LEARNING
GUIDE

Faculty of Engineering and Information Technology

Electrical Engineering

48521 Fundamentals of Electrical Engineering

Spring 2010
SUBJECT GUIDE

Welcome

Fundamentals of Electrical Engineering is a subject in the Engineering Degree course for students who major in Electrical Engineering.

This subject focuses on developing a set of field-of-practice skills and knowledge:

• It develops a theoretical framework for your field-of-practice knowledge.
• It develops competence in the use of laboratory equipment through laboratory work.
• It lets you apply core skills and knowledge to a field-of-practice.

Fundamentals of Electrical Engineering is a subject in the first year of the course – it helps to develop your academic and information literacy skills, and starts to build the academic foundations of professional engineering. It also helps you to acquire mastery of laboratory equipment required for the academic and workplace experiences.

You will be expected to start taking on more responsibility for your own learning. While self-managed learning offers you choices about how and when you study, we also understand that you will learn best if there are convenient opportunities for you to interact with fellow students and course staff.

Therefore, the subject provides a balance between the convenience of independent learning and the stimulation of academic life. We hope you enjoy the content, learning experiences and assessment tasks that make up this subject as well as the benefits of managing your own learning.

Your Subject Coordinator

Dr McLean is a Senior Lecturer at UTS in the School of Electrical, Mechanical and Mechatronic Systems within the Faculty of Engineering and Information Technology. Subjects taught include Electronics and Circuits, Circuit Analysis, Introductory Digital Systems, Signals and Systems, Data Acquisition and Distribution, Digital Electronics, Analog Electronics, Signal Processing, Power Circuit Theory, Embedded Software and Fundamentals of Electrical Engineering. He has undertaken numerous research projects in collaboration with industry that normally involve the development of embedded systems hardware and software. These include microcontroller-based power system protection devices, DSP-based power-line carrier systems and a broadband Internet distribution system for the home.
Where this subject fits into the course

This subject is a Stage 2 field-of-practice subject which is a fundamental component of the Electrical Majors within various Bachelor of Engineering Degrees.

The need for this subject

It is assumed that you have already been introduced to and attained competence in basic electrical concepts, simple DC and AC circuit analysis, passive elements, time-domain and frequency-domain representation of signals, and the use of basic laboratory equipment. In this subject you will gain experience in the analysis of electromagnetic phenomena using basic field theory, magnetic circuits, transformers, transducers, semiconductors and simple diode circuits, basic discrete transistor amplifiers and operational amplifiers and their applications. It will be seen that engineering requires judgement, approximation and experience – and draws on many fields of mathematics and science.

The subject lays the foundation for many areas of further interest to the engineer – electromagnetics, electrical machines, circuit analysis and electronics.

Subject aims and objectives

This subject aims to provide students with a knowledge and understanding of:

- the key conceptual underpinnings of electromagnetic phenomena
- the basic construction and utilisation of semiconductor devices
- the basic principle of moving electrical machines
- the basic principle behind electronic amplifiers and some of their applications
- simple engineering design principles
- the use of electronic measurement equipment and basic laboratory setup and construction skills

Skills in designing, building, testing and measuring circuits are developed through a series of laboratories.

The subject will prepare you for more advanced topics on electronics and electromechanical systems which you may encounter in professional practice and in further subjects.
Content

The content covered is divided into sections, each of which addresses a fundamental area of electrical engineering. The intention is that, as you work your way through the subject, your learning will be cumulative. That is, the content you cover in one section should directly help you to understand the topics that follow. A weekly learning schedule, based on a recommended study sequence of the sections, is given in the Study Guide. For each of the above sections, a separate list of topics and suggested reading is also provided in the Study Guide.

Prerequisite knowledge

You are expected to have successfully completed Introduction to Electrical Engineering, Physical Modelling, and have successfully completed or are concurrently attempting Mathematical Modelling 2, or their equivalent.

Other subject information

The following information takes precedence over the default policies outlined in section 3.3.1 of the Faculty’s Student Guide.

Internet

The subject uses UTSOnline which contains the subject documentation and links to important learning aids. The URL is:

http://online.uts.edu.au

You should regularly visit and explore the web site to keep informed of any important announcements such as timetable or assessment changes.

Lectures

You should attend all the lectures. They normally occur twice a week with a one hour duration. During the lectures you will have the opportunity to meet with fellow students and with your subject coordinator who will answer questions and highlight selected topics.

Laboratories

The laboratories are structured sessions that allow you to put into practice the knowledge delivered in lectures, using specialised equipment.

Twenty-four hour access to the computing laboratories will be given to students during the semester. If you are unsure of your PIN and access arrangements, visit:

pinaccess.uts.edu.au

"In theory, there is no difference between theory and practice. But, in practice, there is, "
- Jan L.A. van de Snepscheut
Assessment

Assessment for this subject is criterion-referenced. This means that your performance is measured against a set of criteria, not against the performance of other students.

The assessment criteria for this subject

In assessing your performance we will be looking for evidence that:

- You are able to apply the laws of electrostatics and electromagnetism to physical arrangements that exhibit symmetry or to those where various simplifying assumptions can be made.
- You have understood the concepts used in analysing and designing magnetic circuits including permanent magnets, transformers, moving coils, magnetic actuators and simple machines.
- You can measure and characterize semiconductor devices in the laboratory, and perform approximate analyses of circuits involving semiconductors to verify theory with practice.
- You are able to analyse and design discrete electronic amplifiers and circuits using operational amplifiers.
- You have understood the different methods of measuring electrical quantities and can apply them in a practical setting.

Assessment tasks

The assessment tasks and their weighting are given in the Subject Outline.

Please note that Rule 2.9 of the University describes the circumstances under which the University may retain a copy of your work. You should ensure that you are familiar with this rule by visiting the following web site:


In this subject, your work may be retained for purposes of assessment, disciplinary procedures, quality and accreditation processes and related activities.

Assessment dates

All assessment dates are shown in the Study Guide.
Assessment policy and procedures

You are required to read and become familiar with the UTS Procedures for the Assessment of Coursework Subjects, and in particular Section 5.2 – which deals with completing assessment tasks and plagiarism. You may visit the following web site for the current version of the manual:


Section 5 also outlines procedures for obtaining special learning and assessment arrangements, such as extended time in tests and examinations. Normally you apply for these arrangements through the Academic Liaison Officer. A list of current Academic Liaison Officers is on the web at:


Calculators

Only non-programmable calculators are allowed for the mid-semester test and final exam. If you do not own a non-programmable calculator, you can arrange a loan of one by contacting the UTS Union.

Assessment dates

All assessment dates are shown in the Study Guide. The date of the final examination will be published in the Exam Timetable, which will be available on the UTS web site towards the end of the semester.

Enrolment

Ensure that you are enrolled in the subject before the end of Week 2:

http://www.uts.edu.au/onestop/studentadmin/

Submitting and collecting assessment items

All assessment items should be submitted directly to your tutor. If you are unable to submit them during the normal tutorial times, and your tutor is a casual tutor, then you should contact them ahead of time to discuss how the assessment item should be submitted. During the semester, all assessment items will be retained by the tutor for collection. After the end of the semester all assessment items will be retained by the subject coordinator for collection.

Please remember

- Check the subject web site regularly each week to make sure you don’t miss any important announcements about assessment items.
- Submit all assessment items on the date due as extensions are very difficult to arrange.
- Keep a copy of all assessment items you submit.
STUDY GUIDE

There are three components to completing your study of Fundamentals of Electrical Engineering. They are:

- reading the lecture notes and attempting the accompanying exercises
- reading the textbooks and attempting the set problems
- undertaking laboratories and completing the assessment tasks

To guide you through these tasks there is a Timetable.

Structure of the Timetable

The Timetable will help you manage your learning in Fundamentals of Electrical Engineering. It does so through the following design features:

- It is organised in logical, linked and digestible steps, so that where your learning is headed remains clear. Each session of the Timetable refers to:
  - A lecture in the Lecture Notes. Each lecture may have associated exercises and quizzes that should be attempted in that session.
  - Textbook sections that are required reading and textbook problems that should be attempted in that session.
  - Assessment tasks that should be started, or are due.

- The Timetable asks you, therefore, to be an active learner; not a passive reader. You should keep in mind that to achieve the necessary competence to pass this subject it is not sufficient to just read the pages of the lecture notes and textbooks a few weeks before the final exam. Apart from understanding the concepts given in the lecture notes, you also need to practice solving problems, undertake laboratories, complete assignments and tests and allow yourself sufficient time to reflect on what you have learnt.

- You can see what the learning tasks will be for each session of the Timetable before you begin. This enables you to mentally prepare for the learning tasks while you work through the session topic. In this way your learning stays focused on the main areas of the session; you don’t lose your way in the details.

"Whether you think that you can, or that you can't, you are usually right."
- Henry Ford
  (1863-1947)
The Lecture Notes

The lecture notes should be read before each session so that lectures can concentrate on particular topics of interest rather than trying to cover all the material.

Structure of the Lecture Notes

The Lecture Notes are developed through a continual process of feedback from students attempting to learn the topics presented in the textbook. Difficult or hard-to-grasp topics are expanded; or are presented in a different manner to the textbook; or highlight the real-world application of the topic. Prerequisite material is often recapped. The focus of the Lecture Notes is towards the practical application of theory, so those topics that are important to this goal are treated fairly thoroughly. The Lecture Notes are therefore a complement to the textbook, as well as a summary of the important topics.

Skim through first

If you are already familiar with the material in any section or if you want to get an overall feel for what it contains, you may like to skim through it first, looking at the headings and margin notes.

Textbooks

Textbooks are where you find the detail of the topics covered in this subject.

Prescribed textbook

The prescribed textbooks for this subject are:


Reference textbooks

The following is a list of reference textbooks that delve deeper into the topics of this subject. They may be used for alternative explanations or you may consider purchasing them to expand your library:


The Assessment Tasks

The assessment tasks are published in documents separate to the Lecture Notes. It is up to you to submit each assessment item on time. The due dates for assessment tasks are given in the Timetable.

Learning in partnership

Using a fellow student as a learning partner has been found repeatedly to be an important learning support. The idea is that you contact a fellow student, by phone or whatever means is most convenient, to discuss your interpretation of a learning task, to check if your approaches are the same and to generally clear up any confusions which may have arisen. It has been found that well over half of the concerns students experience about their learning are to do with simply checking that they are 'on the right track' and can be solved using this method. If, however, the concern or uncertainty remains, it is then recommended that you contact your subject coordinator.

Your learning plan

Your time

Organising your time is a major challenge in learning. Leaving recommended readings and assignments to the last minute is a common problem. To assist you with this challenge you may find it useful to plan your study time before you start work on this subject. First decide on the best place and time each week to study without distractions and then make sure to adhere to your own plan.

It is estimated that over a period of 14 semester weeks you should set aside a total of approximately 8 hours of study time each week. It is recommended that you break up those hours into at least two study sessions each on a different day of the week. This is a rough guide only, as people learn at different rates and from different levels of experience.

Your assessment due dates are prescribed directly on the Timetable and are highlighted.
## Timetable

<table>
<thead>
<tr>
<th></th>
<th>LECTURE</th>
<th>TEXT BOOK</th>
<th>PROBLEMS</th>
<th>LAB / TUTORIAL</th>
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| 1A  | **Electrostatics**  
Introduction. A brief history of electrostatics.  
The electric field. Potential difference.  
Paul | Ch. 2 §1-5, 8-10  
Ch. 3 § 1-7,9-10 | Paul  
2.1.1, 2.5.2, 2.8.2  
3.1.3, 3.2.4, 3.4.2, 3.5.7, 3.7.6, 3.9.1 | … | 1 2 3 | 1 2 3 |
| 2 Aug | **Electrodynamics**  
Magnets. Gauss’ Law for magnetostatics.  
[CLASS DIVIDED INTO GROUPS] | Paul | Ch. 3 § 11-13  
Ch. 4 § 1 | Paul  
3.11.2, 3.12.1  
4.1.8 | … | 1 2 3 | 1 2 3 |
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<td>9 Aug</td>
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<td>12 Aug</td>
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<tr>
<td>3A</td>
<td><em>Semiconductors</em>&lt;br&gt;Semiconductor structure. $p$-type semiconductor. $n$-type semiconductor. The $p$-$n$ junction. The $p$-$n$ junction characteristic (diode v-i characteristic). Diode models. The Hall-effect device. Breakdown diodes. The photodiode. The light emitting diode (LED). The Schottky diode. The varactor diode.</td>
<td>S&amp;S Ch. 3 § 1-4, 7</td>
<td>S&amp;S 3.2, 3.4, 3.7, 3.21, 3.33, 3.34</td>
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<td>3B</td>
<td><em>Field Mapping</em>&lt;br&gt;The method of curvilinear squares. The coaxial cable. The two conductor transmission line.</td>
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<td>4A 23 Aug</td>
<td><strong>Diode Circuits</strong>&lt;br&gt;The peak detector. The clamp circuit. The clipping circuit.</td>
<td>S&amp;S Ch. 3 § 6</td>
<td>S&amp;S 3.66, 3.67</td>
<td>L1 T T</td>
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<td>4B 26 Aug</td>
<td><strong>Magnetic Circuits</strong>&lt;br&gt;The magnetic circuit. Magnetic and electric equivalent circuits. DC excitation. AC excitation. Characteristics. Determining ( \Phi ) given ( F ). Determining ( \phi ) given ( F ) (load line). Equivalent circuit of a permanent magnet.</td>
<td>Paul Ch. 3 § 8</td>
<td>T L1 T</td>
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<tr>
<td>5A 30 Aug</td>
<td><strong>Graphical Analysis</strong>&lt;br&gt;The static characteristic. The dynamic characteristic. The transfer characteristic. Graphical analysis. The small signal diode model. The large signal diode model.</td>
<td>S&amp;S Ch. 3 § 3</td>
<td>T T L1</td>
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<td>5B 2 Sep</td>
<td><strong>Field Energy</strong>&lt;br&gt;Energy stored in the magnetic field. Electric field energy. Total field energy. Hysteresis losses. Eddy currents.</td>
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<td>6A 6 Sep</td>
<td><strong>Rectification</strong>&lt;br&gt;Full wave rectifier (FWR) circuits (centre-tapped transformer, bridge). Capacitor filter. Zener regulator.</td>
<td>S&amp;S Ch. 3 § 5</td>
<td>S&amp;S 3.53, 3.57, 3.60</td>
<td>L2 T T</td>
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<td>6B 9 Sep</td>
<td><strong>The Transformer Principle</strong>&lt;br&gt;Transformer electric and magnetic equivalent circuits. Stray capacitance. Sign convention.</td>
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<td>T L2 T</td>
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Quiz (Lec 1A–1B)  Assignment
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<td>7A</td>
<td>The MOSFET</td>
<td>S&amp;S Ch. 5 § 1-4, 7</td>
<td>S&amp;S 5.36a, 5.36b, 5.38, 5.69, 5.72</td>
<td>T T L2</td>
<td>1 2 3</td>
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<td>7B</td>
<td>Revision</td>
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<td>16 Sep</td>
<td>Lectures 1A-6B inclusive.</td>
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<td>8A</td>
<td>Tutorial Week</td>
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<td>8B</td>
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<td>Mid-Semester Test</td>
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<td>23 Sep</td>
<td>Mid-semester test.</td>
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<td>27 Sep</td>
<td>Lectures 1A-6B inclusive.</td>
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<td>NT</td>
<td>Non-Teaching Week</td>
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<td>30 Sep</td>
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<td>9A</td>
<td>Public Holiday</td>
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<td>4 Oct</td>
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<td>9B</td>
<td>The Transformer</td>
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<td>LECTURE</td>
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</table>
| 10A 11 Oct | *The MOSFET Voltage Amplifier*  
Small signal equivalent circuit. The common-source amplifier. The common drain (or source follower) amplifier. | S&S Ch. 5 § 5-6, 8 | S&S 5.48, 5.53, 5.54, 5.56, 5.59 | L3 T T | L2 |
| 10B 14 Oct | *The Force Equation*  
Force equation of singly excited electromechanical transducer. Electric field transducer. Electrostatic voltmeter. | | | T L3 T | L2 |
| 11A 18 Oct | *The Bipolar Junction Transistor*  
| 11B 21 Oct | *The Moving Coil Machine*  
Generator principle. Motor (or meter) principle. | | | L4 T T |
| 12A 25 Oct | *Frequency Response*  
The amplifier block. Voltage and current amplifiers. Maximum power transfer. The decibel (dB). Frequency response of capacitively coupled circuits. | S&S Ch. 1 § 4-6  
Ch. 8 § 1-3 | S&S 8.1, 8.25, 8.28, 8.29 | T L4 T | L3 |
| 12B 28 Oct | *Bridges and Measurements*  
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| 13A     | *The Operational Amplifier*  
The emitter-coupled differential amplifier.  
Common mode rejection ratio (CMRR). The operational amplifier. | S&S Ch. 2 § 1  
S&S Ch. 7 § 3  
S&S 2.3, 7.41, 7.51 | T T T | L3 |
| 1 Nov   |           |          |                |            |
| 13B     | *Meters*  
| 4 Nov   |           |          |                |            |
| 14A     | *Op-Amp Circuits*  
S&S Ch. 12 § 9  
S&S 2.6, 2.10, 2.13, 2.15, 2.26, 2.40, 2.42, 2.46, 2.71, 2.73, 2.76, 12.43, 12.44 | T T T | L4 |
| 8 Nov   |           |          |                |            |
| 14B     | *Revision*  
Review of subject. Final exam preview. |          | T T T | L4 |
| 11 Nov  |           |          |                |            |
| 15      | *Final Exam* |          | ... | ... |
| 16      |           |          |                |            |
| 17      |           |          |                |            |

Key:  
T – tutorial  
L1 – Inductance  
L2 – Diode Circuits  
L3 – Transformer  
L4 – MOSFET Amplifier  

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