. COURSE SCHEDULE

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture/Tutorial Wed 16-18</th>
<th>Lecture/Tutorial Wed 16-18</th>
<th>Lecture/Tutorial Thurs 11-13pm</th>
<th>Lecture/Tutorial Thurs 11-13pm</th>
<th>Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>Vector calculus; coordinate systems</td>
<td>Electric fields: Coulomb’s Law Gauss’ law</td>
<td>Vector calculus; coordinate systems</td>
<td>Hall Effect</td>
</tr>
<tr>
<td>2</td>
<td>Electric fields: Maxwell Equations</td>
<td>Electric Potential Laplace’s equation Poisson’s equation; Conductors</td>
<td>Magnetic Fields; Biot-Savart Law Ampere’s Law</td>
<td>Electric fields: Maxwell Equations</td>
<td>Hall Effect</td>
</tr>
<tr>
<td>3</td>
<td>Vector Potential</td>
<td>Maxwell’s Equations</td>
<td>Maxwell’s Equations</td>
<td>Maxwell’s Equations</td>
<td>e/m ratio of electrons</td>
</tr>
<tr>
<td>4</td>
<td>The wave equation</td>
<td>Revision</td>
<td>Revision</td>
<td>Mid-session Exam (worth 20% of Assessment)</td>
<td>e/m ratio of electrons</td>
</tr>
</tbody>
</table>
9. EXPECTED RESOURCES FOR STUDENTS

Textbooks: Prescribed textbook
The following textbook is prescribed for the course:
The lecturer may specify other titles in class.

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

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

10. COURSE EVALUATION and DEVELOPMENT

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.

11. OTHER INFORMATION

Administrative Matters
For general expectations, rights, responsibilities such as attendance and workload of students please refer to the School policies, see http://scoff.ee.unsw.edu.au/. For information of relevant Occupational Health and Safety policies please see http://www.hr.unsw.edu.au/ohswe/ohs/ohs_policies.html. Student equity and diversity issues could be found via Student Equity Officers (Disability) in the Student
Equity and Diversity Unit (9385 4734). Further information for students with disabilities is available at http://www.studentequity.unsw.edu.au/disabil.html