Photovoltaic and Renewable Energy Engineering

Course Outline

Term 1 2021

SOLA2060

INTRODUCTION TO ELECTRONIC DEVICES

Contents

1. Staff contact details

Contact details and consultation times for course convenor

Name: A/Prof Stephen Bremner
Office location: Room 217 Tyree Energy Technologies Building
Tel: (02) 9385 7890 (this goes through MS Teams)
Email: spbremner@unsw.edu.au

Consultation hours will be decided by a poll conducted in the first week.
You are encouraged to ask questions after class or post your questions on the Discussion Board on Moodle or through MS Teams.

Contact details for tutors

Kai Yuen Chan kai-yuen.chan@unsw.edu.au
Muhammad Umair Khan muhammadumair.khan@student.unsw.edu.au

All course material and announcements will be posted on Moodle. Please note that you will be deemed to have received this information, so you should take careful note of all announcements. You can also confirm through your tutor on MS Teams.

2. Important links

- Moodle
- Health and Safety
- Student Resources
- UNSW Timetable
- UNSW Handbook
- Engineering Student Support Services Centre
- UNSW Photovoltaic and Renewable Energy Engineering

3. Course details

Credit points

This is a 6 unit-of-credit (UoC) course and involves 5 hours per week (h/w) of face-to-face contact.
The normal workload expectations of a student are approximately 25 hours per term for each UOC, including class contact hours, other learning activities, preparation and time spent on all assessable work.
You should aim to spend about 10-12 h/w on this course. The additional time should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

Contact hours

	Day	Time	Location
Lectures	Monday	10-11 am	Online (MS Teams)
	Tuesday	9-11 am	Online (MS Teams)
Tutorials	Tuesday	12 – 2 pm	Law Building 276
	Tuesday	2 -4 pm	Online (MS Teams)
Lab (weeks 3,7,9)*	Same as tutorial	Same as tutorial	TETB LG10

Please refer to your class timetable for the learning activities you are enrolled in and attend only those classes.
* The labs will most likely be simulation based, to make the assessment items the same for all enrolled students.

Summary and Aims of the course

This subject will cover a broad range of topics including semiconductor materials, p-n junctions, diodes, solar cells, field effect transistors, light emitting diodes and bipolar junction transistors. Circuit applications will include basic circuit topologies that illustrate key operating characteristics of electronic devices.

The aim of this course is to help students understand the principles and operation of fundamental electronic devices, in particular, those relevant to Renewable Energy applications.
Learning outcomes
After successful completion of this course, you should be able to:
1. Explain the key physical characteristics of semiconductors and the principles behind fundamental structures like *pn* junctions.
2. Explain the operation of common semiconductor devices.
3. Build and evaluate circuits consisting of electronic components including diodes and transistors.

This course is designed to achieve the above learning outcomes which address the specific UNSW and Faculty of Engineering graduate capabilities listed below. This course also addresses the Engineers Australia (National Accreditation Body) Stage I competency standard as outlined below.

Pre-requisites and Assumed Knowledge
It is assumed that students enrolled in this course are familiar with electrical circuits, solid state and semiconductor physics at a level of PHYS1231. It is also assumed that you can competently use Microsoft Excel (or equivalent software) for data manipulation and graphing.
Following Courses

SOLA2060 is a pre-requisite for SOLA3507 Solar Cells and SOLA5055 Semiconductor Devices.

Relationship to Other Courses

SOLA2060 is a core course for BE (Honours) Photovoltaic and Solar Energy (SOLAAH3707) and BE (Honours) Renewable Energy (SOLABH3707) Streams.

Student learning outcomes

This course is designed to address the learning outcomes below and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown. The full list of Stage 1 Competency Standards may be found in Appendix A.

After successfully completing this course, you should be able to:

Learning Outcome		**EA Stage 1 Competencies**
1.	Calculate key parameters for semiconductors and fundamental structures like *pn* junctions.	PE1.1, PE1.3, PE2.1, PE2.2, PE3.3
2.	Explain the operation of common semiconductor devices and calculate key parameters for these devices.	PE1.1, PE1.3, PE1.5, PE2.1, PE2.2, PE2.3, PE3.2, PE3.3, PE3.6
3.	Build and analyse circuits consisting of electronic components including diodes and transistors.	PE1.1, PE1.3, PE1.5, PE2.1, PE2.2, PE3.2

4. Teaching strategies

Delivery Mode

The teaching strategy for this course comprises a series of lectures and tutorial sessions. Three hours of lectures per week will introduce theory, worked examples and case studies. The plan is to pre-record the lectures for you to watch at a convenient time prior to meeting at the allotted times for discussion of questions that you as a learning group may have with the content covered. Tutorial problems will allow you to practice solving problems related to each topic and develop skills needed for the in-class tests, lab assignments and the final exam. During some weeks, tutorials will be used to go through the problem sets for each topic (see the course schedule for details). In some weeks, you will work on lab or simulation projects, which will help you to develop practical skills related to assembling and evaluating electronic circuits. The course contains a significant component of self-learning through the experience gained by doing the lab or simulation projects.

Learning in this course

You are expected to attend all lectures, tutorials and labs in order to maximise learning. You will need to complete pre-work for each of your tutorial and lab classes. In addition to the lecture notes and recordings, you will be expected to read relevant texts as required. Group learning is encouraged, but any submitted work must be solely yours, as according to

Student Responsibilities and Conduct. UNSW assumes that self-directed study of this kind is undertaken in addition to attending face-to-face classes throughout the course.

5. Course schedule

Week	Week starting	Lecture Topic	Tutorial/Lab
1	15 Feb	Introduction/Basic Electronics Concepts /Intro to semiconductors	
2	22 Feb	Transport/Generation Recombination in semiconductors	Tutorial
3	1 Mar	The pn junction	Laboratory (LG10)
4	8 Mar	Diodes and their applications	Tutorial
5	15 Mar	Optolectronic devices: LEDs, laser diodes, photodetectors, solar cells (Quiz 1)	Tutorial
6	22 Mar	Revision	Revision
7	29 Mar	Bipolar Junction Transistors: operation and circuits	Laboratory (LG10)
8	5 Apr	Op amps: operation and circuits	Tutorial
9	12 Apr	MOSFETs: operation and circuits	Laboratory (LG10)
10	19 Apr	DC-DC converters (Quiz 2)	Tutorial
11	26 Apr	Review	Extra Lab/Tutorial

6. Assessment

Assessment overview

Assessment	Group Project?	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
Quizzes	No	50 minutes	25%	1,2, and 3	Topics assessed from weeks 1-4, weeks 6-9.	Exam	N/A	1 week at most
Lab Reports	No	About 5 pages	25%	1,2, and 3	Material covered in class relevant to laboratory exercise.	During week 4, 8 and 10	N/A	2 weeks at most
Final exam	No	2 hours	50%	1, 2 and 3	All course content from weeks 1-10 inclusive.	Exam period, date TBC	N/A	Upon release of final results

Assignments

Quizzes (Total 25%)
There will be two tests based on material covered in the lectures and tutorial questions from the previous topics. Given the constraints in place these will most likely be online in nature. You will be given details in class.

Lab Reports (Total 25%)
In weeks 3, 7, and 9, (see the schedule) you will either work in groups on the three lab projects or as individuals on simulation projects. The laboratory projects are designed to give you an opportunity to apply what you have covered in the lectures and tutorials to practical problems relating to electronic devices. The simulation labs will use LTSpice to analyse simple circuits using devices covered. You will need to write a report for each lab (real or simulation), presenting the data acquired and answering some specific questions. The reports must be submitted on-line via Moodle by the stated due dates. Reports submitted after results have been released will not be marked.

Final Exam (Total 50%)
The exam in this course will be an online 2 hour written examination. The examination tests analytical and critical thinking and general understanding of the course material in a controlled fashion. Questions may be drawn from any aspect of the course (including the lab projects), unless specifically indicated otherwise by the lecturer. Marks will be assigned according to the correctness of the responses. More details on the conduct of the examination will be released during the course.

Presentation

All submissions are expected to be neat and clearly set out. Your results are the pinnacle of all your hard work and should be treated with due respect. Presenting results clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect.

Submission

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of 20 percent (20%) of the maximum mark possible for that assessment item, per calendar day.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day.

Work submitted after the 'deadline for absolute fail' is not accepted and a mark of zero will be awarded for that assessment item.

For some assessment items, a late penalty may not be appropriate. These are clearly indicated in the course outline, and such assessments receive a mark of zero if not completed by the specified date. Examples include:

a. Weekly online tests or laboratory work worth a small proportion of the subject mark, or
b. Online quizzes where answers are released to students on completion, or
c. Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date, or
d. Pass/Fail assessment tasks.

Marking

Marking guidelines for assignment submissions will be provided at the same time as assignment details to assist with meeting assessable requirements. Submissions will be marked according to the marking guidelines provided.

Examinations

You must be available for all quizzes, tests and examinations.

Final examinations for each course are held during the University examination periods: February for Summer Term, May for T1, August for T2, and November/December for T3.

Please visit myUNSW for Provisional Examination timetable publish dates.

For further information on exams, please see the Exams webpage.

Calculators

You will need to provide your own calculator of a make and model approved by UNSW for the examinations. The list of approved calculators is available at student.unsw.edu.au/exam-approved-calculators-and-computers

It is your responsibility to ensure that your calculator is of an approved make and model, and to obtain an "Approved" sticker for it from the Engineering Student Supper Services Centre prior to the examination. Calculators not bearing an "Approved" sticker will not be allowed into the examination room.

Special consideration and supplementary assessment

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to submitting an assessment or sitting an exam.

Please note that UNSW now has a Fit to Sit / Submit rule, which means that if you sit an exam or submit a piece of assessment, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

7. Expected resources for students

There are loads of texts in the library that deal with semiconductor devices and how they operate. Below are some recommendations, but you should also have a look there for a text that appeals to your way of learning.

Recommended Texts:
B.G. Streetman, S.K. Banerjee, Solid State Electronic Devices, Sixth Edition, Prentice Hall

Other recommended books
M.A. Green, Solar Cells- Operating Principles, Technology and System Applications, The University New South Wales. (Good for pn junction and solar cell basics).

A.R. Hambley, Electrical Engineering: Principles and Applications, Fourth Edition, Pearson.

A.S. Sedra and K.C. Smith, Microelectronic Circuits, Sixth Edition, Oxford University Press, 2011. (Good for mathematical based circuit analysis).

Horowitz and Hill, Art of Electronics, Any edition, Cambridge University Press. (Good for understanding electronic concepts and circuit operation, light on the maths)

Software
LTSpice: Circuit simulator. Can be downloaded from

http://www.linear.com/designtools/software/#LTspice.

On-line Resources
Moodle: As a part of the teaching component, Moodle will be used to disseminate teaching materials, host fora and occasionally practice quizzes. Announcements concerning course information will be given in the lectures and/or on Moodle. Assessment marks will also be made available via Moodle: https://moodle.telt.unsw.edu.au/login/index.php.
MS Teams: Most of the active content will be run through Teams. Tutorials will be grouped around your allotted time. Lectures will take place through Teams. Lecture recordings will also be available in Teams.

UNSW Library website: https://www.library.unsw.edu.au/

8. Course evaluation and development

Feedback on the course is gathered periodically using various means, including the UNSW myExperience process, informal discussion in the final class for the course, and the School's Student/Staff meetings. Your feedback is taken seriously, and continual improvements are made to the course based, in part, on such feedback.

In this course, recent improvements resulting from student feedback include emphasising the circuit analysis aspects as well as the laboratory exercises.

9. Academic honesty and plagiarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism, visit: student.unsw.edu.au/plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

If plagiarism is found in your work when you are in first year, your lecturer will offer you assistance to improve your academic skills. They may ask you to look at some online resources, attend the Learning Centre, or sometimes resubmit your work with the problem fixed. However more serious instances in first year, such as stealing another student's work

or paying someone to do your work, may be investigated under the Student Misconduct Procedures.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis) even suspension from the university. The Student Misconduct Procedures are available here: www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

10. Administrative matters and links

All students are expected to read and be familiar with UNSW guidelines and polices. In particular, students should be familiar with the following:

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Equitable Learning Services

Appendix A: Engineers Australia (EA) Competencies

Stage 1 Competencies for Professional Engineers

	Program Intended Learning Outcomes
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing
	PE1.3 In-depth understanding of specialist bodies of knowledge
	PE1.4 Discernment of knowledge development and research directions
	PE1.5 Knowledge of engineering design practice
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice
PE2: Engineering Application Ability	PE2.1 Application of established engineering methods to complex problem solving
	PE2.2 Fluent application of engineering techniques, tools and resources
	PE2.3 Application of systematic engineering synthesis and design processes
	PE2.4 Application of systematic approaches to the conduct and management of engineering projects
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability
	PE3.2 Effective oral and written communication (professional and lay domains)
	PE3.3 Creative, innovative and pro-active demeanour
	PE3.4 Professional use and management of information
	PE3.5 Orderly management of self, and professional conduct
	PE3.6 Effective team membership and team leadership