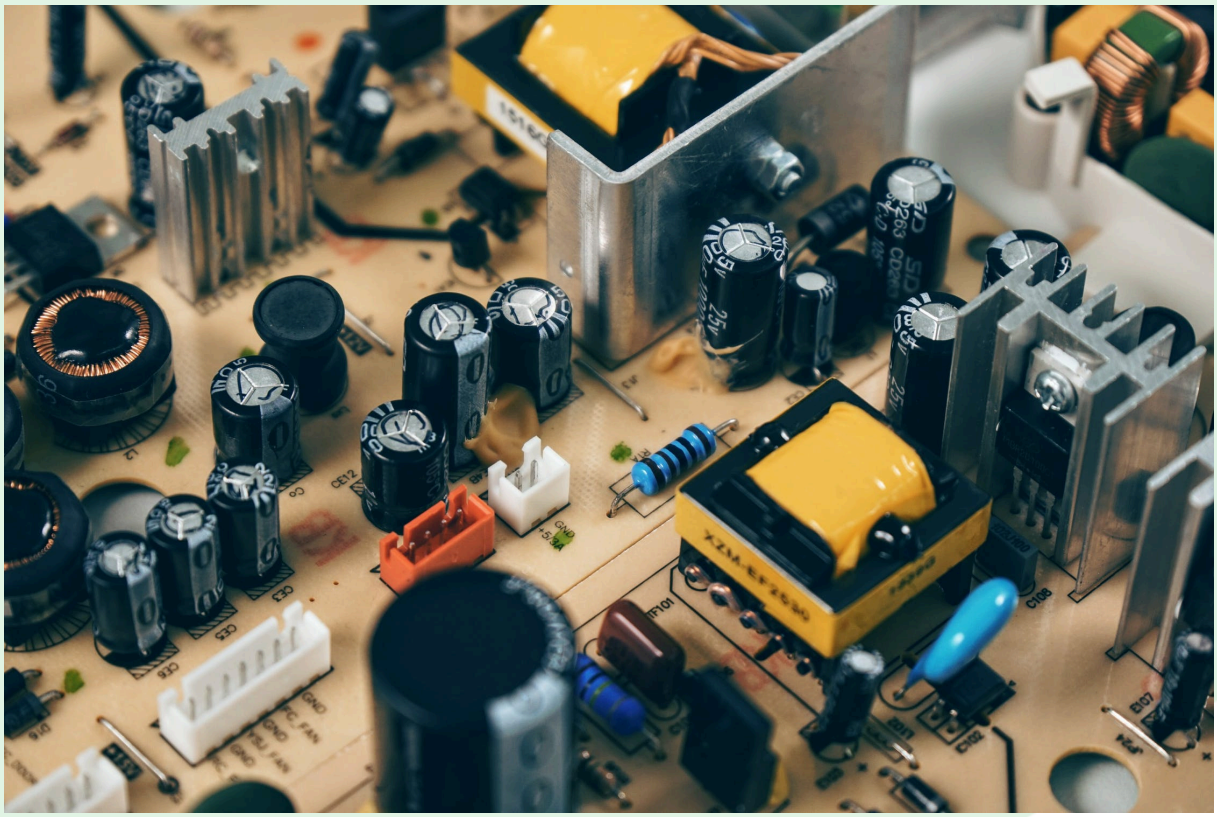
School of Photovoltaic and Renewable Energy Engineering

UNSW Engineering

SOLA2060

Introduction to Electronic Devices

Term 1, 2022



Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Stephen Bremner	spbremner@unsw.edu.au	To be advised	TETB 217	57890

Demonstrators

Name	Email	Availability	Location	Phone
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School Contact Information

School of Photovoltaic and Renewable Energy Engineering

Email: spreeteaching@unsw.edu.au

Course Details

Units of Credit 6

Summary of the Course

Fundamentals of the operation and applications of a range of important semiconductor devices. Material covered includes basic semiconductor properties, pn junction theory, as well as the operating principles of bipolar junction transistors, Schottky diodes, MOSFETs, solar cells, and other optoelectronic devices. Circuits relevant to renewable energy applications that incorporate these devices are introduced and analysed.

Course Aims

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 op-amps.

Circuit applications will include basic circuit topologies that illustrate key operating characteristics of electronic devices and circuit principles critical for renewable enegry applications.

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.

Course Learning Outcomes

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 of pn junctions.	PE1.1, PE1.3
2. Explain the operation of common semiconductor devices and calculate key parameters of these devices.	PE1.1, PE1.3
3. Build and analyse circuits consisting of electronic components including diodes and transistors.	PE1.3, PE1.5

Teaching Strategies

The teaching strategy for this course comprises a series of lectures and workshop sessions. Three hours of lectures per week will introduce theory, worked examples and case studies. The plan is for you to watch pre-recorded lectures at a convenient time prior to meeting at the allotted times for discussion of questions that you, as a learning group, may have with respect to the content covered. Workshop 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, workshops 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.

Additional Course Information

You are expected to attend all lectures, workshops and labs in order to maximise learning. You will need to complete pre-work for each of your workshops 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.

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Quizzes	25%	Week 5,10	1, 2
2. Reports	25%	Week 5,8,10	1, 2
3. Final Exam	50%	To be confirmed	1, 2

Assessment 1: Quizzes

Assessment length: 1 hour each
Due date: Week 5,10

In class quizzes will be run during the term to assess understanding of material and allow students to gauge their understanding. There will be two quizzes during the term and are worth 25% of final mark in total.

Students will complete a practice quiz in week 4 to gauge student progress.

Assessment criteria

Please see Moodle Site for Assessment Criteria during term.

Assessment 2: Reports

Due date: Week 5,8,10

There will be three assignments associated with three simulation projects, each with a report to be submitted. The projects will be a series of in-depth problems related to the material covered in class. Students will be expected to find additional material to help explain the results from simulations and present in the submitted reports. The three assignments are worth 25% of final grade.

Assessment criteria

Please see Moodle site for Assessment Criteria during term.

Assessment 3: Final Exam

Assessment length: 2 hours
Due date: To be confirmed

A two hour final exam drawn mostly from workshop problems and assignments will be held in the University exam period. More information will be provided during the term on the structure of the exam.

Assessment criteria

Please see Moodel site for Assessment Criteria during term.

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

Course Schedule

Lectures Tuesday 10 - 11 am, Wednesday 9 - 11 am

Workshops Tuesday 11 am - 1 pm, Tuesday 2 - 4 pm

View class timetable

Timetable

Date	Type	Content
Week 1: 14 February - 18 February	Lecture	Introduction to Semiconductors
Week 2: 21 February - 25 February	Lecture	Carriers in Semiconductors
	Workshop	Problem Set 1
Week 3: 28 February - 4 March	Lecture	PN junctions
	Workshop	LTSpice Simulation Assignment 1 / Problem Set 1
Week 4: 7 March - 11 March	Lecture	Optoelectronic PN junction devices
	Workshop	Problem Set 1
Week 5: 14 March - 18 March	Lecture	Diode Circuit Applications
	Workshop	Problem Set 2
	Assessment	In class Quiz 1
Week 6: 21 March - 25 March	Homework	Review Week (UNSW Flexibility Week)
Week 7: 28 March - 1 April	Lecture	MOSFETs
	Workshop	LTSpice Simulation Assignment 2 / Problem Set 2
Week 8: 4 April - 8 April	Lecture	Op Amps
	Workshop	Problem Set 2
Week 9: 11 April - 15 April	Lecture	Renewable Energy Applications
	Workshop	LTSpice Simulation Assignment 3 / Problem Set 3
Week 10: 18 April - 22 April	Lecture	Renewable Energy Applications

	Workshop	Problem Set 3
	Assessment	In class Quiz 2
Study Week: 25 April - 28 April	Online Activity	Revision for final exam if requested

Resources

Prescribed Resources

Recommended Texts:

B.G. Streetman, S.K. Banerjee, Solid State Electronic Devices, Sixth Edition, Prentice Hall (Good for pn junction explanations as well as MOSFETs)

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

Software

LTSpice: Circuit simulator. Can be downloaded from http://www.linear.com/designtools/software/#LTspice. Veryuseful to learn how to use!

Recommended Resources

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.

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

Helpful for semiconductors and pn junctions

https://www.pveducation.org/ some nice animations

There are actually lots of websites that go through semiconductor devices.

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 modifications resulting from student feedback include emphasising the circuit analysis aspects and a greater emphasis on converter circuits..

Laboratory Workshop Information

There are no physical labs planned for this subject. Assignments will be computer simulation based (LTSpice) and will look at diodes, MOSFETs, and some key circuits for RE applications.

Submission of Assessment Tasks

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of 5% mark reduction per day, consistent with other SPREE courses, and capped at 5 days (120 hours), after which a student cannot submit an assessment.

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.

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

Academic Information

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.

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

Image Credit

Image taken from https://www.pexels.com/search/circuit/

CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	✓
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	✓
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	✓
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering 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	
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	
PE3.2 Effective oral and written communication in 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	