

# ELEC 4603 – Solid State Electronics

## SESSION 1 – 2009

### GENERAL COURSE INFORMATION AND ASSESSMENT CRITERIA

<b>Lecturer-in-Charge:</b>	Prof. Andrew Dzurak Centre for Quantum Computer Technology Level 2, Newton Building
<b>Teaching Assistant:</b>	Kok Wai Chan (kokwai@student.unsw.edu.au)
<b>Laboratory Demonstrators / Tutors:</b>	Graeme Lowe (graeme.lowe@student.unsw.edu.au)

#### 1. AIMS AND SCOPE

Solid State Electronics follows directly from Analogue Electronics in the electronics series. The latter focused primarily on the idealised linear amplifier and common non-linear applications. In this course, we turn our attention to those aspects of electronics circuits that require a more fundamental understanding of the devices found in a variety of different circuits, and the non-idealities encountered therein. A wide range of important applications rely on such an understanding. These applications can be broadly grouped as digital circuits, high-speed applications and power applications.

In addition to these areas, Solid State Electronics also explores devices besides just the diode, bjt and mosfet covered at a 'black-box' level in earlier courses such as Analogue Electronics. Solid State Electronics covers the operation and use of high-speed transistors structures, light-emitting devices (including both the led and the laser) and other advanced electronic devices.

This subject endeavours to teach students not only just how these electronic devices operate, but also develop some insight into the underlying solid-state physics. The topics to be covered include the following:

- basic semiconductor physics
- the p-n junction
- bipolar junction transistors
- field effect transistors
- optoelectronic devices
- photovoltaic cells
- basic semiconductor fabrication techniques

## 2. PREREQUISITES

The prerequisite for Solid State Electronics is ELEC2133 (Analogue Electronics). It will be assumed that students have mastered this subject. Students are strongly advised to revise any unfamiliar topics in their own time.

## 3. TEXTBOOK AND REFERENCES

The textbook set for this course is:

**Muller & Kamins, *Device Electronics for Integrated Circuits*, 3<sup>rd</sup> ed., Wiley, 2003  
- P621.3815/308 (UNSW Library)**

An alternative textbook, which covers much of the same material, but with greater emphasis on semiconductor fabrication, is:

**S. M. Sze, *Semiconductor Devices: Physics and Technology*, 2<sup>nd</sup> ed., Wiley, 2002  
- P621.38152/120 (UNSW Library)**

In addition to the textbooks which combine the semiconductor devices and electronics, other reference books include semiconductor device textbooks and electronic circuit textbooks. For semiconductor devices, a series of books which covers operation of devices in a clear, readable manner with many good analogies and explanations is *The Modular Series on Solid State Devices* edited by R.F. Pierret and G.W. Nuedeck. Each volume is short, covering a specific topic only. The volumes of interest are I, II, III and IV. Although the material is covered at a basic level, the treatment is very complete and, consequently, for this course, not all sections are relevant.

The material covered by textbooks dealing exclusively with electronics circuits has remained relatively unchanged over many years and consequently there are many well-polished textbooks. Three of the more popular ones are listed below. Of the three, Millman & Grabel has a more theoretical and complete approach, particularly for feedback and frequency response. Sedra & Smith has the best coverage of device fabrication. Burns & Bond approaches electronic circuits from a semiconductor physics perspective and was formerly the textbook for this course. All three textbooks have some coverage of digital circuits.

Sedra & Smith, *Microelectronic Circuits*, 4<sup>th</sup> ed., Oxford University Press, 1998.

Millman & Grabel, *Microelectronics*, McGrawHill, 2<sup>nd</sup> ed., NY.

Burns & Bond, *Principles of Electronic Circuits*, PWS, 2<sup>nd</sup> ed., 1997.

Finally, for those interested in designing and building realistic functioning circuits, a variety of books exists which give examples of many types of circuits. Several such books exist, but a well-respected and popular anthology of circuits with many useful practical tips is *The Art of Electronics*.

Horowitz & Hill, *The Art of Electronics*, 2<sup>nd</sup> ed., Cambridge University Press, 1989.

## 4. ASSESSMENTS

Assessments in this subject will be based on the following scheme:

Laboratory (2 experiments)	20%
Assignments (2)	10%
Final Examination	70%

You must pass both the laboratory component and the exam component to attain an overall pass in the course.

## 5. THE COURSE WEBSITE

The course WebCT site will be the primary point of contact, for administrative matters, with the student. Any important announcements will be placed on the Announcements page, which the student is obliged to check regularly. Lecture notes, tutorial questions and laboratory notes will also be progressively made available for download on this site. All enrolled students should have access to the ELEC4603 Solid State Electronics WebCT site, which may be accessed at:

<http://elearning.unsw.edu.au>

## 6. COMMUNICATING WITH STUDENTS

The university's official means of communicating with students is via their student e-mail account at [zXXXXXXX@student.unsw.edu.au](mailto:zXXXXXXX@student.unsw.edu.au), where XXXXXXX is your student number. All students must check this e-mail account on a regular basis.

## 7. CONTACT INFORMATION

All queries or concerns about this course should be directed, in the first instance, to the Teaching Assistant Kok Wai via the course WebCT Vista page or unimail contact.

## 8. TUTORIALS AND ASSIGNMENTS

Tutorials will commence on the **third week** of term. These tutorials will be used to discuss the tutorial questions, which will be posted on the WebCT course website. You need only attend one tutorial each fortnight.

There will be two compulsory written **assignments**. It is expected that the students complete assignments on their own. **Students found guilty of academic misconduct, including excessive collaboration, copying another's assignment, or allowing one's assignment to be copied by another student, will not receive any marks for that assignment.** In addition, a more severe penalty may be imposed.

## 9. LABORATORY WORK

Electronics is very much an experiment-oriented subject. Successful practical implementation of designs and effective reporting of results are of crucial importance in developing your skills as a competent electronics engineer.

The experimental component of this course is complementary to the lectures. In it, students will have the opportunity to gain experience with the use of optoelectronic devices, as well as to characterise the dc parameters of a bjt and a mosfet, and explore their high-frequency properties.

**A pass grade in all laboratory experiments is required to pass this course overall.** All of the experiments are compulsory and are worth, in total, 20%.

**The preliminary preparation for each laboratory experiment consists in reading through the laboratory notes and familiarising yourself with the concepts involved. Ensure that you understand what each experiment is about before the relevant laboratory session.**

Keeping systematic notes is an important aspect of experimental technique. Your laboratory notebooks should be the primary record of your design and calculations and results of your experiments. The preliminary preparation should be done in the laboratory notebook. Results, measurement and observations should be recorded directly into the notebook as they are gathered (and not on loose scraps of paper). Except when drawing circuits and waveforms, pen must be used rather than pencil. There is no need to do a 'draft' and then a 'good copy' — this merely wastes time.

The notes for laboratory experiments may be downloaded from the course web-site. The experiments are:

- |  |                 |
|--|-----------------|
| Exp 1. <b>Fibre-Optic Communication</b>                        | (2 lab periods) |
| Exp 2. <b>Characterisation of Bjt and Mosfet DC Parameters</b> | (3 lab periods) |

Laboratory sessions are scheduled every alternate week, i.e., you attend a laboratory period every odd week or every even week, depending on your lab allocation. Lab classes with section ending in E are scheduled for even weeks, and those with section ending in D are scheduled for odd weeks. Laboratory work officially commences in **week 2** (even week) of session, with the **E**-groups.

Please take careful note of the **laboratory experiment completion deadlines**.

### 9.1 LABORATORY ARRANGEMENT

Each student will be allocated a bench number. It is essential that students conduct their experiment at the allocated bench position; otherwise they will be marked absent.

You are expected to work on the experiment **on your own** and copying is an infringement of university examination regulations. Discussion on experimental work is encouraged, but over zealous assistance should be avoided.

## 9.2 ASSESSMENT OF LABORATORY WORK

- (i) All preliminary preparation, results of experimental measurements and discussion of results **must be neatly recorded** in a laboratory book. **Work presented in loose sheets will NOT be marked.**
- (ii) **Assessment of your work will be conducted orally.** It is the student's responsibility to organise the documentation of his laboratory work in a fashion that shows his/her understanding and achievements. During the oral examination, **students are expected to demonstrate the operation of their circuit.** Do not dismantle the circuit until you have received a written clearance in your laboratory note book that the assessment is complete.
- (iii) Each experiment will be marked out of **20 points.**
- (iv) Marking will only be done during the laboratory period by the demonstrators present. It is the responsibility of the students to make sure that his/her mark is recorded by the demonstrator. Experiments will only be marked during a student's assigned lab time. Do not attend another lab group to get marked unless permission has been given by a demonstrator.

## 9.3 DEADLINE FOR MARKING OF LABORATORY WORK

The laboratory experiments for this subject have to be completed and marked by the following dates.

Exp 1. 2 <sup>nd</sup> laboratory class	(week 4/5)
Exp 2. 5 <sup>th</sup> laboratory class	(week 10/11)

Each laboratory experiment is worth 20 points. If you are **late by less than 1 week, 5 points** will be deducted. A further **5 points** will be deducted for each additional week late. Even if you have no points left, **you must still satisfactorily complete the laboratory work to pass the course.** Note that the deadlines merely represent the last day an experiment can be marked without penalty.