UNSW COURSE OUTLINE

Faculty of Engineering

School of Electrical Engineering and Telecommunications

ELEC 3115

Electromagnetic Engineering

Session 1, 2011

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2. COURSE STAFF DETAILS

Course convenors:  Prof. R. Ramer, room EE 305, 9385 4759, ror@unsw.edu.au, week 7 – 12, part B
Dr. R. Dutta, room EE 124 C, 9385 7884, rukmi.dutta@unsw.edu.au, week 1 – 6, part A

Laboratory Demonstrators:  Dr Mary Beilby, 9385 5463, mjb@newt.phys.unsw.edu.au
Tamara Reztsova, 9385 4730, rt@phys.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 the laboratory for the course. The laboratory starts from week 2. All information in relation to lab 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 1-12. These lectures are equally shared between Dr Rukmi Dutta (Part A in weeks 1-6) and Professor Rodica Ramer (Part B in weeks 7-12). All information about lecture notes, tutorials and mid-session examination for the course 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.

  - **Lectures**
    - **Part A, Weeks 1-6**
      - Monday 9:00 am to 11:00 am, Wb Th A
      - Friday 11:00 am to 12:00am, ChemSc M17
    - **Part B, Weeks 7-12**
      - Monday 9:00am to 11:00 am, Wb Th A
      - Friday 11:00 am to 12:00 pm, ChemSc M17

  - **Tutorials**
    - **Group 1, odd weeks** (Part A in weeks* 2, 3, 5, and B in 7, 9, 11)
      - Friday 12:00 pm to 1:00 pm, ChemSc M17
    - **Group 2, even weeks** (Part A in weeks 2, 4, 6 and B in weeks 8, 10, 12)
      - Friday 12:00 pm to 1:00 pm, ChemSc M17

* Note tutorial starts for both groups together on week 2, but for rest of the weeks it will split into two groups.

  - **Lab sessions (start from week 2)**
    - Monday 2:00 pm to 5:00 pm, School of Physics OMB1,
    - Wednesdays 2:00 pm to 5:00 pm, School of Physics OMB1,

  - **Consultations**
    Weeks 1-12. Students are encouraged to ask questions at the end of the tutorial time. One extra hour will be available for further discussions.
Note. Guest visits from industry and/or research organizations partners are planned. The exact details will be provided during the session.

**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 under low frequency and transmission lines, Smith charts, impedance matching circuits, waveguides, and antennas under high frequency.

This course aims to convey to students an understanding of 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 and basic circuit theory techniques.

- **Aims**
  The goal of Elec 3115 is to introduce basic electromagnetics and to establish the fundamentals of 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.
     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 MATH2111 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.

4. TEACHING STRATEGIES
   The course consists of the following elements: lectures, laboratory work, homework and tutorial work.
• **Lectures**
  The lectures, delivered in the class, will cover a range of engineering electromagnetics. There are three hours of lectures per week. Tutorial is for 1 hour per fortnight. Class is divided into two groups for the tutorial. Group 1 should attend the tutorial in even weeks and the Group 2 should attend the same in odd weeks.

**Weeks 1 to 6 Part A.**
General field properties; Review of vector calculus and coordinate systems; static electric fields, static magnetic fields. Coulomb, Gauss, Bio-Savat and Ampere’s laws. Magnetic vector potential. Boundary value problems and method of images. Materials: dielectric and magnetic materials, their properties, capacitance and inductance, applications. Introduction to electromagnetics in devices such as 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.

**Weeks 7 to 12 Part B.**

• **Tutorial Information**

  **Weeks 1-12**
  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.

• **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 2. 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. The manual is available in the lab and also in the blackboard site maintained by school of physics.

• **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**
  Two midterm tests 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.
  Part A mid-term exam is scheduled for week 5 (time/date TBA).
  Part B mid-term exam is scheduled for week 10 (time/date TBA).

5. **ASSESSMENT**

- **Mid-Term Exams:**
  There are two mid-term exams 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. **These exams will be of 1 hour duration and worth 10% each.**

- **Final Exam:**
  The exam in this course is a 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. The final examination material includes questions from both Part A and Part B.

- **Laboratory work:**
  The lab work will be marked by the demonstrator during the lab session. The manual is available in the lab and also in the blackboard site maintained by school of physics.

**Final mark** will be calculated as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two Mid-Term Exams (1 hour each in week 5 and 10)</td>
<td>20%</td>
</tr>
<tr>
<td>Final Exam (3 hours) at the end of session</td>
<td>60%</td>
</tr>
<tr>
<td>Laboratory</td>
<td>20%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
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</table>
7. ACADEMIC HONESTY AND PLAGIARISM
Plagiarism is the unacknowledged use of others peoples work, including the copying of assignments works and laboratory results from 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

8. COURSE SCHEDULE

<table>
<thead>
<tr>
<th>PART A (Low Frequency) Dr. Rukmi Dutta</th>
<th>Lecture Monday (9-11)</th>
<th>Lecture Friday (11-12)</th>
<th>Tutorial Friday(12-1)</th>
<th>Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction, Vector calculus; coordinate systems</td>
<td>Electric fields: Coulomb’s Law Gauss’ law</td>
<td></td>
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<tr>
<td>2</td>
<td>Electric Potential Dielectric Boundary interface</td>
<td>Capacitance Electro-static force</td>
<td>Tutorial 1 of Part A (Group 1 and 2)</td>
<td>Hall Effect</td>
</tr>
<tr>
<td>3</td>
<td>Method of image Boundary value problems</td>
<td>Steady-electric current</td>
<td>Tutorial 2 of Part A (Group 1)</td>
<td>Hall Effect</td>
</tr>
<tr>
<td>4</td>
<td>Static magnetic field and laws associated with it</td>
<td>Inductance Force in magnetic field</td>
<td>Tutorial 2 of Part A (Group 2)</td>
<td>e/m ratio of electrons</td>
</tr>
<tr>
<td>5</td>
<td>Mid-session Exam (worth 10% of final assessment)</td>
<td>Time varying electro-magnetic field</td>
<td>Tutorial 3 of Part A (Group 1)</td>
<td>e/m ratio of electrons</td>
</tr>
<tr>
<td>6</td>
<td>Skin effect, Iron losses</td>
<td>Revision</td>
<td>Tutorial 3 of Part A (Group 1)</td>
<td>Dielectric constant and capacitance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PART B (High Frequency) Prof Rodica Rammer</th>
<th>General background: Maxwell’s equations, vector magnetic potential etc.</th>
<th>General background: Maxwell’s equations, vector magnetic potential etc. continued.</th>
<th>Tutorial 1 of Part B (Group 1)</th>
<th>Dielectric constant and capacitance</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>TL</td>
<td>TL</td>
<td>Tutorial 1 of Part B (Group 2)</td>
<td>Magnetic hysteresis</td>
</tr>
<tr>
<td>8</td>
<td>Impedance Matching</td>
<td>Impedance Matching</td>
<td>Tutorial 2 of Part B (Group 1)</td>
<td>Magnetic hysteresis</td>
</tr>
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9. EXPECTED RESOURCES FOR STUDENTS

- **Lecture notes and all relevant course announcements can be found:**
  School web page>Current students>Study Notes >Lecture Notes> ELEC3115
  https://subjects.ee.unsw.edu.au/elec3115

- **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
  1. Electromagnetics-J. D. Kraus & D. A. Fleisch; McGraw Hill, fifth edition

- **On-line Resources**
  Some additional on-line resources relevant to the course:
  Course website:
  http://subjects.ee.unsw.edu.au/elec3115
Library resources:
http://info.library.unsw.edu/web/services/teaching

- **Video Lectures**
  Video lecture of Part A recorded in Session 1, 2010 is available at http://eemedia.ee.unsw.edu.au/

  The some of the recorded lectures are slightly different because of the restructuring of the course in session 1, 2011.

10. **COURSE EVALUATION and DEVELOPMENT**

- **Continual Course Improvement**
  Students are advised that the course in under constant revision in order to improve the learning outcomes of its students. Please forward any feedback (positive or negative) on the course to the course convener or via the Course and Teaching Evaluation and Improvement Process (CATEI).

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/ohswc/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.

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