UNSW SYDNEY | Australia's Global University

Mechanical and Manufacturing Engineering

Course Outline

Term 2 2020

MECH9720

Solar Thermal Energy Design

Contents

1. Staff contact details

Contact details and consultation times for course convenor

Name: A/Professor Robert A Taylor
Tel: (02) 9385 5400
Email: UNSW.MECH.9720@gmail.com
Moodle: T2 2020 MECH9720 Solar Thermal Energy Design (All assessments and content)
Microsoft Teams Video Chat Hours: Meet with staff of the MECH 9720 Team live during normal lecture hours (Monday 13:00 - 15:00, Weeks:1,3-5,7-11) or by special appointment.

Contact details and consultation times for course demonstrator:

Name: Amr Omar
Email: UNSW.MECH.9720@gmail.com
Microsoft Teams Chat Hours: Leave questions for Amr on the MECH 9720 Team chat or schedule a special appointment.

2. Important links

- Moodle
- Lab Access
- Health and Safety
- Computing Facilities
- Student Resources
- Course Outlines
- Engineering Student Support Services Centre
- Makerspace
- UNSW Timetable
- UNSW Handbook
- UNSW Mechanical and Manufacturing Engineering

3. Course details

Credit points

This is a 6 unit-of-credit (UoC) course and involves 2 hours per week (h/w) of scheduled online 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 9 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	Delivery Mode
Lectures	N/A	2 hrs/wk	Moodle Recorded Lectures & Moodle Lessons
Teams Chat/ Office Hours	Monday (Weeks:1,3-5,7-11)	13:00 - 15:00	MECH 9720 Team
Demonstrations	Weekly	1 hr/wk	Moodle Recorded Demonstrations
Lab (Group Assessment)	N/A	2 hrs (excluding analysis/reporting)	Moodle Recorded Lab Videos; Raw Data Provided.

All classes in T2 2020 will be online. Please consult this course's Moodle module for details about delivery.

Summary and Aims of the course

Solar thermal energy is created when radiation from the sun is converted to heat energy (directly) or into electrical energy (indirectly via heat) for applications in the residential, industrial, and commercial sectors. This course will give you an engineering perspective of how solar thermal technology is designed, constructed, and operated. The first section of the course deals with the characteristics of sunlight, along with some methods of analysis and measurement of solar radiation. The second section of the course covers the working principles of solar thermal technology (low and high tech) and gives you the general tools necessary to analyse heat and mass transfer within these devices. Lastly, we will cover how these technologies can be integrated into systems including control, circulation, and storage. The content reflects the experience of the lecturer/guests in the research, development, and installation of these systems, experience which is drawn upon throughout the lectures and tutorials. This course focusses on the terminology, principles and methods used in solar thermal engineering. Engineering heat transfer analysis will be used to solve much of the quantitative components of the course (MECH3610).

This course should aide students who intend to take more classes, or pursue a career, in renewable energy and/or the thermal sciences. The course deliberately stays away from photovoltaics and focuses on the conversion of solar energy into heat. This heat can then be used for a wide variety of applications ranging from pool heating at ~30 ^oC to processing minerals (e.g. Aluminium) at >700 ^oC.

In summary, this course will provide an engineering basis for a technical analysis of the characteristics of solar radiation and solar collectors. It will provide students with tools for conducting solar thermal collector efficiency evaluations and for the prediction of long-term performance of solar thermal systems. Thus, the course will include energy storage and system modelling via computer simulation of the performance and economic worth of solar thermal systems.

Student learning outcomes

The objectives of the course are to:

- Use engineering terminology associated with solar thermal energy systems (information literacy)
- Obtain a basic understanding of how to measure and calculate salient radiation properties and data, such as the incident solar irradiation on a plane, that will allow you to solve solar thermal energy design problems (independent enquiry)
- Understand how to conduct solar collector efficiency tests as per the AS/NZ standard (independent enquiry)
- Learn how to use solar thermal energy systems software tools (digital literacy)
- Apply the above to solar thermal systems from an engineering perspective. If these are realized, with respect to solar thermal technology, you will be:
    - Capable of independent, self-directed practice
    - Capable of lifelong learning in the energy systems fields

Capable of operating within the agreed Code of Practice

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.	Obtain a basic understanding of how to measure and calculate salient radiation properties and data that will allow you to solve solar thermal energy design problems	PE1.1
2.	Be able to use engineering terminology associated with solar thermal energy systems	PE1.2, PE1.3
3.	Communicate using the terminology associated with solar thermal energy to deliver a professional, technical report.	PE3.1, PE3.5
4.	Apply the above to assess the techno-economic feasibility of solar thermal systems from an engineering perspective	PE2

4. Teaching strategies

The teaching strategies that will be used include:

- Asynchronous presentation of the material in video recordings of past lectures
- Consideration of the engineering calculations trade-offs for these technologies
- **25** Interactive Lessons in Moodle
- Consideration of how engineering choices play out in real-world business examples to give students a feel for how fluid mechanics and heat transfer are applied
- Videos and presentations of complex problem solving for the demonstration material
- Videos and data about laboratory testing in accordance with Australian standards for concentrated and unconcentrated solar thermal collectors
- The use of freeware, in-house, and commercial software to solve solar engineering problems

Suggested approaches to learning in the course include:

- Careful reading and viewing of all course content on Moodle, including Lecture, Demonstration, Lab videos, and all online Lessons
- Active participation in the Lab group assessment
- Additional reading related to the material presented in lectures to broaden the knowledge base
- Conscientiously working through ALL the worked problems
- Perusal of the past examination paper(s) in this course to ensure that you know how to answer typical questions
- Asking questions and interaction with fellow students in Teams

5. Course schedule

Week	Topic	Location	Suggested Readings
1	Solar Thermal Overview / **3** Moodle Lessons: *Introduction to Solar Energy Systems; Non-Concentrating Solar Thermal Collectors; Concentrating Solar Thermal Collectors*	Moodle (content delivery) Teams (course staff interaction)	Class readings by Moodle week
2	No Lecture (Queen’s Birthday) **2** Moodle Lessons: *The Solar Resource; Black Bodies and Radiation*	Moodle (content delivery) Teams (course staff interaction)	Class readings by Moodle week
3	Solar Resources/Instrumentation / **2** Moodle Lessons: Solar Instruments and Measurements Part 1 & Part 2	Moodle (content delivery) Teams (course staff interaction)	Class readings by Moodle week
4	Diffuse/Tilted Surfaces / **2** Moodle Lessons: *Inclined Surfaces and Diffuse Radiation Models; Applications of Inclined Surfaces*	Moodle (content delivery) Teams (course staff interaction)	Class readings by Moodle week

Week	Topic	Location	Suggested Readings
5	Flat Plate Collectors / **2** Moodle Lessons: *Absorber Plates and Reflection; Collector Efficiency and Operation* Solar Collector Analysis I / **2** Moodle Lessons: *Solar Collector Heat Losses; Evaluating the Solar Collector Efficiency Factor*	Moodle (content delivery) Teams (course staff interaction)	Class readings by Moodle week
6	Flexibility Week (Revision Only)	N/A	N/A
7	Solar Collector Analysis II / **2** Moodle Lessons: *Collector Stagnation Temperature, Part 1 & Part 2*	Moodle (content delivery) Teams (course staff interaction)	Class readings by Moodle week
8	Engineering Trade-Offs / **3** Moodle Lessons: *Flat Plate Solar Collector Optimisation; TRNSYS & Other Solar Modelling Software; Solar Hot Water Systems Part 1*	Moodle (content delivery) Teams (course staff interaction)	Class readings by Moodle week
9	Evacuated Tube Collectors / **2** Moodle Lesson: *Evacuated Tubes; Solar Hot Water Systems Part 2*	Moodle (content delivery) Teams (course staff interaction)	Class readings by Moodle week
10	Concentrated Solar Thermal Systems / **2** Moodle Lessons: *Large Scale Solar Thermal Development, Part 1 and Part 2*	Moodle (content delivery) Teams (course staff interaction)	Class readings by Moodle week
11	Balance of System/System Analysis / **3** Moodle Lessons: *Exam Practice Questions 1-3*	Moodle (content delivery) Teams (course staff interaction)	Class readings by Moodle week

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
Laboratory Report	Yes (4-6)	15-20 pages + *peer review*	25%	1-4	Lecture content from first half of course. Solar Collector Analysis, Australian Standards for Testing, Report Writing, Working in Groups	Friday, Midnight, Week 7, Moodle	Wednesday, Midnight, Week 8	Two weeks after submission
System Advisor Model (SAM) Technical Report	No	10-15 pages	25%	1 and 4	All solar thermal technologies from lecture content	Friday, Midnight, Week 10, Moodle	Wednesday, Midnight, Week 11	Two weeks after submission
ONLINE Quizzes (10)	No	Multiple choice / calculated questions (1-5 per week)	10%	1-4	Lecture material from prior week(s).	Due before start of scheduled lecture time the following week	N/A	Within 3 days of Quiz close
Final exam	No	Short Answer / Problem Solving	40%	1, 2 and 3	Comprehensive (~50/50 : qualitative/ quantitative)	Available on Moodle: Released 17th August; Due 5pm, 21st August)	Wednesday, Midnight, 26th August	Upon release of final course results

Assignments

Assignments and marking guidelines for them will be all available on Moodle from the beginning of the course. If deemed necessary, email clarifications and hints will be provided through Moodle, so please ensure you check Moodle and Teams periodically during the session.

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.

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

The course has a ‘Take Home’ Exam, available on Moodle. You will be given one business week to complete and submit during the Exam period (e.g. the week of the 17-21 of August).

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.

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 attempt 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

The following represents a list of the most useful resources for this course:

- MECH9720 Course Notes* (Moodle)
    - The course notes are needed to solve the demonstration session problems and roughly follow along with the course content.
- Online Lessons (in Moodle)
- Video recordings of lectures from previous years (in Moodle)
- Problem solving /demonstration videos (in Moodle)
- Assignment details (templates, examples, rubrics) in Moodle;
- Lecture notes/slides in Moodle
- Worked and numeric solutions to selected problems in Moodle
- An ongoing discussion in Teams (with Live access to staff Monday afternoons, 1-3pm)
- Links to solar resources and other supplementary information

Suggested reading

Duffie J.A. & Beckman, W.A. Solar Engineering of Thermal Processes, Wiley 2013 [4th edition available from https://library.unsw.edu.au in the Wiley eBooks Collection]
Cengal, Y.A. and Ghajar, A.J., Heat and Mass Transfer, McGraw Hill, 2011
Academic Journals: Solar Energy, J. Solar Energy Engineering, Applied Energy, Energy Renewable Energy, Renewable and Sustainable Energy Reviews.

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

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 removal of the PG report (additional work for PG students), the addition online quizzes (in lieu of a test), resources and feedback (including the adaptive lecture lessons), new laboratory facilities (now as videos due to COVID-19), changes to the assessments (as groups, to reduce workload), more worked problems available, and additional feedback on progress throughout the course.

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