UNSW Course Outline

SOLA4012 Photovoltaic Systems Design - 2024

Published on the 15 May 2024

General Course Information

Course Code : SOLA4012
Year : 2024
Term : Term 2
Teaching Period : T2
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : School of Photovoltaic and Renewable Engineering
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Postgraduate, Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

There is increasing need in generating electricity from renewable energy sources and reducing greenhouse gas emissions. Photovoltaic (PV) systems are one of the few distributed renewable electricity generation options that can be readily used in urban areas (as grid connected

systems) and in remote areas (as off-grid systems), with little environmental impact at the site and potential economic benefits for the user and the network operator. PV systems are also part of the sustainable solution required in centralised energy plants (solar farms).

The aim of the course is to provide students with tools and information on the technical and economic issues with respect to the design, installation, and operation of photovoltaic energy systems. In particular, the course aims to develop students' design, problem solving, and communication skills to implement PV systems in accordance to Australian Standards.

Course Aims

Do you want to be an active part of the exciting journey to a sustainable society based on solar PV energy?

This course will prepare you to be an active part of the exciting journey to a sustainable society based on renewable energy. Because the most important component of all PV systems is the human component.

The PV industry is a multi-billion dollar industry, growing at an accelerating rate due to the cost and efficiency improvements achieved in the last twenty years, thanks in part to important contributions by UNSW researchers and alumni. Even though these quick improvements in PV and the fast-growing capacity has been unprecedented, the industry needs to grow at an even faster rate if the world is to meet its targets in carbon emission reductions. The challenge now is to achieve terawatts of capacity installed every year around the world!

This course is about you and how you can become a great designer of PV systems, taking into consideration all key design variables (technical, economical, environmental, and regulatory) under a diversity of contexts. During the course you will start developing professional skills and experience in making decisions and informed assumptions to design PV systems of different scales using real data, first working individually and then as a team.

By the end of the course you will be capable of designing high quality PV systems, optimised to provide high performance and value, while complying with all relevant Australian Standards. This will allow you to apply for the CEC (Clean Energy Council) provisional accreditation for the design of PV systems.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Recommend and justify suitable PV system architecture based on the specific requirements of the application and location.
CLO2 : Calculate the impact of PV systems on the local electricity network and how they can influence the power factor via reactive and active power.
CLO3 : Design and document a PV system fully compliant with all relevant Australian Standards for a safe and optimal operation.
CLO4 : Optimise PV designs based on technoeconomic principles using software tools
CLO5 : Develop proposals for utility scale PV projects and its associated business model.

Course Learning Outcomes	Assessment Item
CLO1 : Recommend and justify suitable PV system architecture based on the specific requirements of the application and location.	• Online quizzes • Commercial PV project- compliance submission • Commercial PV project- Tender submission • Utility scale PV project
CLO2 : Calculate the impact of PV systems on the local electricity network and how they can influence the power factor via reactive and active power.	• Online quizzes • Commercial PV project- compliance submission • Commercial PV project- Tender submission • Utility scale PV project
CLO3 : Design and document a PV system fully compliant with all relevant Australian Standards for a safe and optimal operation.	• Online quizzes • Commercial PV project- compliance submission • Commercial PV project- Tender submission • Utility scale PV project
CLO4 : Optimise PV designs based on technoeconomic principles using software tools	• Online quizzes • Commercial PV project- Tender submission • Utility scale PV project
CLO5 : Develop proposals for utility scale PV projects and its associated business model.	• Online quizzes • Utility scale PV project

Learning and Teaching Technologies

Moodle - Learning Management System | Microsoft Teams

Learning and Teaching in this course

There are three main components to learning and teaching in this course:

1. Online One-Note lecture notes to accompany each week's relevant subject
2. In-person lectures to cover theoretical content of the course
3. In-person studio sessions to collaborate and work in teams to complete studio activities and course assignments

Other Professional Outcomes

SOLA 4012 & Program Specializations

https://www.unsw.edu.au/engineering/student-life/student-resources/program-design

Additional Course Information

Course pre-requisites

All students are expected to complete SOLA2540 or SOLA9001 before enrolling in this course.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Online quizzes Assessment Format: Individual	15%	Start Date: Not Applicable Due Date: Not Applicable
Commercial PV project- compliance submission Assessment Format: Individual	30%	
Commercial PV project- Tender submission Assessment Format: Individual	15%	
Utility scale PV project Assessment Format: Group	40%	

Assessment Details

Online quizzes

Assessment Overview

There are seven quizzes that test learning from the content in the online lessons. The quizzes are strictly individual and can be done online at any time after the student has completed the online lessons.lessons. Feedback will be provided after the submission date within a week through the learning management system. The last quiz is done in an online interview format. The interview-quiz is individual between the student and the course coordinator or demonstrator. The interview-quiz will assure that students have learned the content of the course. The interview will

be marked against assessment criteria and feedback will be provided during and/or after the interview.

Course Learning Outcomes

- CLO1 : Recommend and justify suitable PV system architecture based on the specific requirements of the application and location.
- CLO2 : Calculate the impact of PV systems on the local electricity network and how they can influence the power factor via reactive and active power.
- CLO3 : Design and document a PV system fully compliant with all relevant Australian Standards for a safe and optimal operation.
- CLO4 : Optimise PV designs based on technoeconomic principles using software tools
- CLO5 : Develop proposals for utility scale PV projects and its associated business model.

Assignment submission Turnitin type

This is not a Turnitin assignment

Hurdle rules

Students must demonstrate understanding of all key content of the course in the online quizzes and interview. **A minimum average mark of 80% must be obtained in quizzes/interview in order to pass this subject (i.e., average mark of six quizzes and interview, you won't fail if one of your quiz or interview mark is below 80%).** The interview will be used as check points with questions based in the online quizzes. Failure to achieve this minimum mark will result in an unsatisfactory fail (UF) grade, regardless of the performance in the rest of the course.

Commercial PV project- compliance submission

Assessment Overview

Based on a tender request from a large retailer, for the installation of a non-exporting, grid-connected PV system for their commercial buildings around Australia, with an energy storage option, you will have to find a suitable warehouse from the retailer somewhere in Australia and produce a full system design for the tender response. You will submit a 6-page report, plus attachments. Work will be marked against marking criteria and feedback will be provided within 10 days of the submission date through the learning management system.

Course Learning Outcomes

- CLO1 : Recommend and justify suitable PV system architecture based on the specific requirements of the application and location.
- CLO2 : Calculate the impact of PV systems on the local electricity network and how they can influence the power factor via reactive and active power.
- CLO3 : Design and document a PV system fully compliant with all relevant Australian Standards for a safe and optimal operation.

Detailed Assessment Description

In this assessment task you will apply your knowledge to a real-world design challenge of a commercial grid connected PV system (Core Learning Outcome). As a part of this project, you and your team member will play the roles of 'junior engineers' in a PV company. Although this is an individual assessment, you are encouraged to collaborate with your team during this process. However, the work submitted must be solely yours.

The project involves the use of the modelling software System Advisory Model (SAM) to design the PV system and of AutoCAD to deliver professional array layout. SAM will be used to carry out a techno-economic optimisation of the system performance and cost. The aim is to produce a comprehensive design of a grid connected PV system for a location and load to be selected. The project report will be prepared as a compliance report explicitly showing all the important design criteria and considerations.

Assignment submission Turnitin type

This assignment is submitted through Turnitin and students can see Turnitin similarity reports.

Hurdle rules

Students must demonstrate they can design a complete PV system for optimum performance and in conformance to all the relevant Australian Standards. **A minimum mark of 80% must be obtained in the Commercial PV Project – Compliance report to pass this subject.** Failure to achieve this minimum mark will result in an unsatisfactory fail (UF) grade, regardless of the performance in the rest of the course.

Commercial PV project- Tender submission

Assessment Overview

You will optimise your PV design including a battery storage option and present a final Tender submission for assessment. You will submit a 8-page report, plus attachments. Work will be marked against marking criteria and feedback will be provided within 10 days of the submission date through the learning management system.

Course Learning Outcomes

- CLO1 : Recommend and justify suitable PV system architecture based on the specific requirements of the application and location.
- CLO2 : Calculate the impact of PV systems on the local electricity network and how they can influence the power factor via reactive and active power.
- CLO3 : Design and document a PV system fully compliant with all relevant Australian Standards for a safe and optimal operation.

- CLO4 : Optimise PV designs based on technoeconomic principles using software tools

Detailed Assessment Description

In this assessment task you will apply your knowledge to a real-world design challenge of a commercial grid connected PV system (Core Learning Outcome) including a storage option (Advanced Learning Outcome). As a part of this project, you and your team member will play the roles of 'junior engineers' in a PV company. Although this is an individual assessment, you are encouraged to collaborate with your team during this process. However, the work submitted must be solely yours.

In addition to the modelling and professional PV outline developed for the compliance report, you will need to deliver professional level single line diagrams (SLD) for the tender submission. SAM will be used to carry out a techno-economic optimisation of the system performance and cost. The aim is to produce a comprehensive design of a grid connected PV system for a location and load to be selected. The project report will be prepared as a 'Tender submission', i.e., you are preparing a full tender submission in order to 'win' a contract for the installation of a new PV system.

Assignment submission Turnitin type

This assignment is submitted through Turnitin and students can see Turnitin similarity reports.

Utility scale PV project

Assessment Overview

Your team has been given the task of scouting land for a new project of at least 5 MW in Australia. You will carry out a desktop feasibility study, followed by a business case for the project. Depending on the quality and economics of the project, the board of the company will decide if the project can proceed to the next stage. You will submit a 10-page report and 5 minute video/ presentation.

Each member will be assessed of their performance and contributions by other team members against assessment criteria. Feedback will be provided within 10 days of the submission date through the learning management system.

There will be team evaluation where team members assess their peer's contributions to the assignment. Marks will be moderated based on the relative contribution of each team member.

Course Learning Outcomes

- CLO1 : Recommend and justify suitable PV system architecture based on the specific

requirements of the application and location.
- CLO2 : Calculate the impact of PV systems on the local electricity network and how they can influence the power factor via reactive and active power.
- CLO3 : Design and document a PV system fully compliant with all relevant Australian Standards for a safe and optimal operation.
- CLO4 : Optimise PV designs based on technoeconomic principles using software tools
- CLO5 : Develop proposals for utility scale PV projects and its associated business model.

Detailed Assessment Description

This project is based on utility scale PV systems, meaning that your team will be working on a solar farm. As part of this project, your team will play the role of a 'PV developer' trying to setup a new solar farm project in Australia. The project will run through the last half of the term aiming at producing a comprehensive project that can be presented to investors for funding during week 10. The team will have to select the location of the solar farm taking into consideration aspects like irradiance and grid connection. The final submission will be prepared as an investment report so your company can obtain funding for your project. This project will allow you to implement all the knowledge gained through the course involving the use of Australian standards, modelling software, together with engineering and economic principles to design a solar farm.

Assignment submission Turnitin type

This assignment is submitted through Turnitin and students can see Turnitin similarity reports.

General Assessment Information

Grading Basis

Standard

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 0 : 20 May - 26 May	Other	Welcome to SOLA 4012 Microsoft Teams Channel
Week 1 : 27 May - 2 June	Topic	Course introduction, PV basics, design thinking and team creation
	Reading	Week 1 One-Note Online Lecture Notes
	Online Activity	Online Quiz 1 (trial quiz): This quiz is for the purpose of making students familiar with the process and will not be marked.
Week 2 : 3 June - 9 June	Topic	PV site specific design and modelling, component matching, cables, and protections
	Online Activity	Online Quiz (Week 2)
	Reading	Week 2 One-Note Online Lecture Notes
Week 3 : 10 June - 16 June	Topic	Array circuit protection, AC power, waves, phasors, and power factor
	Reading	Week 3 One-Note Online Lecture Notes
	Online Activity	Online Quiz (Week 3)
Week 4 : 17 June - 23 June	Topic	PV architecture, inverters, and grid connection, earthing and faults
	Reading	Week 4 One-Note Online Lecture Notes
	Online Activity	Online Quiz (Week 4)
Week 5 : 24 June - 30 June	Topic	Tendering for PV projects, installation of PV systems, system safety, wind loads and mounting
	Reading	Week 5 One-Note Online Lecture Notes
	Online Activity	Online Quiz (Week 5)
	Assessment	Commercial PV project - Compliance report submission
Week 6 : 1 July - 7 July	Reading	Week 6 One-Note Online Lecture Notes: Summary of PV finance metrics
	Other	Flexibility Week
Week 7 : 8 July - 14 July	Topic	The grid, inverters, islanding, inverter safety, standards, and taxonomy of large-scale PV systems (part 1)
	Reading	Week 7 One-Note Online Lecture Notes
	Online Activity	Online Quiz (Week 7)
	Assessment	Commercial PV project - Tender report submission
Week 8 : 15 July - 21 July	Topic	Quality of supply, three phase systems and taxonomy of large-scale PV systems (part 2)
	Reading	Week 8 One-Note Online Lecture Notes
	Online Activity	Online Quiz (Week 8)
Week 9 : 22 July - 28 July	Topic	Virtual reality experience of large-scale PV system, PV financing & business models, large scale PV grid connection process
	Reading	Week 9 One-Note Online Lecture Notes
	Online Activity	Online Interview
Week 10 : 29 July - 4 August	Topic	HV grid connection, operation, and maintenance of PV farms plants, power purchase agreements (PPAs)
	Reading	Week 10 One-Note Online Lecture Notes
	Assessment	Utility scale PV project group video presentation submission
	Assessment	Utility scale PV project group report submission

Attendance Requirements

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

General Schedule Information

We will have in-person lectures on Mondays between 15:00-17:00 and studio sessions on

Thursdays between 11:00-13:00 at TETB (H6) Gnd 16. The room will be booked in one hour advance from 10:00 before each studio session to give groups opportunity to prepare for the studio activities and work on course assignments.

- For each week, there is an accompaying online One-Note lecture content and students are highly encouraged to review this material before attending lectures.
- During Weeks 2-5 and Weeks 7 and 8 we will have online quizzes and during Week 9 we will have an online interview.
- We have three main assignments for the course with the respective deadlines in Week 5, Week 7 and Week 10 (more details in Course Schedule).

Course Resources

Prescribed Resources

Weekly OneNote online lecture notes

Reference Books:

- Grid-Connected PV Systems, Design and Installation - GSES
- Grid-Connected PV Systems with Battery Storage - GSES

To access the relevant Australian Standards below, you need to access TechStreet through the UNSW library link below (please make sure you're signed in with your zID and password). You can also find more information here: https://www.library.unsw.edu.au/using-the-library/information-resources/standards

1. https://primoa.library.unsw.edu.au/discovery/fulldisplay?vid=61UNSW_INST:UNSWS&tab=Everything&docid=alma9939361750001731&searchScope=SearchFirst&context=L&lang=en
2. Type in the standard's name that you are after and follow the instructions on the website
3. You can either download or view them online. When you download a file to your local computer, it will expire after a number of days so you may need to repeat this process.

Australian Standards (via UNSW Library)

- Building Code of Australia
- AS/NZS 1170.2:2011 - Structural design actions - Wind actions
- AS/NZS 1768:2007 - Lightning Protection
- AS/NZS 3000:2007 - Electrical Wiring Rules
- AS/NZS 3008.1.1:2017 - Electrical installations - Selection of cables
- AS/NZS 4777.1:2016 - Grid connection of energy systems via inverters - Installation requirements

- AS/NZS 4777.2:2020 - Grid Connections of Energy Systems via Inverters - Inverter requirements
- AS/NZS 5033:2021 - Installation and safety requirements for photovoltaic (PV) arrays

Design Tools

- System Advisory Model (SAM)

Drawing Tools

- AutoCad

Recommended Resources

Online resources:

- UNSW Library website - https://www.library.unsw.edu.au/
- Australian Bureau of Meteorology - http://www.bom.gov.au/climate/
- NASA (weather data) - https://eosweb.larc.nasa.gov/
- NREL National Solar Radiation Database (weather data) - https://nsrdb.nrel.gov/
- Renewables Ninja - https://www.renewables.ninja/
- APVI Solar Maps - http://pv-map.apvi.org.au/
- Nearmap tool (via UNSW Network) - http://au.nearmap.com/
- Clean Energy Council - http://www.cleanenergycouncil.org.au/
- PVeducation - http://www.pveducation.org/pvcdrom

Other recommended design tools

- PVSYST - Software for photovoltaic Systems
- PV-Lib - Python Open-Source Tool
- Helioscope
- RatedPower
- PV Lighthouse

Course Evaluation and Development

Formal student feedback will be gathered by MyExperience surveys. These surveys will be critically assessed by the course convener and other fellow educators to come up with strategies to improve the delivery and quality of the course.

Students are encouraged to provide constructive feedback to the course convener and demonstrators throughout the term.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Baran Yildiz		TETB Level 3 Room 317	(02) 9385 4284	Consultation hours: Mondays: 15:00 - 17:00	No	Yes
Demonstrator	Jinyi Guo					No	No
	Lamees Al Kiyumi					No	No
	Samhan Samhan					No	No
	Mojgan Tajdidzadeh					No	No
	Ashraful Howlader					No	No

Other Useful Information

Academic Information

I. Special consideration and supplementary assessment

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to, or within 3 working days of, submitting an assessment or sitting an exam.

Please note that UNSW has a Fit to Sit rule, which means that if you sit an exam, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

II. Administrative matters and 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
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Equitable Learning Services

III. Equity and diversity

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equitable Learning Services. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

IV. Professional Outcomes and Program Design

Students are able to review the relevant professional outcomes and program designs for their streams by going to the following link: https://www.unsw.edu.au/engineering/student-life/student-resources/program-design.

Note: This course outline sets out the 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 or your primary learning management system (LMS) 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/Moodle/LMS, the description in the Course Outline/Moodle/LMS applies.

Academic Honesty and Plagarism

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.

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 or contract cheating) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

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 five percent (5%) of the maximum mark possible for that assessment item, per calendar day.

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. This is for all assessments where a penalty applies.

Work submitted after five days (120 hours) will not be 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 will be clearly indicated in the course outline, and such assessments will receive a mark of zero if not completed by the specified date. Examples include:

- Weekly online tests or laboratory work worth a small proportion of the subject mark;
- Exams, peer feedback and team evaluation surveys;
- Online quizzes where answers are released to students on completion;
- Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date; and,
- Pass/Fail assessment tasks.

Faculty-specific Information

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

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

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

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

School-specific Information

SPREE Student Information Hub

Students are welcome to visit the SPREE Student Information Hub for information such as sample study plans, course outlines, thesis project, industrial training etc.

School Contact Information

For course-related matters, please contact course convenor directly via emails. Please email spreeteaching@unsw.edu.au for any other matters.