SOLA2060
Introduction to Electronic Devices

Course Outline - Semester 1, 2019

Never Stand Still | Engineering | School of Photovoltaic and Renewable Energy Engineering

Course Staff

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Consultations: For all enquiries about the course please contact the course convener. A regular weekly consultation will be decided in Week 1. You are encouraged to ask questions after class or post your questions on the Discussion Board on Moodle.

Keeping Informed: 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.

Course Details

Credits

This is a 6 UOC course with typically 5 hours of class per week, and so the expected workload is 10–12 hours per week throughout the 10/11 week trimester.

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.

Context and 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 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 in ***Appendix A***. This course also addresses the Engineers Australia (National Accreditation Body) Stage I competency standard as outlined in ***Appendix B***.

Syllabus

This course covers a wide range of material, looking at a range of semiconductor devices, and their applications. The first section of the course looks in depth at semiconductor materials, carrier transport, and p-n junctions, which enable you to explain the behaviour of p-n junction and their application as light emitting diodes and solar cells. The course also covers bipolar junction transistors, field effect transistors, metal-semiconductor junctions and metal-insulator-semiconductor junctions.

Indicative Lecture and Tutorial Schedule (Subject to change)

Week	Week starting	Lecture Topic	Tutorial/Lab
1	18 Feb	Introduction/Basic Electronics Concepts /Intro to semiconductors	
2	25 Feb	Transport/Generation Recombination in semiconductors	Tutorial
3	4 Mar	The pn junction: thermal equilibrium	Laboratory (LG10)
4	11 Mar	The pn junction: forward vs reverse bias	Tutorial
5	18 Mar	Diodes and their applications (Quiz 1)	Tutorial
6	25 Apr	Optolectronic devices: LEDs, laser diodes, photodetectors, solar cells	Laboratory (LG10)
7	1 Apr	Bipolar Junction Transistors: operation and circuits	Tutorial
8	8 Apr	Metal-semiconductor junctions, Metal-Insulator Junctions	Tutorial
9	15 Apr	MOSFETs: operation and circuits	Laboratory (LG10)

10	22 Apr	(Quiz 2)	Tutorial
11	29 Apr	Review	Laboratory (if needed)

Contact Hours

The course consists of 2 hours of lectures and 2 hours of tutorial class each week as listed below.

	Day	Time	Location
Lectures	Tuesday Thursday Tuesday (wk 11 only)	3 - 4 pm 3 – 5 pm 3 – 5 pm	Law Theatre G02 Ainsworth 102 Ainsworth 102
Tutorials	Tuesday	4 - 6 pm	Blockhouse G6
	Wednesday	2 – 4 pm	Ainsworth G01
	Wednesday	4 – 6 pm	Squarehouse 114
Note: In some weeks, labs will run (in TETB LG10) instead of tutorial class, see the class schedule above.			

Assessment

Assessment	Percentage of Total Mark	Date Due
Lab reports	25%	TBA
Quizzes	25%	TBA
Final Exam	50%	TBA

The assessment scheme in this course reflects the intention to assess your learning progress through the semester.

Lab Reports (Total 25%)

In some weeks (see the schedule) you will work in groups on the two lab 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. You will need to write a report for each lab, presenting the data acquired by your group and answering some specific questions. The reports must be submitted on-line via Moodle by the due date. Late reports will attract an immediate penalty of 50%, then an additional 10% per day (including weekends). Reports submitted after results have been released will not be marked.

Quizzes (Total 25%)

There will be two in-class tests based on material covered in the lectures and tutorial questions from the previous topics. These will take place in the Tuesday lecture time and will take place under normal exam conditions.
Online quizzes designed to test analytical and critical thinking and general understanding of the course materials will be available to give an idea of the type of material that will be tested. One of these will be a no-marks online quiz in Week 3 to test the concepts covered in class up to that point in order to give you feedback on your progress.

Final Exam (Total 50%)

The exam in this course is a standard closed-book 2 hour written examination. University approved calculators are allowed. 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.

Relationship of Assessment Methods to Learning Outcomes

	Learning Outcomes		
Assessment	**1**	**2**	**3**
Lab reports	✓	✓	✓
Quizzes	✓	✓	✓
Final Exam	✓	✓	✓

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. 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 other weeks, you will work on lab 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 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, 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.

Course Resources

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.

Other Matters

Academic Honesty and Plagiarism

Plagiarism is the unacknowledged use of other people's work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a form of academic misconduct, and the University has very strict rules that include some severe penalties. For UNSW policies, penalties and information to help you avoid plagiarism, see https://student.unsw.edu.au/plagiarism. To find out if you understand plagiarism correctly, try this short quiz: https://student.unsw.edu.au/plagiarism-quiz.

Student Responsibilities and Conduct

Students are expected to be familiar with and adhere to all UNSW policies (see https://student.unsw.edu.au/guide), and particular attention is drawn to the following:

Workload

It is expected that you will spend at least ten to twelve hours per week studying a 6 UoC course, from Week 1 until the final assessment, including both face-to-face classes and independent, self-directed study. In periods where you need to complete assignments or prepare for examinations, the workload may be greater. Over-commitment has been a common source of failure for many students. You should take the required workload into account when planning how to balance study with employment and other activities.

Attendance

Regular and punctual attendance at all classes is expected. UNSW regulations state that if students attend less than 80% of scheduled classes they may be refused final assessment.

General Conduct and Behaviour

Consideration and respect for the needs of your fellow students and teaching staff is an expectation. Conduct which unduly disrupts or interferes with a class is not acceptable and students may be asked to leave the class.

Work Health and Safety

UNSW policy requires each person to work safely and responsibly, in order to avoid personal injury and to protect the safety of others.

Special Consideration and Supplementary Examinations

You must submit all assignments and attend all examinations scheduled for your course. You should seek assistance early if you suffer illness or misadventure which affects your course progress. All applications for special consideration must be lodged online through myUNSW within 3 working days of the assessment, not to course or school staff. For more detail, consult https://student.unsw.edu.au/special-consideration.

Continual Course Improvement

This course is under constant revision in order to improve the learning outcomes for all students. Please forward any feedback (positive or negative) on the course to the course convener or via UNSW myExperience. You can also provide feedback to RESOC who will raise your concerns at student focus group meetings. As a result of previous feedback obtained for this course and in our efforts to provide a rich and meaningful learning experience, we have continued to evaluate and modify our delivery and assessment methods. For example, labs have been updated to remove non-essential components and consultation hours have been extended. In addition, new labs have been introduced.

Administrative Matters

On issues and procedures regarding such matters as special needs, equity and diversity, occupational health and safety, enrolment, rights, and general expectations of students, please refer to the School and UNSW policies:
http://www.engineering.unsw.edu.au/electrical-engineering/policies-and-procedures
https://my.unsw.edu.au/student/atoz/ABC.html

Appendix A: UNSW Graduate Capabilities

The course delivery methods and course content directly or indirectly addresses following UNSW graduate capabilities:

a) Scholars capable of independent and collaborative enquiry, rigorous in their analysis, critique and reflection, and able to innovate by applying their knowledge and skills to the solution of novel as well as routine problems;
b) Entrepreneurial leaders capable of initiating and embracing innovation and change, as well as engaging and enabling others to contribute to change;
c) Professionals capable of ethical, self- directed practice and independent lifelong learning;
d) Global citizens who are culturally adept and capable of respecting diversity and acting in a socially just and responsible way.

Appendix B: Engineers Australia (EA) Professional Engineer Competency Standard

	Program Intended Learning Outcomes		Relevant LO
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals	✓	LO1, LO2, LO3
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing		
	PE1.3 In-depth understanding of specialist bodies of knowledge	✓	LO1, LO2, LO3
	PE1.4 Discernment of knowledge development and research directions		
	PE1.5 Knowledge of engineering design practice	✓	LO2, LO3
	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	✓	LO1, LO2, LO3
	PE2.2 Fluent application of engineering techniques, tools and resources	✓	LO1, LO2, LO3
	PE2.3 Application of systematic engineering synthesis and design processes	✓	LO2
	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)	✓	LO1, LO2, LO3
	PE3.3 Creative, innovative and pro-active demeanour	✓	LO2
	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	✓	LO2