SOLA9103

Renewable Energy System Modelling & Analysis

Term 2, 2022

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Merlinde Kay	m.kay@unsw.edu.au	Please email to make an appointment	TETB Room 215	9065 5520

Lecturers

Name	Email	Availability	Location	Phone
Simon Heslop	s.heslop@unsw.edu.au	email to make an appointment		
Phillip Hamer	p.hamer@unsw.edu.au	email to make an appointment		

Demonstrators

Name	Email	Availability	Location	Phone
Shukla Poddar	s.poddar@unsw.edu.au	weeks 5-10		

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

The purpose of this course is to provide students with fundamental knowledge and relevant skills for energy system performance analysis, modelling and monitoring. Students taking this course will develop a competency in using these techniques for energy system performance assessment, understanding losses, diagnostics and forecasting for renewable energy and building systems. There is a focus on the use of statistical techniques and handling large data sets. Students will apply these techniques to real systems.

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 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 the use of statistical techniques, data exploration and handling large data sets. Students will apply these techniques to real systems.

The course aims to provide students with the opportunity to explore and gain further understanding of Renewable Energy (RE) system modelling through the investigation and impact of model assumptions and uncertainties with a direct emphasis on their application to real world datasets from the field of renewable energy engineering. Students who take this course should become familiar with analysis techniques required to carry out resource and operational performance assessments of RE systems.

Course Aims

· Techniques for energy system performance analysis and monitoring,

· Mathematical models for renewable energy and building energy modeling

· Performance assessment, understanding losses, diagnostics

· Short-term and long-term forecasting

· Data cleaning and handling large datasets

Course Learning Outcomes

1. Use analysis and modelling techniques to evaluate renewable energy system performance, and express performance in terms of the standard derived parameters.
2. Use general and RE specific data analysis and modelling techniques to understand, interrogate, question and challenge assumptions in RE modelling.
3. Use statistical methods and modelling techniques to evaluate and understand system losses,

degradation and diagnose system faults.
4. Apply appropriate data management, data cleaning and data visualisation techniques to manage, query, explore and communicate information from large weather and energy data sets.
5. Use modelling to undertake a resource assessment, predict short and long-term renewable energy system performance and appropriately describe the uncertainty of the prediction.

This course is designed to address the learning outcomes below and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown. The full list of Stage 1 Competency Standards may be found in Appendix A. After successfully completing this course, you should be able to:

Learning Outcome		EA Stage 1 Competencies
1.	Apply appropriate 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 data analysis and modelling techniques to understand, describe, interrogate, and challenge assumptions and results of RE models.	PE1.1, PE1.2, PE1.3, PE2.2, PE3.4

Teaching Strategies

Lectures – to provide fundamental knowledge relevant to performance and assessment of renewable energy systems

Workshops – to develop relevant problem solving techniques

Labs – to develop practical and analytical skills

Assignment – to encourage broader interdisciplinary thinking and design in a group context

Exam – final assessment of understanding

The teaching strategy for this course comprises a series of lectures and workshop sessions. The

lectures will introduce concepts related to renewable energy system modelling and analysis, through the combined use of online resources, case studies, and worked examples. Workshops will build on the theory presented in the lectures.

The workshops are designed to engage students with the course material, and to help students successfully complete the course assignments. The workshops provide students with the opportunity to develop, practice, and apply their knowledge and modelling and analysis skills to real world RE modelling and analysis tasks.

A variety of additional resources are available through Moodle, including non-assessable practice quizzes, bonus activities, links to webinars, and journal and magazine articles. Students can use these resources to self-assess their understanding of the course content, or to dive deeper into a topic area that sparked an interest.

Within the course, students are encouraged to actively participate in order to maximise their own learning.

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 SOLA2540-9001 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 Grid-connected Photovoltaics.

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 an advanced disciplinary course in the School of Photovoltaic and Renewable Energy Engineering (SPREE). It is a requisite course (Advanced Disciplinary Knowledge) for the Master of Engineering Science in Renewable Energy Engineering (SOLADS8338) and is an elective course for the Master of Engineering Science in Photovoltaic and Solar Energy (SOLACS8338).

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Data exploration and visualisation	10%	17/06/2022 05:00 PM	2, 4
2. PV system performance analysis	20%	15/07/2022 05:00 PM	1, 2, 3, 4
3. Resource assessment	30%	05/08/2022 05:00 PM	2, 4, 5
4. Final Exam	40%	To be confirmed	1, 2, 3, 5

Assessment 1: Data exploration and visualisation

Assessment length: 4 pages maximum
Due date: 17/06/2022 05:00 PM
Deadline for absolute fail: The due dates for both items
Marks returned: 2 weeks after submission

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

Assessment criteria

Submission Due: 5pm, Friday Week 3 - 17th June

Peer Assessment Due: 5pm, Thursday Week 4 - 23rd June

This assignment will provide students with the opportunity to apply knowledge covered in the lectures and practice skills in the workshops in relation to weather data, data analysis and data visualisation.

Students will undertake data exploration of an unspecified data sources in order to provide three key insights of the data for Renewable Energy modelling. Data will be provided.

This assessment is to be done individually, and will be peer assessed, with a report to be submitted via Moodle. Marks will be awarded based on the completeness and quality of your submission, and how well you complete the peer assessment process.

No late reports will be accepted for this assessment task and a grade of zero will be awarded if a student does not complete the peer assessment section of the assignment.

Assessment 2: PV system performance analysis

Assessment length: 15 pages maximum
Due date: 15/07/2022 05:00 PM

Deadline for absolute fail: 23rd July by 5pm
Marks returned: within 2 weeks after submission

Report of the method and results assessing the performance of 1 year of PV system data.

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

Assessment criteria

Due: 5pm, Friday Week 7

This assignment will provide students with the opportunity to apply knowledge and practice skills related to weather data, data analysis and visualisation, bankable datasets, resource assessment, uncertainty, and PV system modelling.

Students will undertake a resource and energy production assessment for a proposed PV farm.

This assessment is to be done individually with a report to be submitted via Moodle. ***Late reports will attract a penalty of 5% on the due date.*** Reports submitted after the deadline for absolute fail or after the results have been released will incur the maximum penalty.

Assessment 3: Resource assessment

Assessment length: 10 pages maximum
Due date: 05/08/2022 05:00 PM
Deadline for absolute fail: 13th August by 5pm
Marks returned: within 2 weeks after due date

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).

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

Assessment criteria

Due: 5pm, Friday Week 7

This assignment will provide students with the opportunity to apply knowledge and practice skills related to weather data, data analysis and visualisation, bankable datasets, resource assessment, uncertainty, and PV system modelling.

Students will undertake a resource and energy production assessment for a proposed PV farm.

This assessment is to be done individually with a report to be submitted via Moodle. ***Late reports will attract apenalty of 5% on the due date.*** Reports submitted after the deadline for absolute fail or after the results have beenreleased will incur the maximum penalty.

Assessment 4: Final Exam

Due date: To be confirmed

Final exam to be held during the exam period.

Attendance Requirements

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

Course Schedule

The course consists of a 3-hour lecture and a 2-hour workshop session each week, as listed below:

	Day	**Time**	**Location (Moodle)**
Lectures	Thursday	12pm – 3pm	Online (Weeks 1-3, 4-10)
Workshops	Friday	2pm – 4pm	Online (Weeks 1-10)

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 2022 will be online. Please consult this course's Moodle module for details about delivery.

Week	**Topic**
1	0.1: Course Introduction 1. : Weather Data 2. : Data Visualisation
2	1. : Statistical Metrics 2. : Data Quality Assessment 2.3: Data Filling
3 & 4	3.1: Resource Assessments & Variability 3.2: Bankable Datasets
5 to 7	1. : PV Modelling – Part 1: Modelling Irradiance 2. : PV Modelling – Part 2: Shading, Soiling & Reflection Losses 3. : PV Modelling – Part 3: POA to Cell Temperature; to DC and AC Output
8	1. : PV System Monitoring 2. : PV System Analysis
9	6.1: Wind Energy

View class timetable

Timetable

Date	Type	Content
O-Week: 23 May - 27 May		
Week 1: 30 May - 3 June	Lecture	0.1:Course Introduction 1.1: Weather Data 1.2: Data Visualisation
	Workshop	Excel or Python Basics
Week 2: 6 June - 10 June	Lecture	2.1 Statistical Metrics 2.2 Data Quality Assessment 2.3 Data Filling
	Workshop	Data Quality Assessment
Week 3: 13 June - 17 June	Lecture	3.1: Resource Assessments & Variability
	Workshop	Statistical Metrics
	Assessment	Assignment 1 due - Topics assessed include: Data Exploration; Data Visualisation; and your assumed knowledge content
	Assessment	Data exploration and visualisation
Week 4: 20 June - 24 June	Lecture	3.2: Bankable Datasets
	Workshop	Creation of an Hourly Synthetic Weather File in PVsyst
Week 5: 27 June - 1 July	Lecture	4.1: PV Modelling – Part 1: Modelling Irradiance
	Workshop	Modelling PV Systems in PVsyst – I
Week 6: 4 July - 8 July	Lecture	4.2: PV Modelling – Part 2: Shading, Soiling & Reflection Losses
	Workshop	Modelling Module Temperature
		*UNSW Flexibility Week
Week 7: 11 July - 15 July	Lecture	4.3: PV Modelling – Part 3: POA to Cell Temperature; to DC and AC Output
	Workshop	Catchup Week – Complete Assignment 2

	Assessment	Assignment 2 due - Topics assessed include: Data Analysis; Data Visualisation; Data Quality Assessment; Resource Assessment; and PV System Modelling.
	Assessment	PV system performance analysis
Week 8: 18 July - 22 July	Lecture	5.1: PV System Monitoring 5.2 : PV System Analysis
	Workshop	Modelling PV Systems in PVsyst – II
Week 9: 25 July - 29 July	Lecture	6.1: Wind Energy
	Workshop	Handling Real World Problems
Week 10: 1 August - 5 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.
	Assessment	Resource assessment

Resources

Recommended Resources

Software

• PVsyst – Photovoltaic modelling software: https://www.pvsyst.com/

• 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/

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 workshopl resources for both the Microsoft Excel and Python learning streams; and the introduction of the online Course Book, available on Moodle.

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

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.

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.