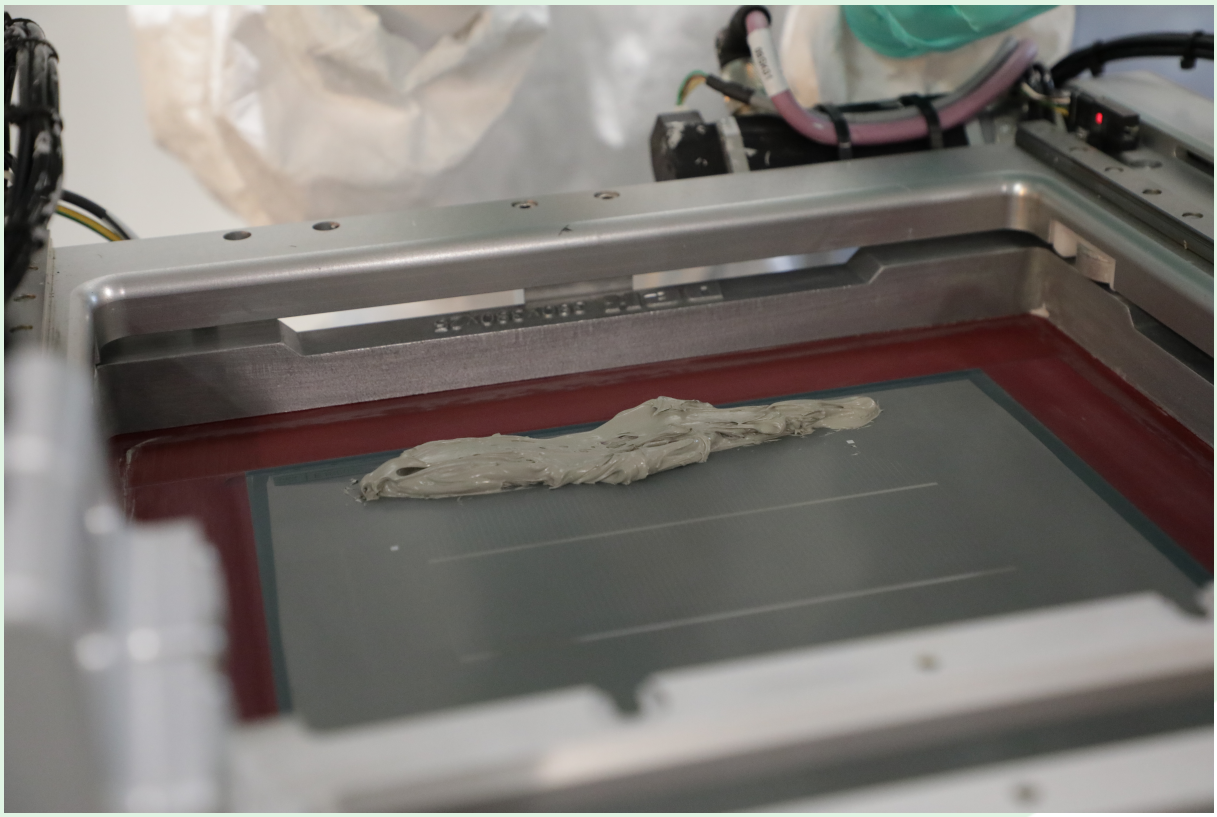
SOLA3020

Photovoltaic Technology and Manufacturing

Term 2, 2022



Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Bram Hoex	b.hoex@unsw.edu.au	MS Teams	TETB 132	93857934

Demonstrators

Name	Email	Availability	Location	Phone
Michelle Vaqueiro Contreras	m.vaqueirocontreras@unsw.edu.au	MS Teams	NA	NA

School Contact Information

For current students, all enquiries for The School of Photovoltaics and Renewable Energy are managed by The Nucleus:

Engineering Student Support Services – The Nucleus - enrolment, progression checks, clash requests, course issues or program-related queries

Phone: (+61 2) 9385 8500 – Nucleus Student Hub

For future students, all enquiries for The School of Photovoltaics and Renewable Energy are managed by the Future Student Team:

UNSW Future Students – potential student enquiries e.g. admissions, fees, programs, credit transfer

Phone: (+61 2) 9385 1844 – Future Students

Course Details

Units of Credit 6

Summary of the Course

Silicon photovoltaic modules comprise ~90% of the photovoltaic modules manufactured and sold worldwide. This course introduces students to the technology used to manufacture screen-printed silicon solar cells and important manufacturing concepts such as device design, yield, throughput, process optimisation, reliability, in-line quality control and fault diagnosis. Using the versatile SunSolve platform, the students will explore various aspects of solar cell optimisation and directly assess its impact on the PV module performance.

Course Aims

The aims of this course are:

- To introduce students to the technologies used to manufacture silicon photovoltaic modules;
- To expose students to a solar cell manufacturing environment and important manufacturing concepts such as device design, yields, throughput, process optimisation, reliability, in-line quality control and fault diagnosis; and
- To develop students' ability to optimise a solar cell production line involving many inter-related processes and processing parameters.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Apply an understanding of the physics and chemistry underlying the main photovoltaic manufacturing processes to the optimisation of screen-printed solar cell production lines;	PE1.1, PE1.3, PE1.5
2. Analyse solar cell performance and losses through the use of common testing and characterisation techniques;	PE1.1, PE1.3, PE2.2
3. Use an experimental methodology and apply important manufacturing concepts such as device performance, yield, throughput, quality control to optimise solar cell production lines; and	PE1.5, PE2.2
4. Communicate an awareness of emerging manufacturable solar cell technologies.	PE3.2

Teaching Strategies

The teaching strategy for this course comprises online content (videos & website) and blended workshop sessions. The online video series will present theory related to manufacturing technology and processes and up-to-date information about available equipment, costing and quality control resources. Also, some select seminars from the School of Photovoltaic and Renewable Energy Engineering (SPREE) are

included which will go into detail in some important aspects of the course.

All workshop sessions require the use of SunSolve. A tutor will be available to give assistance during each of the scheduled workshop sessions.

The course contains a substantial component of self-learning through the experience gained via operating SunSolve simulation. The main textbook for this course is the PV-Manufacturing.org website which was first released in January 2018 and is continuously updated (let the course convenor know if you find any mistakes!). This website describes the main processes used in photovoltaic manufacturing with tailored animations and videos. The PV-Manufacturing.org website is complemented by additional information provided via Moodle & MS Teams such as the lecture videos and slides.

Additional Course Information

This is a 6 unit-of-credit (UoC) course and involves 4 hours per week (h/w) of scheduled online contact (2 hours Q&A and 2 hours Workshop).

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.

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Quiz	10%	End of each week (except week 6)	1, 2, 3, 4
2. Tutorial Exercises and Participation	5%	Weekly	1, 2, 3
3. Group Presentation	5%	Week 3	4
4. Assignment 1	20%	Week 5	1, 2, 3
5. Assignment 2	20%	Week 10	1, 2, 3, 4
6. Final Exam	40%	Exam Period	1, 2, 3, 4

Assessment 1: Quiz

Assessment length: Up to 20 multiple choice questions
Due date: End of each week (except week 6)
Deadline for absolute fail: End of each week
Marks returned: Instantly

Weekly quizzes based on the course content

Assessment criteria

The weekly quiz assesses the content from each specific week.

Assessment 2: Tutorial Exercises and Participation

Submission notes: During the workshop
Due date: Weekly
Deadline for absolute fail: Following Week
Marks returned: Instantly

Testing the topics of the week (Learning Outcomes 1-3) and is part of the formative assessment of the course.

Participation Criteria: Tutorial Exercises must be checked and marked off by Tutor.

Assessment 3: Group Presentation

Assessment length: Up to 15 minutes
Due date: Week 3
Deadline for absolute fail: Week 4 (Alternative: 1000 word essay on a chosen topic)
Marks returned: End of week 4

With your group, prepare and present a 10 min presentation on your assigned PV manufacturing discussion topics. For your presentation, provide sufficient technical background so that your audience can appreciate the findings you present. Use whatever resources you like to present in an interesting and compelling way. Remember, an “interested” audience is a good audience!”

Assessment criteria

Assesses presentation skills and handling of questions.

Assessment 4: Assignment 1

Assessment length: 3-4 multiple part questions
Due date: Week 5
Deadline for absolute fail: Standard penalty clause
Marks returned: End of week 6

This assignment covers the content of the first 5 weeks (Learning Outcomes 1-3) and is part of the formative assessment of the course.

This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

Assessment 5: Assignment 2

Assessment length: 3-4 multiple part questions
Due date: Week 10
Marks returned: End of of week 11 (study week)

This assignment covers the content of the first 8 weeks (Learning Outcomes 1-4) and is part of the formative assessment of the course.

This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

Assessment 6: Final Exam

Assessment length: 3-4 multiple part questions
Due date: Exam Period

This assignment test the full course content, Learning Outcomes 1-4 and is part of the summative assessment of the course.

Assessment criteria

Course content week 1-10

Attendance Requirements

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

Course Schedule

View class timetable

Timetable

Date	Type	Content
Week 1: 30 May - 3 June	Lecture	Current status of the photovoltaic market
	Online Activity	Introduction to SunSolve and basic statistics
Week 2: 6 June - 10 June	Lecture	Crystal growth and wafering
	Online Activity	Optimisation of surface texture
Week 3: 13 June - 17 June	Lecture	Wet chemistry: cleaning and texturing
	Group Work	Group presentations
	Assessment	Group Presentation
Week 4: 20 June - 24 June	Lecture	Junction formation and electron-hole pair generation/recombination
	Online Activity	Optimisation of bill of materials
Week 5: 27 June - 1 July	Lecture	Antireflection coating and surface passivation
	Online Activity	Optimisation of antireflection coatings
	Assessment	Assignment 1
Week 6: 4 July - 8 July		UNSW Flexibility Week
Week 7: 11 July - 15 July	Lecture	Metallisation and cell testing
	Online Activity	Optimisation of metallisation
Week 8: 18 July - 22 July	Lecture	Current and future module fabrication
	Online Activity	Bifacial vs monofacial solar cells
Week 9: 25 July - 29 July	Lecture	Manufacturing statistics and photoluminescence imaging
	Online Activity	Optical losses in heterojunction solar cells
Week 10: 1 August - 5 August	Lecture	Recent trends in photovoltaics
	Laboratory	SIRF visits & Assignment 2 assistance

Study Week: 8 August - 11 August	Online Activity	Exam preparation section.

Submission of Assessment Tasks

Work submitted late without an approved special consideration or extension by the course coordinator or delegated authority is subject to a late penalty of 5% mark reduction per day, capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, consistent with UNSW Assessment Implementation Procedure.

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.

Important 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 ·

· Special Consideration

· Equitable Learning Services

· Exams

· Approved Calculators

· UNSW Email Address

Disclaimer

This course outline sets out description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle should be consulted for the up to date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline (as updated in Moodle), the description in the Course Outline/Moodle applies.

Image Credit

Bram Hoex

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	