SOLA3507

Solar Cells

Term 1, 2022

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Fiacre Rougieux	fiacre.rougieux@unsw.edu.au	After lectures	TETB 104	0437115868

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

In this course, students will gain both a fundamental and practical understanding of the design and operation of solar cells. The course will enable the student to extend their knowledge of semiconductor device and provide a sound basis for a deep understanding of current solar cell technologies. Key practical processes such as solid state diffusion, gettering and device contacting are introduced. A range of laboratory-based and commercial solar cell technologies are reviewed together with recent technological advances in the field. The course makes use of simulation tools to reinforce an understanding of device physics and the different solar cell technologies. The simulation tools are also used to design and optimize advanced solar cells concepts. The course introduces a suite of relevant characterisation techniques that are used to understand the characteristics of solar cells including spectral response, temperature sensitivity, resistive losses, current generation and open-circuit voltages.

Course Aims

The broad aim of this course is to provide the students with the knowledge that is required to understand the design, operation and characterisation of solar cells. More specifically the course aims to:

- Develop within students a fundamental theoretical understanding of the operation of solar cells;
- Expose students to a wide range of solar cell technologies, which are practised in laboratory and commercial environments; and
- Teach students to use available tools and techniques to characterise solar cells

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Describe solar cell operations using physical and electrical models	PE1.1, PE1.2, PE1.3, PE3.2
2. Simulate solar cell devices using numerical models	PE1.2, PE1.3, PE2.1, PE2.3
3. Design solar cells by optimising parameters for maximum efficiency	PE2.1, PE2.3
4. Analyse measured characteristics of solar cells to determine sources of loss	PE2.1, PE2.3

Teaching Strategies

Please refer to the information in Moodle

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Exercises	30%	Week 3, 7	1, 2, 3, 4
2. Quiz	15%	Week 1-10	1, 2, 3
3. Project	25%	Week 10	1, 2, 3
4. Final Exam	30%	Not Applicable	2, 3

Assessment 1: Exercises

Due date: Week 3, 7

Analysis, Evaluation and Design of solar cells

Assessment 2: Quiz

Due date: Week 1-10

Lecture material from respective week.

Assessment 3: Project

Due date: Week 10

Analysis, Evaluation and Design of solar cells

Assessment 4: Final Exam

All course content from weeks 0-10 inclusive.

Attendance Requirements

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

Course Schedule

View class timetable

Timetable

Date	Type	Content
O-Week: 7 February - 11 February		
Week 1: 14 February - 18 February	Lecture	Generation and recombination
	Laboratory	Exercise #1
Week 2: 21 February - 25 February	Lecture	Carrier collection and electrochemical potential
	Laboratory	Exercise #1
Week 3: 28 February - 4 March	Lecture	The ideal Solar Cell, Diffusion and Gettering
	Laboratory	Exercise #1
Week 4: 7 March - 11 March	Lecture	Contact Formation and Metallisation
	Laboratory	Exercise #2
Week 5: 14 March - 18 March	Lecture	Solar Cell characterisation
	Laboratory	Exercise #2
Week 6: 21 March - 25 March		
Week 7: 28 March - 1 April	Lecture	Solar Cell Optics
	Laboratory	Exercise #2
Week 8: 4 April - 8 April	Lecture	Loss analysis
	Project	Project
Week 9: 11 April - 15 April	Lecture	Efficiency limits
	Project	Project
Week 10: 18 April - 22 April	Lecture	High efficiency cell concepts
	Project	Project

Resources

Prescribed Resources

M. A. Green (1982) “Solar Cells”. Red book.

https://www.pveducation.org/

Recommended Resources

Learning resources for this course include:
• The PC1D software package is included on all the computers in 416 and 455
• M. A. Green (1982) “Solar Cells”. Red book.
• Jenny Nelson, “The Physics of Solar Cells”
• Photovoltaic Solar Energy: From Fundamentals to Applications
• Peter Wurfel, Physics of Solar Cells
Additional reference material made available to students via Moodle
UNSW Library website: https://www.library.unsw.edu.au/
Moodle: https://moodle.telt.unsw.edu.au/login/index.php

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

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	