Term 1, 2020 Course Outline

SOLA5057-GSOE9017

Energy Efficiency/ Managing Energy Efficiency

Contents

1. Staff contact details

Course Convener:	Prof. Gavin Conibeer, TETB, g.conibeer@unsw.edu.au Room 245, TETB, Tel: 9385 7858
Lecturers:	Prof. Gavin Conibeer, Dr. Mehrdad Farshchimonfared, Prof. Alistair Sproul

Consultations: For all enquiries about the course please contact the course convener. For all other questions or enquiries you are encouraged to ask the lecturer after class or post your question on the Discussion Forum on Moodle.
https://moodle.telt.unsw.edu.au/login/index.php

Keeping Informed: All course material and announcements will be posted on Moodle. Please note that you will be deemed to have received this information, so you should take careful note of all announcements. Email contact via UNSW student email will also be used at times.

Please see the course Moodle.

2. Important links

- Moodle
- Health and Safety
- Student Resources
- UNSW Timetable
- UNSW Handbook
- Engineering Student Support Services Centre
- UNSW Photovoltaic and Renewable Energy Engineering

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 14-16 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

The course consists of a 2 hour lecture and project session and a 2 hour tutorial session each week as listed below. NOTE Lectures will run from week 1 until week 10 (with no lecture in week 7, flexible study week). Tutorials will run from week 2 until week 10 (with no tutorial in week 7, flexible study week).

	Day	Time	Location
Lecture and projects	Wednesday Weeks 1-6	3 - 5pm	Ainsworth Lecture theatre (G03-J17)
Lecture and projects	Wednesday Weeks 8-10	3 - 5pm	Ainsworth Lecture theatre (G03-J17)
Tutorials	10 tutorial classes throughout each week, as assigned and timetabled Weeks 2-6 & 8-10		

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

This course focuses on the efficient use of energy, predominantly in residential, commercial, and industrial settings. Transport, water and energy efficiency policy in Australia will also be covered. An understanding of the technical and economic possibilities of energy efficiency in the area of energy systems is vital for all engineers, and especially those involved in management of energy costs and environmental performance of a wide range of organisations, e.g. businesses, government organisations and public institutions.

Pre-requisites and Assumed Knowledge
It is assumed that you can competently use Microsoft Excel (or equivalent software) for data manipulation and graphing. A background in Mathematics and Physics is assumed and preferably also an introductory level knowledge of Electrical energy and power, Heat Transfer, Fluid Mechanics and Thermodynamics.
Following Courses
The course is a suggested pre-requisite for SOLA3010/SOLA9009 and GSOE9122.
Relationship to Other Courses
SOLA5057 is a 3rd or 4th year course in the School of Photovoltaic and Renewable Energy Engineering. It is a compulsory course for the Renewable Energy Engineering (BE Hons) program and a “Disciplinary and Professional Elective” for the Photovoltaics and Solar Energy (BE Hons) program.

GSOE9017 is an elective course (Advanced Disciplinary Knowledge) for the Photovoltaic and Solar Energy (SOLAES5341**)** and Masters of Engineering Science in Photovoltaic and Solar Energy (SOLACS8338). SOLA5057 is an elective course (Disciplinary Knowledge) for the Masters of Engineering Science in Renewable Energy (SOLADS8338).

Context and Aims

The emphasis in this course is on a "whole of system" engineering approach to end use energy. Traditional engineering focuses on small components of a total system. Opportunities to use energy most efficiently are possible only once the whole system is considered. This approach can allow much larger energy reductions of end use energy consumption to be achieved (in some cases as much as 95% energy reductions can be achieved whilst still delivering the same service). Assignments based on energy audits of a student's own energy usage in transportation and household energy usage allow students to gain hands on experience of how to reduce energy consumption. Analysis of energy systems will focus on understanding the basic physical processes involved, identifying and quantifying the minimum energy requirements of energy consuming processes.

Learning outcomes

After successful completion of this course, you should be able to:

1. Identify and quantify energy efficiency opportunities across a range of energy consuming end use applications.
2. Analyse the economic potential of various energy efficiency options.
3. Carry out effective energy audits.
4. Communicate the results of such audits.

This course is designed to achieve the above learning outcomes which address the specific UNSW and Faculty of Engineering graduate capabilities listed in ***Appendix A***. This course also addresses the Engineers Australia (National Accreditation Body) Stage I competency standard as outlined in ***Appendix B***.

Syllabus

If Australia and the world are to reduce emissions of greenhouse gases, both renewable energy and more efficient use of that energy will be required. Energy efficiency is the cheapest, fastest, safest and simplest way to reduce emissions. This course covers the various methodologies, technologies and policies that can be used to reduce energy use, while still producing what that energy is needed for - heat, light and movement.

Topics covered include current and predicted energy use and associated GHG emissions; residential and commercial energy usage; energy management programs; building management systems; heating, ventilation and air conditioning; and consumer products and office equipment. The impacts of transport are also covered, together with opportunities to reduce transport energy requirements through more efficient engines, public transport, and urban design. Industrial systems examined include heat recovery; cogeneration; compressed air and steam distribution; and motor systems, pumps and fans. Efficient use of water and increased efficiency of water supply can also significantly reduce energy use. Various government policy measures at the local, state, commonwealth and international level are covered in terms of their effectiveness and relevance in Australia. Finally, barriers to improved energy efficiency such as up-front cost, lack of information, and the cost of energy in Australia are examined.

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 successful completion of this course, you should be able to:

Learning Outcome		**EA Stage 1 Competencies**
1.	Identify and quantify energy efficiency opportunities across a range of energy consuming end use applications.	PE1.1,1.3,1.5,1.6 PE2.1,2.2,2.3
2.	Analyse the economic potential of various energy efficiency options.	PE1.1,1.3,1.5,1.6 PE2.1,2.2,2.3
3.	Carry out effective energy audits and analysis of energy systems.	PE1.5,1.6 PE2.4 PE3.2,3.4
4.	Communicate the results of such audits and analyses.	PE1.5,1.6 PE2.4 PE3.2,3.4

4. Teaching strategies

The teaching strategy for this course comprises a series of adaptive learning packages (ALPs), lectures, projects and tutorial sessions.
All the knowledge content for the course is included in the Adaptive Learning Packages that will be released each week on Moodle. It is expected that students will work through these interactive packages before the lecture each week.
The short lectures on Wednesdays will summarise the key points of these ALPs and allow time for discussion of any points that are not clear.
The lecture each week will be followed by project work. The class will be divided into project groups and work on a topic related to the topic of the week. The outputs from the projects will form the basis of the assignments 1 and 2 and the power factor assignment.
There will be laboratory classes arranged in the middle part of the course. Groups will be arranged through Moodle at least two weeks in advance of lab classes. This lab will investigate variable speed motors and will include a brief assessment.
Tutorials classes will be held each week for small groups. Tutorials will build on this knowledge by students undertaking more quantitative problem solving with an emphasis on a fundamental physical understanding of the processes involved. An understanding of first year university physics is sufficient. Weekly Problem Sets will cover all topics for this course. A demonstrator will be available to give assistance during each of the scheduled tutorial sessions.
Guest lectures form an important part of the course, with industry and academic experts giving their opinions on topics in energy efficiency.

5. Course schedule

Week	Class Schedule (subject to small changes)
Week 1	Introduction to course *Case study – the Tyree Energy Technologies Building (TETB)* Economic Terms and Energy Policy *Project: Arrangment of project groups;* *Transport to/from UNSW*
Week 2	Residential Energy, Hot Water, Energy Management *Project: Household energy usage*
Week 3	Lighting, MEPS, Energy Audits, Design Rating Schemes *Project: Deliverable on personal energy usage*
Week 4	Transport Efficiency *Project: The Power Factor Virtual Laboratory*
Week 5	Commercial, HVAC, Co-Generation, Coefficient of Performance, Energy management control systems *Project: Computer energy usage*
Week 6	Industrial Energy Efficiency 1: Electric motors, Electric motor systems, pumps and fans *Project: Design of pipe layouts to minimise energy use* *Guest lecture: TBA Dr Jose Bilbao – TETB trigeneration system*
Week 7	Flexible study week - no lecture
Week 8	Industrial Energy Efficiency 2: Furnaces, Heat recovery, Distributed generation, Combined cycle generation *Project: Co-generation*
Week 9	Cogeneration, Absorption cooling, Production & distribution of process steam and compressed air Review of course Discussion of Digital Exam and example questions
Week10	Guest lectures: *TBA – A systems approach to energy efficiency* *Dr Mehrdad Farshchimonfared – HVAC: reduced energy use;*

- The course structure is subject to small changes during the term. In particular, the projects and guest lectures in *italics* may move weeks and change slightly in content or presenter.

Week	Summary of Tutorial Program
2 -10	Tutorials will cover material from the previous week's Activities

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

6. Assessment

Assessment overview

Assessment	Group Project? (# Students per group)	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Marks returned
Assignment 1: Energy Audit	No	20 pages	20%	1,2,3,4	ALP and lecture material from weeks 1-3 Energy system analysis skills Report writing skills	11.55pm Friday 6th March (week 3) via Moodle	Two weeks after submission
Assignment 2: Co-generation	No	18 pages	20%	1,2,3,4	ALP and lecture material from weeks 1-3 Energy system analysis skills Report writing skills	11.55pm Friday 10th April (week 8) via Moodle	Two weeks after submission
Quizzes and Laboratories	No	Multiple choice and simple answers	15%	1,2	Quizzes: each week's quiz will test material from the previous week Labs: material from weeks 2,3 & 6	Quizzes: 11.55pm each Tuesday Labs: on completion of the lab	
Final exam	No	2 hours	45%	1,2	All course content from weeks 1-10 inclusive.	Exam period, date TBC	Upon release of final results

The assessment scheme in this course reflects the intention to assess your learning progress through the semester.

Assignments

Assignment 1 (Total 20%)

Students will quantitatively assess the domestic energy consumption of a household and the impact of travelling to and from university/work over a year. In addition students will identify different ways these impacts could be minimized.

This analysis will be carried out in project work during the Wednesday classes of weeks 1,2,3.

The report must be submitted on-line via Moodle in pdf form. *Late reports will attract a penalty of 20% per day* (including weekends). Reports submitted after results have been released will incur the maximum penalty.

Assignment 2 (Total 20%)

Students will undertake a range of end use energy efficiency assessments and calculations and submit a report. Data will be provided.

This analysis will be carried out in groups in project work during the Wednesday classes of weeks 5,6&8.

The report must be submitted on-line via Moodle in pdf form. *Late reports will attract a penalty of 20% per day* (including weekends). Reports submitted after results have been released will incur the maximum penalty.

Final Digital Exam

The exam in this course is a 2 hour digital examination which will be carried out on dedicated computer work stations. The examination tests analytical and critical thinking and general understanding of the course material in a controlled fashion. Questions may be drawn from any aspect of the course, unless specifically indicated otherwise by the lecturer. Marks will be assigned according to the correctness of the responses.

Weekly Online Quizzes

These will be available on Moodle for each week of the course.

Laboratory classes

Laboratory classes will be held in Weeks 3-8. Times will be advised. These may not be in your tutorial class times. Sessions will be available to be booked in at least 2 weeks prior. Attendance is required and marks will be given for successfully completing the laboratory task.

Class participation

Class and tutorial attendance is expected. It is expected that you will attend all lecture and tutorial sessions and participate in the project activities – class polls, quizzes etc. The guest lecture content may be assessed in the exam and/or the online quizzes.

On-line learning material

The knowledge content for the course is delivered via the Adaptive Learning Packages (ALPs) on Moodle. These ALPs present the course content in an interactive learning format. Completion of the two or three ALPs for each week is required prior to the lecture for that week. The lectures will summarize material in the ALPs but not repeat the majority of it, so ALP completion is an essential part of the course.

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 20 percent (20%) 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.

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

Reference Books

- Energy Efficiency Manual: for everyone who uses energy, pays for utilities, designs and builds, is interested in energy conservation and the environment by Donald R. Wulfinghoff
- Energy Management Handbook (8th Edition) by Wayne C. Turner and Steve Doty *Both are available online via UNSW Library.*
- Heat Transfer: A Practical Approach by Yunus A. Cengel
- Thermodynamics: An Engineering Approach by Yunus A. Cengel, Michael A. Boles.
- Fluid Mechanics – Fundamentals and Applications by Yunus A. Cengel and John M. Cimbala
- Factor Five: Transforming the Global Economy through 80% Improvements in Resource Productivity, Ernst von Weizsäcker, Karlson 'Charlie' Hargroves, Michael H. Smith, Cheryl Desha and Peter Stasinopoulos
- Factor 4: Doubling Wealth – Halving Resource Use by E. Weizaecker, A. Lovins and L.H. Lovins
- Natural Capitalism – Creating the Next Industrial Revolution by P. Hawken, A. Lovins and L.H. Lovins
- Cents and Sustainability Securing Our Common Future by Decoupling Economic Growth from Environmental Pressures, Michael H. Smith, Karlson 'Charlie' Hargroves and Cheryl Desha
- Rocky Mountain Institute: http://www.rmi.org/
- AS/NZS 3598:2014 Australian/New Zealand Standard™ Energy audits (currently under revision) – Access via UNSW Library website

Websites

Course website: https://moodle.telt.unsw.edu.au/login/index.php

On-line Resources

- Stanford Energy Lectures by Amory Lovins, (2009) https://www.youtube.com/watch?v=O5txQlEI7bc&t=1596s
- Natural Edge Project (Australian project (2002-2015) looking at ways to tackle climate change. Good sections on Energy Efficiency, useful books). Home page: https://research.qut.edu.au/tnep/
    - 600 page online textbook on Energy Efficiency https://research.qut.edu.au/tnep/books/energy-transformed/
    - Design Suite: https://research.qut.edu.au/tnep/books/whole-system-design/
- Factor 10- Engineering: https://www.rmi.org/our-work/areas-of-innovation/office-chief-scientist/10xe-factor-ten-engineering/
- Alliance to Save Energy (USA) http://www.ase.org/
- Australian Alliance for Energy Productivity (previously Australian Alliance to Save Energy) https://a2se.org.au

- Energy Efficiency Council (Australia) http://www.eec.org.au/
- Winning the Carbon War, Jeremy Leggett (2017) https://jeremyleggett.net/the-carbon-war/
- American Council for an Energy Efficient Economy http://aceee.org/
- German Initiative for Energy Efficiency (Deutschen Unternehmensinitiative Energieeffizienz) http://www.deneff.org/
- Energy Savings Trust (UK) http://www.energysavingtrust.org.uk/
- California Energy Commission http://www.energy.ca.gov/

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

Moodle
As a part of the teaching component, Moodle will be used to disseminate teaching materials. Assessment marks will also be made available via Moodle: https://moodle.telt.unsw.edu.au/login/index.php.
Announcements and Discussion Forum
Announcements concerning course information will be given in the lectures and/or on Moodle. A Discussion Forum will also be established on the Moodle course page for you to post questions or initiate course-related discussions

8. Course evaluation and development

This course is under constant revision in order to improve the learning outcomes for all students. Please forward any feedback (positive or negative) on the course to the course convener or via the Course and Teaching Evaluation and Improvement Process. You can also provide feedback to RESOC who will raise your concerns at student focus group meetings. As a result of previous feedback obtained for this course and in our efforts to provide a rich and meaningful learning experience, we have continued to evaluate and modify our delivery and assessment methods.
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 and academic feedback include: A flexible study week; Laboratory classes; Project work in class; Rubrics describing the assessment of assignments; Digital delivery of course materials; Digital assessment in the form of a digital final exm.

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