UNSW Course Outline

SOLA9103 Renewable Energy System Modelling & Analysis - 2024

Published on the 15 May 2024

General Course Information

Course Code : SOLA9103
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
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

How did weather and renewable energy forecasts contribute to the 2017 blackout in South Australia? How did the 2010/11 "once in a 40-year" rainfall event across Queensland influence the uncertainty of predicting long-term PV system performance? How are models used to assess

performance guarantees?

This course will try to answer these and many more questions by providing students with the fundamental knowledge and relevant skills for renewable energy system performance analysis, modelling, and monitoring. Students taking this course will develop a competency in using techniques for resource and energy performance assessment, understanding losses, diagnostics, monitoring, and forecasting of renewable energy systems. There is a focus on statistical techniques, data exploration, and handling large data sets. Students will apply these techniques to actual systems.

Course Aims

The course aims to provide students with fundamental knowledge and relevant skills for energy system performance analysis, modelling and monitoring. Specifically this course will develop students' ability to:

- Apply techniques for energy system performance analysis and monitoring
- Use mathematical models for renewable energy and building energy modeling
- Perform performance assessment, understanding losses, diagnostics
- Perform short-term and long-term forecasting
- Perform data cleaning and handling large datasets

Development of this knowledge and skills support the strengthening of renewable energy engineering knowledge relevant to the industry.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Use analysis and modelling techniques to evaluate renewable energy system performance, and express performance in terms of the standard derived parameters.
CLO2 : Use general and RE specific data analysis and modelling techniques to understand, interrogate, question and challenge assumptions in RE modelling.
CLO3 : Use statistical methods and modelling techniques to evaluate and understand system losses, degradation and diagnose system faults.
CLO4 : Apply appropriate data management, data cleaning and data visualisation techniques to manage, query, explore and communicate information from large weather and energy data sets.
CLO5 : Use modelling to undertake a resource assessment, predict short and long-term renewable energy system performance and appropriately describe the uncertainty of the prediction.

Course Learning Outcomes	Assessment Item
CLO1 : Use analysis and modelling techniques to evaluate renewable energy system performance, and express performance in terms of the standard derived parameters.	• PV system performance analysis • Final Exam
CLO2 : Use general and RE specific data analysis and modelling techniques to understand, interrogate, question and challenge assumptions in RE modelling.	• Data exploration and visualisation • Resource and Energy Production Assessment • PV system performance analysis • Final Exam
CLO3 : Use statistical methods and modelling techniques to evaluate and understand system losses, degradation and diagnose system faults.	• PV system performance analysis • Final Exam
CLO4 : Apply appropriate data management, data cleaning and data visualisation techniques to manage, query, explore and communicate information from large weather and energy data sets.	• Data exploration and visualisation • Resource and Energy Production Assessment • PV system performance analysis
CLO5 : Use modelling to undertake a resource assessment, predict short and long-term renewable energy system performance and appropriately describe the uncertainty of the prediction.	• Resource and Energy Production Assessment • Final Exam

Learning and Teaching Technologies

Moodle - Learning Management System

Other Professional Outcomes

Other Outcomes

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

This course is designed to address the learning outcomes below and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown.

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

	Learning Outcome	EA Stage 1 Competencies 1.
1	Apply appropriate data management, data cleaning and data visualisation techniques to manage, query, explore and communicate information from large weather and energy data sets.	PE1.1, PE1.2, PE2.2, PE2.4, PE3.2, PE3.4
2	Use analysis and modelling techniques to evaluate renewable energy system performance and express performance in terms of the standard derived parameters.	PE1.1, PE1.2, PE1.3, PE2.2, PE3.4, PE3.5
3	Use statistical methods and modelling techniques to evaluate and understand system losses, degradation and diagnose system faults.	PE1.1, PE1.2, PE1.3, PE2.2, PE3.4
4	Use modelling to undertake a resource assessment, predict short- and long-term renewable energy system performance and appropriately describe the uncertainty of the prediction.	PE1.1, PE1.2, PE1.3, PE2.2, PE2.4, PE3.2, PE3.4, PE3.5
5	Use general and RE specific data analysis and modelling techniques to understand, interrogate, question and challenge assumptions in RE modelling.	PE1.1, PE1.2, PE1.3, PE2.2, PE3.4

Additional Course Information

Pre-requisites and Assumed Knowledge

Students should have a good working knowledge of university level statistics and mathematics. Furthermore, it is expected that students have taken SOLA2540 or SOLA9001 Applied Photovoltaics (PV) and hence understand the technical components of PV systems, including how solar cells work and the effect of mismatch, shading and temperature on the operation of photovoltaic modules. It is also recommended that students have taken or are currently enrolled

in SOLA4012 Photovoltaic Systems Design.

It is also assumed that you can competently use Microsoft Excel (or equivalent software) for data manipulation and graphing.

Relationship to Other Courses

SOLA9103 is compulsory “Advanced Disciplinary Courses List 1” course in SOLAGS8621 (Master of Engineering in Renewable Energy). From 2024, SOLA9103 is an elective “Advanced Disciplinary Knowledge Courses” in Master of Engineering Science in Photovoltaic and Solar Energy (SOLAHS8338) and Renewable Energy (SOLAMS8338).

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Data exploration and visualisation Assessment Format: Individual	10%	Start Date: Not Applicable
PV system performance analysis Assessment Format: Individual	30%	Start Date: Not Applicable Due Date: Not Applicable
Resource and Energy Production Assessment Assessment Format: Individual	20%	
Final Exam Assessment Format: Individual	40%	Start Date: Not Applicable Due Date: Not Applicable

Assessment Details

Data exploration and visualisation

Assessment Overview

Students will undertake data exploration of an unspecified data source in order to provide three key insights of the data for renewable energy modelling.

This assessment is to be done individually, and will be peer assessed, with a 4-page report to be submitted via the learning management system. Work will be assessed by both your peers and course convenor/ lecturer/ demonstrator against assessment criteria. Feedback will be provided within ten days of the submission date through the learning management system.

No late reports will be accepted for this assessment task and a grade of zero will be awarded if

you do not complete the peer assessment section of the assignment.

Course Learning Outcomes

- CLO2 : Use general and RE specific data analysis and modelling techniques to understand, interrogate, question and challenge assumptions in RE modelling.
- CLO4 : Apply appropriate data management, data cleaning and data visualisation techniques to manage, query, explore and communicate information from large weather and energy data sets.

Assessment Length

4 pages maximum

Assignment submission Turnitin type

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

PV system performance analysis

Assessment Overview

Report of the method and results assessing the performance of 1 year of PV system data. Maximum length of the report is 15 page. Work will be marked against assessment criteria and feedback will be provided within 10 days of the submission date through the learning management system.

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

Course Learning Outcomes

- CLO1 : Use analysis and modelling techniques to evaluate renewable energy system performance, and express performance in terms of the standard derived parameters.
- CLO2 : Use general and RE specific data analysis and modelling techniques to understand, interrogate, question and challenge assumptions in RE modelling.
- CLO3 : Use statistical methods and modelling techniques to evaluate and understand system losses, degradation and diagnose system faults.
- CLO4 : Apply appropriate data management, data cleaning and data visualisation techniques to manage, query, explore and communicate information from large weather and energy data sets.

Assessment Length

15 pages maximum

Assignment submission Turnitin type

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

Resource and Energy Production Assessment

Assessment Overview

Report of the method and results of a resource and energy production assessment, builds upon the work undertaken in assessment task 1 (Data exploration and visualisation). The maximum length of the final report is 10 pages. Work will be marked against assessment criteria and feedback will be provided within ten days of the submission date through the learning management system.

Course Learning Outcomes

- CLO2 : Use general and RE specific data analysis and modelling techniques to understand, interrogate, question and challenge assumptions in RE modelling.
- CLO4 : Apply appropriate data management, data cleaning and data visualisation techniques to manage, query, explore and communicate information from large weather and energy data sets.
- CLO5 : Use modelling to undertake a resource assessment, predict short and long-term renewable energy system performance and appropriately describe the uncertainty of the prediction.

Assessment Length

10 pages maximum

Assignment submission Turnitin type

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

Final Exam

Assessment Overview

Final exam to be held during the exam period.

Course Learning Outcomes

- CLO1 : Use analysis and modelling techniques to evaluate renewable energy system performance, and express performance in terms of the standard derived parameters.
- CLO2 : Use general and RE specific data analysis and modelling techniques to understand, interrogate, question and challenge assumptions in RE modelling.
- CLO3 : Use statistical methods and modelling techniques to evaluate and understand system losses, degradation and diagnose system faults.
- CLO5 : Use modelling to undertake a resource assessment, predict short and long-term renewable energy system performance and appropriately describe the uncertainty of the prediction.

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	Activity	O - Week
Week 1 : 27 May - 2 June	Lecture	1.0:Course Introduction 1.1: Weather Data 1.2: Data Visualisation
	Workshop	Excel or Python Basics
Week 2 : 3 June - 9 June	Lecture	2.1 Statistical Metrics 2.2 Data Quality Assessment 2.3 Data filling
	Workshop	Data Quality Assessment
Week 3 : 10 June - 16 June	Blended	3.1: Resource Assessments & Variability
	Workshop	Statistical Metrics
	Assessment	Assignment 1 due - Topics assessed include: Data Exploration; Data Visualisation; and yourassumed knowledge content
Week 4 : 17 June - 23 June	Lecture	3.2: Bankable Datasets
	Workshop	Creation of an Hourly Synthetic Weather File in PVsyst
Week 5 : 24 June - 30 June	Lecture	4.1: PV Modelling – Part 1: Modelling Irradiance 4.2: PV Modelling – Part 2: Shading, Soiling & Reflection Losses
	Workshop	Modelling PV Systems in PVsyst – I
Week 6 : 1 July - 7 July	Lecture	No lecture: Flexibility week
	Workshop	Catchup Week – Complete Assignment 2
Week 7 : 8 July - 14 July	Lecture	4.3: PV Modelling – Part 3: POA to Cell Temperature; to DC and AC Output
	Assessment	Assignment 2 due Topics assessed include: Data Analysis; Data Visualisation; Data Quality Assessment; Resource Assessment; and PV System Modelling.
	Workshop	Modelling Module Temperature
Week 8 : 15 July - 21 July	Lecture	5.1: PV System Monitoring 5.2: PV System Analysis
	Workshop	Modelling PV Systems in PVsyst – II
Week 9 : 22 July - 28 July	Lecture	6.1: Wind Energy
	Workshop	Handling Real World Problems
Week 10 : 29 July - 4 August	Lecture	7.1: Forecasting
	Workshop	Catchup Week – Complete Assignment 3 or Analysis of Wind Data (optional)
	Assessment	Assignment 3 due - Topics assessed include: Data Exploration; Data Visualisation; PV System Modelling, Monitoring, Analysis and Fault Diagnostics; and Report writing skills.

Attendance Requirements

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

General Schedule Information

The course consists of a 2-hour lecture and a 2-hour workshop session each week, as listed below:

Day Time Location

Lectures

- Monday 10:00 to 12:00 W Law Theatre G23 (K-F8-G23)

Workshops

- Tuesday 09:00 to 11:00 Tyree Energy Tech CMLB LG35 (K-H6-LG35)
- Thursday 14:00 to 16:00 Tyree Energy Tech CMLB LG35 (K-H6-LG35)
- Thursday 16:00 to 18:00 Tyree Energy Tech CMLB LG35 (K-H6-LG35)

Please refer to your class timetable for the learning activities you are enrolled in and attend only those classes.

All lectures and workshops in T2 2024 will be in person. Please consult this course's Moodle module for details about delivery

Course Resources

Recommended Resources

Software

- PVsyst - Photovoltaic modelling software: https://www.pvsyst.com/ (you will be provided with a licence)
- Microsoft Excel - Students can download Microsoft Excel as part of Microsoft Office 365, available via UNSW IT: https://www.myit.unsw.edu.au/services/students
- Anaconda - A desktop platform to run Jupyter Notebooks and Python: https://www.anaconda.com/

Reference Books

- Solar Energy Forecasting and Resource Assessment by Jan Kleissel
- Modelling Solar Radiation at the Earth's Surface by Viorel Badescu

Online Resources

- Links to additional online resources and research publications will be made available through Moodle.

- UNSW Library website: https://www.library.unsw.edu.au/
- UNSW IT website for students: https://www.myit.unsw.edu.au/services/students
- Moodle: https://moodle.telt.unsw.edu.au/login/index.php
- PV Performance Modelling Collaborative: https://pvpmc.sandia.gov/
- NREL's Solar Position Algorithm Calculator: http://www.nrel.gov/midc/solpos/spa.html
- Australian Bureau of Meteorology: http://www.bom.gov.au/
- NASA - The POWER Project: https://power.larc.nasa.gov/
- EnergyPlus Weather Data: https://energyplus.net/weather
- The Australian Renewable Energy Mapping Infrastructure (AREMI): https://nationalmap.gov.au/renewables/
- The World Bank Group Global Solar Atlas: https://globalsolaratlas.info/map
- The World Bank Group Global Wind Atlas: https://globalwindatlas.info/
- PV Education by C.B. Honsberg and S. Bowden https://www.pveducation.org/
- PV Manufacturing by B. Hoex https://pv-manufacturing.org/

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.

In this course, recent improvements resulting from student feedback included the introduction of Python/Jupyter Notebook workshop activities. 2020 was the first time that students were offered the choice between completing the workshop activities in Microsoft Excel or via Python/Jupyter Notebooks. 2020 also saw the introduction of a set of Week 0 Assumed Knowledge lessons, including review lessons on basic statistics and solar resource basics.

Student feedback from the 2021 iteration of the course has led to further improvements of the workshop resources for both the Microsoft Excel and Python learning streams; and the introduction of the online Course Book, available on Moodle.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Bram Hoex		TETB Room 132	9385 7934	Please email or contact me on MS Teams to make an appointment	Yes	Yes
Lecturer	Phillip Hamer				Email to make an appointment	No	No
	Shukla Poddar				Email to make an appointment	No	No
Demonstrator	Chaudhry Muhammad Furqan				Email to make an appointment	No	No
	Zeinab Haydous					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.