Photovoltaic and Renewable Energy Engineering

Course Outline
Term 3  2020

SOLA1070

SUSTAINABLE ENERGY
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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

<table>
<thead>
<tr>
<th></th>
<th>Day</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures</td>
<td>Tuesday</td>
<td>3pm - 5pm</td>
<td>Microsoft Teams (live)</td>
</tr>
<tr>
<td>Tutorials</td>
<td>Wednesday</td>
<td>12pm – 2pm</td>
<td>Microsoft Teams (live)</td>
</tr>
<tr>
<td></td>
<td>Wednesday</td>
<td>3pm – 5pm</td>
<td>Microsoft Teams (live)</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Learning Outcome</th>
<th>EA Stage 1 Competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Identify the key economic and environmental sustainability indicators.</td>
<td>1.1, 1.3, 1.6, 3.2, 3.3</td>
</tr>
<tr>
<td>2. Describe the operation of a range of renewable energy technologies.</td>
<td>1.1, 1.2, 1.6, 3.2</td>
</tr>
<tr>
<td>3. Perform calculations based on energy conversion and transfer processes.</td>
<td>1.1, 1.2, 2.1, 2.2</td>
</tr>
<tr>
<td>4. Design an energy infrastructure by making decisions based on energy security (ability to meet demand), energy equity (affordability) and environmental sustainability.</td>
<td>1.1, 1.2, 1.6, 3.2, 3.3</td>
</tr>
</tbody>
</table>

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\textsubscript{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\textsubscript{2} emissions, and define and calculate related parameters such as CO\textsubscript{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 CO₂ 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

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Location</th>
<th>Suggested Readings</th>
</tr>
</thead>
</table>
| 1    | Introduction & Sustainability| Microsoft Teams | 1. [https://www.iea.org/sdg/](https://www.iea.org/sdg/)
3. Class readings |
2. University Physics, Volume 1 Chapters 1, 7, and 8
3. Class readings |
<table>
<thead>
<tr>
<th></th>
<th>Topic</th>
<th>Platform</th>
<th>Resources</th>
</tr>
</thead>
</table>
| 3 | Climate Change                 | Microsoft Teams    | 1. [https://www.ipcc.ch/](https://www.ipcc.ch/)  
2. Class readings                                      |
| 4 | Economics and Utility Scale   | Microsoft Teams    | 1. [https://www.eia.gov/tools/glossary/](https://www.eia.gov/tools/glossary/)  
3. Class readings                                      |
| 5 | Energy Efficiency              | Microsoft Teams    | 1. Class readings                                                        |
| 7 | Solar Photovoltaic Power       | Microsoft Teams    | 1. [https://www.pveducation.org/](https://www.pveducation.org/)  
2. Class readings                                      |
2. Class readings                                      |
2. Class readings                                      |
| 10| Industry Guests & Summary      | Microsoft Teams    |                                                                           |
6. Assessment

Assessment overview

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Group Project?</th>
<th>Length</th>
<th>Weight</th>
<th>Learning outcomes assessed</th>
<th>Assessment criteria</th>
<th>Due date and submission requirements</th>
<th>Deadline for absolute fail</th>
<th>Marks returned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moodle Quiz (1 untimed &amp; 2 timed)</td>
<td>No</td>
<td>10 questions</td>
<td>40%</td>
<td>1,3,4 2,3,4</td>
<td>Quiz 1: Weeks 1 – 2 Quiz 2: Weeks 3 – 5 Quiz 3: Weeks 7 – 9</td>
<td>5pm, Sun 11th October 5pm, Sun 18th October 5pm, Sun 15th November</td>
<td>5pm, Fri 16th October 5pm, Fri 23rd October 5pm, Fri 20th November</td>
<td>One week after absolute fail deadline</td>
</tr>
<tr>
<td>Critical Thinking Written Assignment</td>
<td>No</td>
<td>500 words</td>
<td>10%</td>
<td>1,2,4</td>
<td>• Organization and structure • Use of literature resources • Grammar, punctuation, and spelling</td>
<td>5pm, Sun 1st November</td>
<td>5pm, Fri 6th November</td>
<td>One week after absolute fail deadline</td>
</tr>
<tr>
<td>PlayEnergy</td>
<td>No</td>
<td>3 weeks of play</td>
<td>10%</td>
<td>1,2,3,4</td>
<td>• Ability to answer questions about sustainable energy generation • Ability to design a house that minimizes CO2 emissions, &amp; maximizing thermal comfort</td>
<td>Ongoing online gameplay from Wed 28th Oct (wk 7) – Tue 18th Nov of (week 10)</td>
<td>N/A</td>
<td>On completion of the game</td>
</tr>
<tr>
<td>Exam</td>
<td>No</td>
<td>2 hours</td>
<td>40%</td>
<td>1,2,3,4</td>
<td>All course content</td>
<td>Exam period (TBC)</td>
<td>N/A</td>
<td>Upon release of final results</td>
</tr>
</tbody>
</table>
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 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/

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

<table>
<thead>
<tr>
<th>Program Intended Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PE1: Knowledge and Skill Base</strong></td>
</tr>
<tr>
<td>PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals</td>
</tr>
<tr>
<td>PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing</td>
</tr>
<tr>
<td>PE1.3 In-depth understanding of specialist bodies of knowledge</td>
</tr>
<tr>
<td>PE1.4 Discernment of knowledge development and research directions</td>
</tr>
<tr>
<td>PE1.5 Knowledge of engineering design practice</td>
</tr>
<tr>
<td>PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice</td>
</tr>
<tr>
<td><strong>PE2: Engineering Application Ability</strong></td>
</tr>
<tr>
<td>PE2.1 Application of established engineering methods to complex problem solving</td>
</tr>
<tr>
<td>PE2.2 Fluent application of engineering techniques, tools and resources</td>
</tr>
<tr>
<td>PE2.3 Application of systematic engineering synthesis and design processes</td>
</tr>
<tr>
<td>PE2.4 Application of systematic approaches to the conduct and management of engineering projects</td>
</tr>
<tr>
<td><strong>PE3: Professional and Personal Attributes</strong></td>
</tr>
<tr>
<td>PE3.1 Ethical conduct and professional accountability</td>
</tr>
<tr>
<td>PE3.2 Effective oral and written communication (professional and lay domains)</td>
</tr>
<tr>
<td>PE3.3 Creative, innovative and pro-active demeanour</td>
</tr>
<tr>
<td>PE3.4 Professional use and management of information</td>
</tr>
<tr>
<td>PE3.5 Orderly management of self, and professional conduct</td>
</tr>
<tr>
<td>PE3.6 Effective team membership and team leadership</td>
</tr>
</tbody>
</table>