**SOLA3010**

**Low Energy Buildings and Photovoltaics Contents**

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# Staff contact details

## Contact details and consultation times for course convenor

Name: Prof. Alistair Sproul

Office location: Room 134, TETB

## Email: a.sproul@unsw.edu.au

Moodle: <https://moodle.telt.unsw.edu.au/>

Online Consultations: Thursday 3 – 4 pm

Consultation Method: Microsoft Teams (link will be posted on Moodle)

Consultations: Thursday 3 – 4 PM. For all enquiries about the course please contact the course convener. For all other questions or enquiries, you are encouraged to post questions to the lecturer during and after class via Teams or post your question on the Discussion Board on Moodle.

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

Please see the course [Moodle](https://moodle.telt.unsw.edu.au/login/index.php).

# Important links

* [Moodle](https://moodle.telt.unsw.edu.au/login/index.php)
* [Student Resources](https://www.unsw.edu.au/engineering/student-life/student-resources)
* [UNSW Timetable](http://timetable.unsw.edu.au/current/subjectSearch.html)
* [UNSW Handbook](https://www.handbook.unsw.edu.au/)
* [Engineering Student Support Services Centre](https://nucleus.unsw.edu.au/en/contact-us)
* [UNSW Photovoltaic and Renewable Energy Engineering](https://www.unsw.edu.au/engineering/photovoltaic-and-renewable-energy-engineering/study/student-resources)

# Course details

## Credit points

This is a 6 unit-of-credit (UoC) course and involves 5 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 10 -13 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.

## Pre-requisite and Assumed Knowledge

It is assumed that students will have already taken SOLA2540 Applied PV, SOLA9001 Photovoltaics or have equivalent knowledge.

## Contact hours

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Day** | **Time** | **Location** |
| **Lectures** | Monday | 11am – 2pm | Online (via Teams) |
|  |  |  |  |
| **Demonstrations** | Wednesday | 2pm – 4pm | Law 388 |
|  | Wednesday | 4pm – 6pm | Online |
|  | Friday | 2pm – 4pm | Online |

Please refer to your class timetable for the learning activities you are enrolled in and attend only those classes. Note that classes will run Weeks 1-5 and 7-10. Week 6 is a revision week with no new material being taught.

## Summary and Aims of the course

There is currently significant interest in reducing energy use and greenhouse gas production in buildings by designing buildings that are climate-appropriate, implementing energy efficiency measures and producing energy from renewable sources. Prediction of building thermal, lighting performance and solar access, and techniques for energy efficient design will be introduced, with a focus on residential buildings. A competency in the use of building energy simulation software will be developed. Photovoltaics (PV) is one of the few renewable electricity generation options that can be readily used in urban areas and has no environmental impacts at the site. This course will examine the integration of PV modules into the building envelope. Technical issues associated with the use of PV in buildings and the urban environment, such as heat transfer processes, partial shading, and mismatch and system siting, sizing and configuration will be investigated. System performance assessment and prediction will be introduced.

## 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. | Describe the relationship between building design and thermal and lighting performance, heating, cooling and lighting loads, and human comfort in buildings. | PE1.1, PE1.3, PE1.5, PE1.6, PE2.1, PE2.3 |
| 2. | Determine the heat transfer, thermal comfort and lighting performance of a building using manual methods and software, and apply appropriate passive solar and low energy building design strategies. | PE1.1, PE1.3, PE1.5, PE1.6, PE2.1, PE2.2, PE2.3 |
| 3. | Assess solar access at a site using manual methods and/or software. | PE1.1, PE1.3, PE1.5, PE1.6, PE2.1, PE2.2, |
| 4. | Estimate the temperature of BIPV installations and the thermal impact of PV on buildings. | PE1.1, PE1.3, PE1.5, PE1.6, PE2.1, PE2.2, |
| 5. | Write a technical report that assesses the performance of various designs of low energy buildings and BIPV systems | PE1.1, PE1.3, PE1.5, PE1.6, PE2.1, PE2.2, PE3.2, PE3.5 |

# Teaching strategies

The teaching strategy for this course comprises a series of lectures and tutorial sessions. The lecture series will present theory related to understanding the relationship between building design and thermal and lighting performance, and human comfort.

Tutorial sessions will involve a combination of computer-based sessions (where students will learn how to use programs such as SAM and OpenStudio) as well as Problem Sets which will cover all topics for this course. A tutor will be available to give assistance during each of the scheduled tutorial sessions.

Within the course, students are expected to attend all lectures and tutorials and are encouraged to actively participate in order to maximise their own learning. In addition to the lecture notes, you will be expected to read relevant papers and texts as required. Group learning is also encouraged but of course PLAGIARISM IS NOT. UNSW *assumes* that self-directed study of this kind is undertaken in addition to attending face-to-face (or online) classes throughout the course.

# Course schedule

The schedule for the lectures and tutorials is provided below. The topics and the order are subject to change at any time.

**Indicative Online Lecture Schedule**

|  |  |
| --- | --- |
| **Week** | **Topic** |
| 1 | Course Introduction, Psychrometry and Human Comfort |
| 2 | Heat Transfer in Buildings |
| 3 | Lighting and Shading |
| 4 | Lighting and Shading cont. |
| 5 | Climate and Passive Solar |
| 6 | Flexible Week 6 |
| 7 | Climate and Passive Solar cont. |
| 8 | Climate and Passive Solar cont. |
| 9 | PV and Buildings |
| 10 | BIPV Case Studies |

**Indicative Online Tutorial Schedule**

|  |  |
| --- | --- |
| **Week** | **Topic** |
| 1 | Psychrometry & Human Comfort |
| 2 | Heat Transfer |
| 3 | Lighting and Shading |
| 4 | Lighting and Shading |
| 5 | Climate & Passive Solar |
| 6 | Flexible Week 6 |
| 7 | OpenStudio & SAM tutorials |
| 8 | OpenStudio & SAM tutorials |
| 9 | Climate & Passive Solar |
| 10 | Photovoltaics and Buildings |

# Assessment

## Assessment overview

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Assessment** | **Group Project?** | **Length** | **Weight** | **Learning outcomes assessed** | **Assessment criteria** | **Due date and submission requirements** | **Deadline for absolute fail** | **Marks returned** |
| Online  Quiz 1 | No | 1 hour | 7.5% | 1 and 2 | Topic material on:  1. Psychrometry and Human Comfort,  2. Heat Transfer. | Opens: 9am, Wed Wk 4;  Closes: 5pm, Fri Wk 4  Available on Moodle | N/A | After the quiz closes |
| Online Quiz 2 | No | 2 hours | 7.5% | 1,2 and 3 | Topic material on  1. Lighting and Shading. | Opens: 9am, Wed Wk 7;  Closes: 5pm, Fri Wk 7  Available on Moodle | N/A | After the quiz closes |
| Assignment | No | 2500 words | 40% | 1,2,3,4 and 5 | All course content and report writing skills. | Due: 5pm, Mon Wk 11 Submission via Moodle | 2 days | 2 weeks after the submission date. |
| Final Exam | No | 2 hours | 45% | 1,2,3 and 4 | All course content. | Exam period, date TBC | N/A | Upon release of final results |

## Assignments

## Assessments

The assessment scheme in this course reflects the intention to assess your learning progress throughout the term. Submission will be via Moodle for the online quizzes and the assignment (PDF only, no hard copy submissions). The final examination will cover all material in the course.

## Online Quizzes (15%)

The two online quizzes will comprise a number of questions based on materials presented in the first two topics of the course on Psychrometry and Human Comfort, and Heat Transfer for Quiz 1; and on the topic of Lighting and Shading for Quiz 2. This assessment must be completed individually via Moodle. Marks will be assigned according to how completely and correctly the quiz questions have been answered.

## Assignment (Total 40%)

This assignment will involve the use of OpenStudio and SAM to simulate the thermal and daylighting performance of a building and the electrical performance of an associated PV system.

The Assignment is designed to give you a chance to apply your knowledge to real-world problems related to low energy buildings and the use of PV in the built environment. There will be an emphasis on understanding the fundamental physical processes involved in building thermal and lighting performance and the interaction of PV and buildings with the environment. You will gain competency in modelling building performance using software and demonstrate an understanding of the model by interpreting the results. The report must be submitted online via Moodle.

### Presentation

All non-electronic submissions should have a standard School cover sheet, which is available from this course’s Moodle page.

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%) mark reduction on the first day and an additional 10% per day thereafter, consistent with other SPREE courses.

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:

1. Weekly online tests or laboratory work worth a small proportion of the subject mark, or
2. Online quizzes where answers are released to students on completion, or
3. Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date, or
4. 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](https://student.unsw.edu.au/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](https://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 Support Services Centre](https://nucleus.unsw.edu.au/en/contact-us) 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](https://student.unsw.edu.au/sites/all/files/uploads/group271/fit-to-sit-guide.pdf), 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](https://student.unsw.edu.au/special-consideration).

# Expected resources for students

UNSW Library website:<https://www.library.unsw.edu.au/>

Moodle: <https://moodle.telt.unsw.edu.au/login/index.php>

## Reference Books

* Introduction to Architectural Science – S. Szokolay
* Heat and Mass Transfer: A Practical Approach – Y.A. Cengel
* Thermodynamics: An Engineering Approach – Y.A. Cengel, M.A. Boles (useful for psychrometry)
* Energy Efficiency Building Design – Resource Book – Brisbane TAFE – Holger Willrath
* A Handbook on Low-Energy Buildings and District-Energy Systems: Fundamental, Techniques, and Examples – L D Danny Harvey (excellent book! UNSW library has a few hard copies but is also available as an e-book).

## Online Resources

*UNSW Resources*

* UNSW Library website: <https://www.library.unsw.edu.au/>
* Moodle: <https://moodle.telt.unsw.edu.au/login/index.php>

*Climate Information*

* Australian Bureau of Meteorology: <http://www.bom.gov.au>
* NASA – The POWER Project: <https://power.larc.nasa.gov/>

*Low Energy Buildings*

* Australian Greenhouse Office “Your Home” technical manual – Good information of residential design and measures to conserve water & energy: <http://www.yourhome.gov.au/>
* Rocky Mountains Institute: <http://www.rmi.org/Buildings>
* Victorian Energy Smart Housing Manual: <http://www.aprbuildingservices.com.au/C1_Energy_Smart_Housing.html>

BIPV Sites

* IEA Task 7: <https://task07.iea-shc.org/>
* IEA Task 10: <http://www.iea-pvps-task10.org/>
* Whole Building Design Guide - BIPV - Steven Strong: <http://www.wbdg.org/resources/bipv.php>

Design Tools

* SAM – Software for photovoltaic Systems: <https://sam.nrel.gov/>
* OpenStudio – Thermal simulation software utilizing Energy Plus: <https://www.openstudio.net>
* Energy Plus – Accurate thermal simulation (without visualization): <http://www.eere.energy.gov/buildings/energyplus/>
* Desktop Radiance - Imaging software for lighting analysis: <http://radsite.lbl.gov/deskrad/>

Solar Architects

* Bear iD (Netherlands): <http://bear-id.com/>
* Solar Design Associates (US) <http://www.solardesign.com/>
* Kiss + Cathcart Architects (New York) <http://www.kisscathcart.com/>
* Solarcentury (UK) <http://www.solarcentury.co.uk/>
* Studio E Architects (UK) <http://www.studioe.co.uk/>
* Architekturbüro Hagemann <http://www.architekturbuero-hagemann.com/>

Standards and Rating Frameworks & Software

* Building Code of Australia - via UNSW Library (sirius)
* NABERS: <https://www.nabers.gov.au/>
* Green Star: <http://www.gbca.org.au/green-star/>
* NatHers: <http://www.nathers.gov.au/>
* AccuRate: <http://www.energyinspection.com.au/products/accurate/>
* BASIX: <http://www.basix.nsw.gov.au/information/index.jsp>

# 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 …

* The assignment for this course has been simplified and streamlined. For example, ambiguous questions or directions have been avoided.
* Past versions of this course utilized graphical methods for calculating and visualizing shading and solar access. Whenever possible suitable software packages are used instead. However, it is still useful for students to be able to draw simplified examples of shading and solar pathway diagrams.

# 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](https://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](http://www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf)

# 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](https://student.unsw.edu.au/attendance)
* [UNSW Email Address](https://www.myit.unsw.edu.au/services/students/email-students-and-staff)
* [Special Consideration](https://student.unsw.edu.au/special-consideration)
* [Exams](https://student.unsw.edu.au/exams)
* [Approved Calculators](https://student.unsw.edu.au/exam-approved-calculators-and-computers)
* [Academic Honesty and Plagiarism](https://student.unsw.edu.au/plagiarism)
* [Equitable Learning Services](https://student.unsw.edu.au/els)

# 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 |