SOLA2540, SOLA9001

Applied Photovoltaics

Term 1, 2022

Course Overview

Staff Contact Details

Convenors

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Demonstrators

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School Contact Information

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Course Details

Units of Credit 6

Summary of the Course

Can we continue to use fossil fuels for electricity? Think about climate change, global warming, and sustainable economy! Photovoltaic (PV) devices convert sunlight directly to electricity with low levels of greenhouse gas emissions per unit of electricity produced. How affordable is photovoltaic electricity? Learn about fundamental factors important to the operation of PV cells and systems. You will learn how different components of the PV systems work, and how to calculate power generation considering different factors affecting the solar generation. Using simulation and laboratory exercises you will get opportunities to reinforce an understanding of modelling and characterisation of solar cells, modules, and systems. You will also develop a stand-alone PV system design tool and use it to solve real world problems. You will also calculate performance parameters of PV sytems.

Course Aims

The aims of this course are to:

- provide students with the fundamental information needed to understand the principles of PV system operation; and
- develop skills to undertake simple PV system design.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Describe the key properties of light-matter interaction that impact the performance of a photovoltaic device.	PE1.1, PE1.3, PE3.2
2. Calculate the incident solar power on a surface understanding the contributions of orientation, tilt, location, spectral change and weather factors.	PE1.1, PE1.3, PE1.5, PE2.1, PE2.2, PE3.2
3. Calculate output of a PV string at different shading scenarios and array configurations.	PE1.1, PE1.5, PE2.1, PE3.2
4. Match system components for a particular PV system.	PE1.1, PE1.3, PE2.1, PE2.3, PE3.2
5. Design a Stand-Alone PV system based on load assessment and site location in compliance with Australian standards.	PE1.3, PE1.5, PE2.1, PE2.2, PE2.3, PE3.2, PE3.6
6. Calculate payback period and life cycle cost of electricity of a PV system.	PE1.1, PE1.3, PE2.1, PE2.4

Teaching Strategies

Lecture sessions will introduce theory and worked examples. Workshops are designed to develop relevant problem solving skills. During some workshop classes, students will go through lab exercises and associated assignments which will help students to develop skills related to the use of software for modeling solar cells and modules, practical skills related to assembling and measuring the performance of photovoltaic systems and skills related to interpreting experimental results. Quizzes are designed to help with continuous learning and knowledge enhancement. The PV system design assignment will help to develop skills needed for PV systems design.

Additional Course Information

You are expected to attend all lectures, workshops and labs in order to maximise learning. 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	30%	Week 2, 4, 7, 10	1, 2, 3, 4, 6
2. Lab reports	20%	Week 7 & 10	1, 2, 3, 4
3. PV system design	50%		2, 3, 4, 5, 6

Assessment 1: Quizzes

Due date: Week 2, 4, 7, 10

Online quizzes will be run during the term to assess understanding of material, and to help with continuous learning. There will be four quizzes during the term (in Wk 2, 4, 7 and 10).

Assessment criteria

Assessment criteria will be provided during the term.

Assessment 2: Lab reports (Group)

Due date: Week 7 & 10

In some weeks (see the schedule) you will work on lab projects which are designed to give you an opportunity to apply knowledge to practical problems relating to solar cells and systems. You will need to write a report for each lab answering specific questions.

Assessment criteria

Assessment criteria will be provided during the term.

Assessment 3: PV system design

The PV design assignment will give you opportunities to apply knowledge to address practical problems and present it to stakeholders. You will perform stand alone PV system design for a given probelm inlcluding sizing and selection of components and economic analysis..

Assessment criteria

Assessment criteria will be provided during the term.

Hurdle requirement

Students must demonstrate they can design a stand-alone PV system for optimum performance and conformance to relevant Australian Standards. A minimum mark of 60% must be obtained in the PV system design assignment in order to pass this course. Failure to achieve this minimum mark will result in an unsatisfactory fail (UF) grade, regardless of the performance in the rest of the course.

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: 14 February - 18 February	Lecture	PV Systems and components; SPS design (I) - Load assessment
	Laboratory	Lab 0: Circuit simulation with LT Spice
Week 2: 21 February - 25 February	Lecture	Energy Storage
	Workshop	WKS 1: PV systems and load assessment
Week 3: 28 February - 4 March	Lecture	Solar cells and modules (I)
	Workshop	WKS 2: Solar cells and modules
Week 4: 7 March - 11 March	Lecture	Solar resource assessment (I)
	Laboratory	Lab 1: Modelling of solar cells
Week 5: 14 March - 18 March	Lecture	Solar resource assessment (II)
	Laboratory	Lab 2: Mismatch, IV and thermal properties of PV modules
Week 6: 21 March - 25 March		Flexibility Week: Classes will not run this week.
Week 7: 28 March - 1 April	Lecture	Solar cells and modules (II); SPS design (II) – PV Array
	Laboratory	Lab 2: Mismatch, IV and thermal properties of PV modules
Week 8: 4 April - 8 April	Lecture	SPS design (III) - Charge controller and inverter
	Workshop	WKS 3: Solar resource assessment
Week 9: 11 April - 15 April	Lecture	PV system performance and economics; Installation, design and costing
	Workshop	WKS 4: PV systems and components
Week 10: 18 April - 22 April	Lecture	Other PV applications
	Presentation	TBC

Resources

Prescribed Resources

Learning resources for this course include:

Reference Books

Wenham, S., Green, M., Watt, M. & Corkish, R. (2009) Applied Photovoltaics - 2nd Edition, 2009 Revision, Sydney, Australia, UNSW Centre for Photovoltaic Engineering.

Software

LT Spice: https://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html

Retscreen: Energy Project Analysis Software http://www.retscreen.net/ang/home.php

PVSYST: Software for photovoltaic Systems http://www.pvsyst.com/

On-line Resources

PV Education: PV Education is an online, interactive website by C.B. Honsberg and S. Bowden covering material similar to this textbook is also available at http://www.pveducation.org/pvcdrom/.

Moodle: As a part of the teaching component, Moodle will be used to disseminate teaching materials, host forums and occasionally 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.

Course Evaluation and Development

Feedback on the course is gathered periodically using various means, including the UNSW myExperience process, informal discussion iduring the term, 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 removal of non-critical questions from lab assignments, and increasing the weighting for the PV stand-alone PV system design assignment. Final exam has also been removed.

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	✓