SOLA3010 & SOLA9009
Low Energy Buildings and Photovoltaics
Course Outline

6 Units of Credit (UOC)

4 contact hours per week

Course Context and Description

Building energy use comprises about 40% of the total electrical energy used in NSW. Since the advent of artificial heating and lighting methods and the modernist aesthetic, much of the traditional wisdom that informed climate-specific architecture has been abandoned. There is currently significant interest in reducing energy use in buildings and particularly greenhouse gas production in buildings, by:

1. Using intelligent building design that responds to the climatic conditions found at the site.
2. Implementing efficiency measures that reduce waste of energy.
3. Producing energy (heat or electrical) from renewable sources.

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. PV was first used in buildings in the 1970s, usually in remote areas without access to the grid. In the 1980s, grid-connected PV modules on roofs of houses were demonstrated. The term Building-Integrated PV (BIPV) describes the integration of PV modules into building materials so that PV forms part of the building envelope such as the roof, walls or glazing elements of the building. In the 1990s, BIPV demonstration projects in the US, Europe and Japan led to BIPV construction products being developed and commercialised.

BIPV is usually part of the building envelope, hence requiring no separate support structure; and replacing conventional building materials, including high-value commercial building façades which can cost as much as a PV façade. Recently, BIPV products have begun to evolve into elegant building technologies designed to also provide shading, daylighting, rain-cladding or noise protection for buildings. The collection and reuse of the waste heat from PV, known as PV-T technology is also an area being commercialised. Photovoltaics in buildings and the built environment in general is one of the fastest growing markets for PV, particularly in Europe. Although prices for PV electricity in Europe are significantly higher than grid electricity, GHG reduction goals, supported by government initiatives and the high value accorded to a “green” image in buildings have created an environment where PV in buildings has experienced strong growth.

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 in this course with a focus on residential buildings. A competency in the use of building energy simulation software will be developed. The course will examine the use of PV in the urban environment, with a particular focus on 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. Students will tackle urban design problems that require balancing architectural and human requirements with the functional constraints of PV technology. Examples of PV products for buildings and the urban environment will be studied and system performance assessment and prediction will be introduced.

Assumed Knowledge

You will be expected to have an understanding of 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, including the mathematical analysis. Methods for sizing PV systems will also be assumed knowledge. First year physics is also assumed knowledge.

Learning Objectives

By the end of this course, you will be able to:

- Understand the relationship between building design and thermal and lighting performance, heating, cooling and lighting loads and human comfort in buildings.
- Use a psychrometric chart to analyze climate, human comfort and psychrometric processes and the effects of common passive solar strategies.
- Determine the thermal and lighting performance of a building using manual methods and software.
- Apply appropriate passive solar and low-energy design strategies.
- Assess solar access at a site using manual methods and/or software.
- Estimate the temperature of BIPV installations and the effects of PV on the building.
- Specify components for, locate and size BIPV systems.
- Explore ways of balancing architectural and human requirements with the functional constraints of BIPV technology.
- Know how to express the value of BIPV systems.

Delivery of the Course

This course comprises four hours of formal contact per week. The timing and rooms are given below.

	Day	Time	Location
Lectures:	Tuesday	10 am – 11 am	Chemical Science M18
	Thursday	10 am – 11 am	Chemical Science M18
Tutorials:	Monday	11 am – 1 pm	Tyree Energy Tech CMLB LG34
	Tuesday	11 am – 1 pm	Tyree Energy Tech CMLB LG34
	Wednesday	11 am – 1 pm	Tyree Energy Tech CMLB LG34
	Thursday	1 pm – 3 pm	Tyree Energy Tech CMLB LG34
	Friday	11 am – 1 pm	Tyree Energy Tech CMLB LG34

Two one hour lectures per week will introduce theory, worked examples and case studies covering the topics listed in the course schedule. Problem sets will allow you to practice solving problems related to each topic and develop skills needed for the mid-session test, assignment and the final exam. Some tutorials will be used to go through the problem sets for each topic (see the course schedule for details). Other tutorials will be held in the computer labs and will used to develop skills in the use of building performance modelling software and PV system modelling software, and to assist you in their use for the assignment (dates to be advised). Students are encouraged to attend Sustainable House Day on Sunday 8th September to see real examples of sustainable design. (http://www.sustainablehouseday.com/).

Course Contacts

Course website: Moodle

Access via myUNSW

Moodle will be used to post the following:

- important announcements
- lecture slides
- problem sets, and worked solutions
- assignment briefs & resources
- links to resources & downloadable documents

Course Co-ordinator:

Assoc. Prof. Alistair Sproul
Room: 319, Tyree Energy Technology Building
Phone: 9385 4039
Email: a.sproul@unsw.edu.au

Student Responsibilities and Class Policies

1. Grading criteria for assignments are listed on individual assignment briefs. You must submit the assignment and achieve at least 40% on the final exam in order to pass the subject.
2. Late assignments will be penalised 50% per day that the work is late, unless acceptable reasons are given. Once solutions to the assignment are available or marked assignments are returned, no further work will be accepted.
3. Attendance and Attention. Responsibility for learning rests primarily with the student. Lecture slide handouts do not necessarily contain sufficient detail to complete the assessment tasks and prepare for the exam, while tutorials and computer lab classes often cover different material to that covered in lectures. It is therefore recommended that you aim to attend 100% of lectures, tutorials and labs and take notes where appropriate, avail yourself of the course resources, complete your assignments on time and to the best of your ability, and to be fully aware of the course syllabus and any announcements or changes to the syllabus.
4. Students are expected not to distract their colleagues during classes.
5. All assignments and tutorials are for individual effort and individual assessment except where explicitly specified. You are expected to be aware of, and you will be subject to, the UNSW and School policies that cover plagiarism of written work (see below and further details on the Current Students section of the SPREE website). Students will be penalised for plagiarism in tutorial, assignment and exam work.
6. Tutorials and Assignments. Students may feel that the time required to complete the problems sets and assignment is disproportionately large compared to their weighting in the assessment table. However, note that the final exam will draw on material and skills covered in tutorials and assignments. Thus, it will be of benefit to you to put in the effort required to understand and complete the problem sets and assignment to the best of your ability.

Plagiarism

Plagiarism is the presentation of the thoughts or work of another as one's own.*
Examples include:

- Direct duplication of the thoughts or work of another, including by copying work, or knowingly permitting it to be copied. This includes copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person's assignment without appropriate acknowledgement
- Paraphrasing another person's work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
- Piecing together sections of the work of others into a new whole;
- Presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and,
- Claiming credit for a proportion of work contributed to a group assessment item that is

greater than that actually contributed.†

- Submitting an assessment item that has already been submitted for academic credit elsewhere may also be considered plagiarism.
- The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does not amount to plagiarism.

Students are reminded of their Rights and Responsibilities in respect of plagiarism, as set out in the University Undergraduate and Postgraduate Handbooks, and are encouraged to seek advice from academic staff whenever necessary to ensure they avoid plagiarism in all its forms.

Students 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 items.

Please see the resources page for academic assistance in relation to avoiding plagiarism.

* Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle.
† Adapted with kind permission from the University of Melbourne.

Disabilities

If you have a disability that requires some adjustment in your teaching or learning environment, you are encouraged to discuss your study needs with Alistair Sproul prior to, or at the commencement of, the course, or with the Equity Officer (Disability) in the EADU (phone 9385 4734). 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.

Exam Dates

Students should ensure they are able to attend an exam on a date to be allocated during the scheduled dates for UNSW S2 exam period.
https://my.unsw.edu.au/student/resources/AcademicCalendar.html

NOTE: Students who make travel arrangements and are not available for an exam during this period will not be offered alternative arrangements.

Topic Schedule

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

Topic	Lecture Topic
0	Introduction to the Course
1	Psychrometry and Human Comfort
2	Heat Transfer in Buildings
3	Lighting and Shading
4	Climate and Passive Solar
5	Standards and Rating Schemes
6	PV in Buildings
7	BIPV Case Studies
8	Review Lecture

Assessment

Assessment Rationale

A mid-session assignment will be due in Week 5. The final examination will cover all material in the course.

The major assignment is designed to give you a chance to apply your knowledge to real-world problems relating to low energy buildings and the use of PV in the built environment. There will be an emphasis on understanding of 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.

Details of Assessment Tasks

	Due Date	Weighting
Midsession assignment	Week 5 Weds 27th August 2 pm	15%
Major Assignment	Week 12: Friday 24th October, 2 pm	40%
Final Exam	UNSW S2 exam period 7th to 22nd Nov, 2014	45%
	Total	100%

You must submit both the assignments and score at least 40% on your final exam in order to pass the subject.

- The midsession assignment and final exam will be in a similar form to the problem sets.
- All material presented during the session, including lectures, guest lectures, problems sets, midsession assignment and the major assignment, is examinable.
- If necessary, assessment marks may be scaled.

Lateness penalty

A deduction of 50% per day of the total possible mark will be made for any late submissions.

Books and Links

Recommended Texts

- 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 Efficient Building Design – Resource Book – Brisbane TAFE – Holger Willrath
- A Handbook on Low-Energy Buildings and District-Energy Systems: Fundamentals, Techniques, and Examples - L D Danny Harvey – excellent book! – UNSW library has a few hard copies but is also available as an e-book.
- Net Zero Energy Design: A Guide for Commercial Architecture, Thomas Hootman

Web Resources

Climate Information

- Australian Bureau of Meteorology - http://www.bom.gov.au/climate/
- NASA - eosweb.larc.nasa.gov/sse/

Low Energy Buildings

- Australian Greenhouse Office “Your Home” technical manual - Contains info on good residential design and measures to conserve water & energy - http://www.greenhouse.gov.au/yourhome/technical/index.htm
- Victorian Energy Smart Housing Manual - http://www.sustainability.vic.gov.au/www/html/1823-publications---c-f.asp
- Energy Design Resources - http://www.energydesignresources.com/

BIPV Sites

- IEA Task 7 http://www.task7.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

- PVSYST - Software for photovoltaic Systems http://www.pvsyst.com/
- Design Builder – Thermal simulation software utilizing Energy Plus http://www.designbuilder.co.uk/
- Energy Plus - Accurate thermal simulation (without visualization) http://www.eere.energy.gov/buildings/energyplus/
- Ecotect - Visual building energy analysis and design tool http://usa.autodesk.com/ecotect-analysis/
- Desktop Radiance - Imaging software for lighting analysis http://radsite.lbl.gov/deskrad/

Solar Architects

- Bear Architecten Netherlands) http://www.bear.nl/
- 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/
- RELAB LLC http://www.relabllc.com/index.html

Standards and Rating Frameworks & Software

- Building Code of Australia - via UNSW Library (sirius)
- NABERS http://www.nabers.com.au/default.aspx
- Green Star http://www.gbca.org.au/green-star/
- NatHers http://www.nathers.gov.au/
- Accurate http://www.hearne.com.au/products/accurate/
- BASIX http://www.basix.nsw.gov.au/information/index.jsp

BIPV Products

- BIPV Resources including listing of Manufacturers, Products & Case Studies: http://www.pvresources.com/BIPV.aspx

Assistance with Report Writing, Presentations, Referencing and other Academic Skills

Refer to the UNSW Learning Centre for guidance in relation to report writing, presentations, referencing, note taking and time management. (https://student.unsw.edu.au/writing-skills-support)

The Learning Centre website is the central University online resource for staff and student information on plagiarism and academic honesty. It can be located at: www.lc.unsw.edu.au/plagiarism. The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

- Writing;
- Presentations;
- Correct referencing practices;
- Paraphrasing, summarising;
- Note taking;
- Time management;
- Appropriate use of and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.