Photovoltaic and Renewable Energy Engineering

Course Outline

Term 3 2020

SOLA1070

SUSTAINABLE ENERGY

Contents

1. Staff contact details

Contact details and consultation times for course convenor

Name: Dr Murad Tayebjee
Office location: TETB 242
Tel: (02) 9385 4259
Email: m.tayebjee@unsw.edu.au

The SOLA1070 Team in Microsoft Teams is the preferred method of communication.

Contact details and consultation times for additional lecturers/demonstrators/lab staff

Tutor: Bruno Stefani
Email: b.vicaristefani@unsw.edu.au

The SOLA1070 Team in Microsoft Teams is the preferred method of communication.

Please see the course Moodle.

2. Important links

- Moodle
- Computing Facilities
- Student Resources
- Course Outlines
- Engineering Student Support Services Centre
- Makerspace
- UNSW Timetable
- UNSW Handbook

3. Course details

Credit points

This is a 6 unit-of-credit (UoC) course and involves 4 hours per week (h/w) of face-to-face contact.

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 11 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.

Contact hours

	Day	Time	Location
Lectures	Tuesday	3pm - 5pm	Microsoft Teams (live)
Tutorials	Wednesday	12pm – 2pm	Microsoft Teams (live)
	Wednesday	3pm – 5pm	Microsoft Teams (live)

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

Summary and Aims of the course

Students will be introduced to the central concepts of energy and sustainability with a particular focus on sustainable energy systems through their use of the multiplayer ***PlayEnergy*** online simulation/game. Energy efficiency will be introduced as an effective way in which to conserve our natural fuel reserves and reduce environmental damage in a cost-effective way. This course will also introduce students to a range of renewable energy technologies such as photovoltaics, wind generators and solar thermal and allow them to explore ways in which these technologies and energy efficiency can be used to improve the sustainability of electrical power systems. Finally students will attempt to address the challenges involved in balancing between energy security (ability to meet demand), energy equity (affordability) and environmental sustainability in the design of an energy infrastructure for a community.

The course aims are:

- Introduce the concept of sustainability and increase awareness of the different sustainability indicators and the challenges imposed by climate change and natural resource reserves.
- Introduce the concept of energy, energy conversion, and energy efficiency.
- Introduce a range of renewable energy technologies and develop an understanding in students of how these technologies can be used to improve the sustainability of electrical power systems.
- Expose students to the challenges involved in balancing between energy security (ability to meet demand), energy equity (affordability) and environmental sustainability in the design of an energy infrastructure for a community.

SOLA1070 is a 1st year course in the School of Photovoltaic and Renewable Energy Engineering. It is a recommended elective for the Photovoltaics & Solar Energy and Renewable Energy Streams.

This course is an introductory course. More details on the topics covered are given in SOLA2450, SOLA5053, SOLA5057, SOLA3010, and MECH9720

Student learning outcomes

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.	Identify the key economic and environmental sustainability indicators.	1.1, 1.3, 1.6, 3.2, 3.3
2.	Describe the operation of a range of renewable energy technologies.	1.1, 1.2, 1.6, 3.2
3.	Perform calculations based on energy conversion and transfer processes.	1.1, 1.2, 2.1, 2.2
4.	Design an energy infrastructure by making decisions based on energy security (ability to meet demand), energy equity (affordability) and environmental sustainability.	1.1, 1.2, 1.6, 3.2, 3.3

4. Teaching strategies

In 2020 SOLA1070 will be taught completely online with **synchronous** classes on Microsoft Teams. The strategy here is to build a learning community, where there is the possibility for text chat between students at any time. Students will be introduced to basic program using MATLAB. A component of this course is gamified – that is, you will play an online game where you will make design choices on a house to try to minimize your CO_2 emissions, while maximizing your comfort. A weekly breakdown of what you should be able to do is provided below:

Sustainability (Week 1)

- Identify the dimensions of sustainability
- Identify economic, environmental, and social sustainability indicators.
- Discuss complementarities and conflicts between the dimensions of sustainability

Energy & Thermodynamics (Week 2)

- Define the concepts of energy and power in terms of: (a) power applied over time; and (b) rate of energy flow.
- Perform calculations using dimensional analysis to verify the above concepts.
- Perform calculations based on energy conversion and transfer processes.

Climate Change (Week 3) – Professor Jason Evans

- Describe the potential impacts of CO_2 emissions, and define and calculate related parameters such as CO_2 emission intensity.
- Identify strengths and weaknesses in public and academic debate about climate change.

Economics and Utility Scales (Week 4)

- Define, calculate and apply basic techno-economic parameters, including LCOE, the time value of money, and marginal cost of energy generation.
- Describe the relationships between energy efficiency and costs of electricity.
- Describe the implications of implementing large-scale renewable energy technologies on the electricity grid

Energy Efficiency (Week 5) – Prof Alistair Sproul

- Identify methods of reducing energy usage such as using low-energy whitegoods, appropriate building materials, and smart metering
- Assess the effects of increased energy efficiency on lowering CO_2 emissions

Solar Photovoltaic Power (Week 7)

- Explain why the entire solar spectrum cannot be harvested
- Describe the dependence of solar radiation intensity on: time of day; time of year; and location.
- Identify the energy conversion processes in a photovoltaic cell
- Calculate the power and energy generated by a photovoltaic array considering derating factors
- List the functions and desired properties of inverters

Wind Power (Week 8) – Dr Merlinde Kay

- Explain the basic underlying science of wind energy, and engineering aspects of wind turbines.
- Perform basic statistical analysis of wind data
- Perform calculations of annual energy output and determine the capacity factor of a wind turbine
- Have a good appreciation of some of the wider economic, social and environmental aspects of wind energy systems.

Solar Thermal & Storage (Week 9) – A/Prof Robert Taylor

- Compare solar thermal to solar photovoltaics in terms of key metrics and feasible applications
- Be able to explain and calculate the energy output of a solar thermal module as a function of direct and diffuse insolation, wind speed, ambient temperature, and operating temperature.
- Be able to distinguish between different solar thermal technologies and their suitability to different environments/applications.
- Describe the current challenges facing energy storage technologies
- Calculate required battery capacities and charging times

5. Course schedule

Week	Topic	Location	Suggested Readings
1	Introduction & Sustainability	Microsoft Teams	1. https://www.iea.org/sdg/ 2. https://www.un.org/sustainabledevelopment/ 3. Class readings
2	Energy and Thermodynamics	Microsoft Teams	1. https://phet.colorado.edu/en/simulations/filter 2. University Physics, Volume 1 Chapters 1, 7, and 8 (https://openstax.org/details/books/university-physics-volume-1) 3. Class readings

3	Climate Change	Microsoft Teams	1. https://www.ipcc.ch/ 2. Class readings
4	Economics and Utility Scale	Microsoft Teams	1. https://www.eia.gov/tools/glossary/ 2. https://www.aemo.com.au/ 3. Class readings
5	Energy Efficiency	Microsoft Teams	1. Class readings
6	Flexibility Week (Q & A)	Microsoft Teams	1. Wolf, E. L. (2018). Physics and technology of sustainable energy (First edition.). Oxford University Press. (Chapter 2)
7	Solar Photovoltaic Power	Microsoft Teams	1. https://www.pveducation.org/ 2. Class readings
8	Wind Energy	Microsoft Teams	1. Wolf, E. L. (2018). Physics and technology of sustainable energy (First edition.). Oxford University Press. (Chapter 8) 2. Class readings
9	Solar Thermal and Storage	Microsoft Teams	1. Wolf, E. L. (2018). Physics and technology of sustainable energy (First edition.). Oxford University Press. (Chapters 9, 11.2) 2. Class readings
10	Industry Guests & Summary	Microsoft Teams	

6. Assessment

Assessment overview

Assessment	Group Project? (# Students per group)	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
Moodle Quiz (1 untimed & 2 timed)	No	10 questions	40%	1,3 1,3,4 2,3,4	Quiz 1: Weeks 1 – 2 Quiz 2: Weeks 3 – 5 Quiz 3: Weeks 7 – 9	5pm, Sun 11th October 5pm, Sun 18th October 5pm, Sun 15th November	5pm, Fri 16th October 5pm, Fri 23rd October 5pm, Fri 20th November	One week after absolute fail deadline
Critical Thinking Written Assignment	No	500 words	10%	1,2,4	• Organization and structure • Use of literature resources • Grammar, punctuation, and spelling	5pm, Sun 1st November	5pm, Fri 6th November	One week after absolute fail deadline
PlayEnergy	No	3 weeks of play	10%	1,2,3,4	• Ability to answer questions about sustainable energy generation • Ability to design a house that minimizes CO_2 emissions, & maximizing thermal comfort	Ongoing online gameplay from Wed 28th Oct (wk 7) – Tue 18th Nov of (week 10)	N/A	On completion of the game
Exam	No	2 hours	40%	1,2,3,4	All course content	Exam period (TBC)	N/A	Upon release of final results

Assignments

Presentation

All submissions are expected to be neat and clearly set out. Your results are the pinnacle of all your hard work and should be treated with due respect. Presenting results clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect.

Submission

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of 30 percent 30% immediately, followed by 10 percent (10%) 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.

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.

Marking

Marking guidelines for assignment submissions will be provided at the same time as assignment details to assist with meeting assessable requirements. Submissions will be marked according to the marking guidelines provided.

Examinations

You must be available for all quizzes, tests and examinations.

Final examinations for each course are held during the University examination periods: February for Summer Term, May for T1, August for T2, and November/December for T3.

Please visit myUNSW for Provisional Examination timetable publish dates.

For further information on exams, please see the Exams webpage.

Calculators

You will need to provide your own calculator of a make and model approved by UNSW for the examinations. The list of approved calculators is available at student.unsw.edu.au/exam-approved-calculators-and-computers

It is your responsibility to ensure that your calculator is of an approved make and model, and to obtain an "Approved" sticker for it from the Engineering Student Supper Services Centre prior to the examination. Calculators not bearing an "Approved" sticker will not be allowed into the examination room.

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 submitting an assessment or sitting an exam.

Please note that UNSW now has a Fit to Sit / Submit rule, which means that if you sit an exam or submit a piece of assessment, 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.

7. Expected resources for students

UNSW Library website: https://www.library.unsw.edu.au/
Moodle: https://moodle.telt.unsw.edu.au/login/index.php
Microsoft Teams: https://www.microsoft.com/en-au/microsoft-365/microsoft-teams/download-app

8. 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 include:

1. Slides updated with colour-coded backgrounds to identify examinable material
2. Increased the number of worked examples
3. Lecture notes available prior to lectures
4. Large number of practice questions will be supplied towards the end of the term
5. Increased the level of "peer-learning" by having dedicated Microsoft Teams channels

9. 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

10. 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

Appendix A: Engineers Australia (EA) Competencies

Stage 1 Competencies for Professional Engineers

	Program Intended Learning Outcomes
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing
	PE1.3 In-depth understanding of specialist bodies of knowledge
	PE1.4 Discernment of knowledge development and research directions
	PE1.5 Knowledge of engineering design practice
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice
PE2: Engineering Application Ability	PE2.1 Application of established engineering methods to complex 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
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability
	PE3.2 Effective oral and written communication (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