UNSW SYDNEY | Australia's Global University

Mechanical and Manufacturing Engineering

Course Outline

Term 1 2019

MMAN2700

THERMODYNAMICS

Contents

1. Staff contact details

Contact details and consultation times for course convenor

Name: Phil Howlin
Office location: J17/311E
Tel: (02) 9385 4180
Email: mman2700@unsw.edu.au
Moodle: https://moodle.telt.unsw.edu.au/course/view.php?id=38404

Consultation

Consultation for this subject will take place during the workshop sessions of the class. Minimal digital communication is expected. Personal matters can be raised by emailing the course email address (mman2700@unsw.edu.au) outlining the details of the matter and requesting a face-to-face meeting.

Head Demonstrator

Name: Moustafa Ali
Email: mman2700@unsw.edu.au

2. Important links

- Moodle
- Lab Access
- Computing Facilities
- Student Resources
- Course Outlines
- Engineering Student Support Services Centre

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 quantity and difficulty of the material presented is such that an average student should spend about 13 hours each week (4 in class plus 9 outside of class) on learning and assessment preparation in order to obtain a credit in this course.

Contact hours

	Day	Time	Location
Workshops *(Week 1 to 10‡ inclusive)*			
Stream A	Monday	4pm – 6pm	Colombo Theatre A (K-B16-LG03)
	Wednesday	2pm – 4pm	
Stream B	Tuesday	12 noon – 2pm	
	Thursday	4pm – 6pm	
Laboratories *(Weeks 2 and 6 ONLY)*			
Class 7027	Thursday	9am – 10am	UG Lab*
		10am – 11am	Red Centre West 2035 (K-H13-2035)
Class 7028		10am – 11am	UG Lab*
		11am – 12 noon	Webster 302 (K-G14-302)
Class 7029		11am – 12 noon	UG Lab*
		12 noon – 1pm	Quadrangle 1047 (K-E15-1047)
Class 7030		12 noon – 1pm	UG Lab*
		1pm – 2pm	Law Library 111 (K-F8-111)
Class 7031	Monday	9am – 10am	UG Lab*
		10am – 11am	Quadrangle 1045 (K-E15-1045)
Class 7032		10am – 11am	UG Lab*
		11am – 12 noon	Quadrangle 1048 (K-E15-1045)
Class 7033		11am – 12 noon	UG Lab*
		12 noon – 1pm	Civil Engineering 701 (K-H20-701)
Class 7034		12 noon – 1pm	UG Lab*
		1pm – 2pm	Civil Engineering 701 (K-H20-701)
Class 7035		1pm – 2pm	UG Lab*
		2pm – 3pm	Civil Engineering 701 (K-H20-701)
Class 7036		2pm – 3pm	UG Lab*
		3pm – 4pm	Civil Engineering 701 (K-H20-701)
Class 7037	Tuesday	9am – 10am	UG Lab*
		10am – 11am	Civil Engineering 701 (K-H20-701)
Class 7038		10am – 11am	UG Lab*
		11am – 12 noon	Civil Engineering 701 (K-H20-701)
Class 7039		2pm – 3pm	UG Lab*
		3pm – 4pm	Civil Engineering 701 (K-H20-701)
Class 7040		3pm – 4pm	UG Lab*
		4pm – 5pm	Civil Engineering 701 (K-H20-701)
Class 7041		4pm – 5pm	UG Lab*
		5pm – 6pm	Civil Engineering 701 (K-H20-701)
Class 7042	Wednesday	9am – 10am	UG Lab*
		10am – 11am	Morven Brown G5 (K-C20-G5)
Class 7043		10am – 11am	UG Lab*
		11am – 12 noon	Morven Brown G5 (K-C20-G5)

‡ Some classes will occur in Week 11 where they are affected by a Public Holiday in earlier weeks

* UG Lab is the Willis Annexe 116A UG Lab (K-J18-116A)

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 introduces the student to the terminology, principles and methods used in engineering thermodynamics. Thermodynamics is a subject which deals with the transfer of energy essential for life. Thermodynamics has long been an essential part of engineering curricula all over the world. It has a broad application area ranging from microscopic organisms to common household appliances, transportation vehicles, power generation systems and even philosophy. The knowledge of thermodynamics gained in this course is essential to many other courses studied in the mechanical engineering degree programme, such as advanced thermofluids, aerospace propulsion, internal combustion engines, refrigeration and air conditioning and solar energy.

Most engineering jobs in a thermodynamic field will require greater knowledge than can be presented in a single session; however, an introduction to thermodynamics will be valuable to all engineers.

This course aims to prepare students for future studies in thermodynamics through the introduction of some common uses of thermodynamics and the analysis of thermodynamic cycles. Specifically, the aims of the course are to:

- Introduce students to the terminology associated with thermodynamics. Students should develop an understanding of the deeper meanings of familiar words like energy, heat, work, temperature, reversible & irreversible as well as less familiar words like entropy;
- Familiarise students with the 0th, 1st and 2nd laws of thermodynamics and teach students how to apply these laws;
- Instruct students in analysing air standard cycles, such as reciprocating piston engines and gas turbine engines, and vapour power cycles, such as those used in power plants and refrigeration units.

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.	Use the first law of thermodynamics, including an understanding of heat and work, to solve steady-state and transient problems on closed and open systems.	PE1.1, PE1.2, PE1.3
2.	Demonstrate knowledge of the second law of thermodynamics by solving steady-state problems on closed and open systems.	PE1.1, PE1.2, PE1.3
3.	Apply the first and second laws to analyse the behaviour of internal combustion engines (air–standard cycles), Rankine power cycles (basic, regeneration, reheat) and Vapour compression refrigeration cycles.	PE2.1, PE2.2
4.	Identify links between theoretical analysis methods learned in class and actual performance of thermodynamics machines and devices.	PE1.3, PE2.2

4. Teaching strategies

This class makes use of a ‘flipped classroom’ teaching methodology this session. This involves students undertaking and demonstrating learning before face-to-face sessions. The face-to-face sessions will be interactive and based on collaborative problem-solving.

Course content will be available to students in the form of short lecture videos and relevant readings from textbooks, to be viewed and learned before class. There will be a pre-class quiz before the first face-to-face session each week (Week 1 to 10, inclusive) in which students will demonstrate their understanding prior to attending class.

Face-to-face class activities will be in the form of ‘Workshops’, involving the course convener and a group of demonstrators answering questions relating to learned content and assisting the class with solving a set of prescribed problems. There will also be in-class quizzes.

Laboratories in Week 2 and Week 6 will allow students to see some of the less intuitive concepts in thermodynamics work physically in a laboratory environment, and to assist students with developing skills such as following written instructions and recording readings and data. A laboratory report will allow students to demonstrate deeper understanding of what is occurring in the laboratory, and further the development of written communication proficiency.

A functioning power plant will be studied and analysed in a group assignment, further solidifying student understanding of the application of thermodynamics to real-world engineering systems.

5. Course schedule

Week	Pre-Class	In-Class
0	Introductory Terms Properties of Fluids	
1	Ideal Gases First Law for Closed Systems Quiz: Physics and mechanics review	1. Introduction to Course; Introduction to flipped learning method; Outline of course assessments; Group formation 2. Problem Solving: Ideal gas equation of state; Simple first law analysis.
2	Charting processes Heat and Work, Heat of Phase Change Internal Energy, Enthalpy	1. Summary chat; Closed system ideal gas processes, heat and work. 2. Introduction to Pure Substances.
3	Pure Substances, Phases of Matter Reading property tables Interpolation of tables	1. Reading thermodynamics tables; interpolation. 2. Pure substance processes, heat and work; introduction to open processes; control volumes
4	Shaft work machines; Throttles; Nozzles; Mix chambers; HEX;	1. **Quiz 1**; Shaft work machines, throttles, nozzles and diffusers, 2. Mixing chamber, heat exchanger
5	Entropy, Efficiency, Carnot Cycle	1. Entropy generation, device efficiency 2. Carnot cycle
6	Otto, Diesel and Dual Cycle	1. Otto cycle 2. Diesel and Dual cycles
7	Brayton and Jet Propulsion Cycle	1. **Quiz 2**; Brayton Cycle. 2. Advanced Brayton and Jet Propulsion Cycle
8	Rankine Cycle and Improved Rankine Cycle	1. Rankine Cycle 2. Improved Rankine Cycle
9	Vapour Compression Refrigeration Absorption Refrigeration	1. Vapour compression refrigeration 2. Absorption Refrigeration
10	Combined Cycle, Cogeneration	1. **Quiz 3**; Combined Cycle 2. Cogeneration, Final Exam Preparation

This schedule should be considered a plan only. Specific details of what will be covered from week to week is subject to change without notice and will be confirmed in Moodle.

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
Class Pre-work Workshop Quizzes	Mixed	5	~ 1 hour each	15% (10+5)	1, 2 & 3	Understanding of specific thermodynamic topics	Weekly before class Week 4, 7 & 10	Start of class End time of quiz	At end of quiz
Laboratories Laboratory Report	No	N/A	2x2 hr Lab 10-page Report	15% (2+2+11)	1, 3 & 4	Understanding of laboratory and relevance to theory	Attend Weeks 2 & 6 Report Friday Week 10	End of Lab Time Wednesday Week 11	Upon release of final results
Assignment	Yes	5	20-page Report	15%	4	Analysis of operational Power Plant	Wednesday Week 11	Monday Week 12	Upon release of final results
Mid-Term Exam Final exam	No	N/A	2 hours each	55% (15+40)	1, 2 and 3	All course content prior to exam.	Friday Week 7 Exam period, date TBC	N/A	Monday Week 9 Upon release of final results

Class Pre-work Quiz and Workshop Quiz

Please read the following information carefully as it has an effect on your final course mark.

Class Pre-Work and Quiz

Before the first Workshop session each week there will be a Moodle Quiz assigned. There are a total of 10 Pre-work quizzes that will be assigned in this manner. Students may attempt each quiz as many times as they wish before the commencement of their assigned Workshop class, without penalty. If a student achieves a mark equal to 80% or greater in their best attempt, the quiz will be considered 'completed'. If a student completes 9 or 10 out of the 10 pre-work quizzes, the student will be allocated 10% of their course grade as a block of marks. If the student completes 8 or less of the pre-work quizzes, the student will receive zero (0%) for this component of the course.

It is very important to attempt the weekly quiz early and achieve a satisfactory grade *before* the commencement of the Workshop session *each week*. The pre-work quiz should be considered an individual assessment.

Workshop Quiz

In the first Workshop in Week 4, 7 and 10, there will be an in-class Workshop quiz. This quiz will be comprised of the hardest pre-work quiz questions and will be conducted in the first hour of the Workshop timeslot. Students will work in groups for this quiz. Only one attempt will be allowed for this quiz.

The total value of these 3 Workshop quizzes will be 5%, with relative weightings of 1.5% in Weeks 4 and 7 and 2% in Week 10.

Laboratories

Laboratory Pre-work and Attendance

There are 2 laboratories for this course, held in Week 2 and Week 6. Students are required to view a series of laboratory videos and complete a pre-laboratory quiz to demonstrate their knowledge prior to attending the laboratory. At the completion of the laboratory session, students will submit their recorded data to a central repository so that the readings can be shared by the whole class.

Each laboratory is worth 2 marks. This is divided between completion of the quiz and submission of the recorded data, each worth 1 mark. When the two laboratories are taken into consideration, this is worth 4 course marks.

Laboratory Report

Students will write a report in which they analyse the data generated by the class during the laboratory sessions and demonstrate their understanding of the thermodynamic principles at

work. This assessment is worth a maximum of 11 course marks. Details for this report will be shared on Moodle closer to the due date.

Assignment

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

There are 2 invigilated exams for this course: a 'Mid-term Exam' on Friday night of Week 7 and a Final Exam during the University final exam period. **This course follows the double pass school policy; students need to pass the invigilated exams to pass the course i.e. achieve a minimum mark of 27.5 out of 55 (the total examination weight). It is**

insufficient to pass the course just by achieving an overall course mark of 50 without passing the examination component.

The Mid-term Exam will provide opportunity to examine all course content from Week 1 to Week 6 inclusive, and is being held from 6pm to 8pm. Please refer to your class timetable for the location of the exam section you are enrolled in (class activity will show as 'Other').

The final exam will cover all course material from Week 1 to Week 11 inclusive.
You must be available for all 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 has interfered with your assessment performance, you are eligible to 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

Textbook

Cengel, Y.A. & Boles, M.A. (2015) Thermodynamics, An Engineering Approach, Eighth Edition in SI Units, McGraw Hill

This is available in the UNSW bookshop and should be considered a required textbook for the course.

Additional materials provided in UNSW Moodle

The learning materials for the course will be served through the University Moodle site. You can access the course page by logging on to:

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

Other Resources

If you wish to explore any of the lecture topics in more depth, then other resources are available, and assistance may be obtained from the UNSW Library.

UNSW Library website: http://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 creating more time for problem solving by transforming the lecture sessions into problem solving session workshops.

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 School guidelines and polices, available on the intranet. In particular, students should be familiar with the following:

- Attendance
- UNSW Email Address
- Computing Facilities
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Student Equity and Disabilities Unit
- Health and Safety
- Lab Access
- Makerspace
- UNSW Timetable
- UNSW Handbook
- UNSW Mechanical and Manufacturing Engineering

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