UNSW SYDNEY | Australia's Global University

Mechanical and Manufacturing Engineering

Course Outline

Semester 1 2018

MMAN2700

THERMODYNAMICS

Contents

1. Staff contact details

Contact details and consultation times for course convenor

Name: Phil Howlin
Office: J17 Ainsworth Building Room 311E
Tel: (02) 9385 4180
Email: p.howlin@unsw.edu.au

There will be time for content and course related questions at the end of each Tuesday lecture. If questions continue beyond when the lecture theatre is available, discussions can continue outside.

All non-private content or course related queries should be directed to forums first – a problem you are having is unlikely to be unique in a large class and posing a question in a forum lets everyone see the solution.

Private queries may be emailed or dealt with face to face. Face to face consultation can be arranged by email.

Contact details and consultation times for head demonstrator

Name: Harsh Goyal
Email: harsh.goyal@unsw.edu.au

The head demonstrator will be managing a lot of the student and course administration this session. Please initiate enquiries with the head demonstrator instead of with the course convenor for these matters.

Contact details and consultation times for other demonstrators

Problem Solving Sessions	***Laboratories***
Azadeh (Azy) Lofti	Tzi-Chieh (Monica) Chi
Maira Syed	Yashar Shoraka
Sanjiv Gunasekera	Moustafa Ali
Joshua Pham	Alexander Clatworthy

2. Important links

- Moodle
- UNSW Mechanical and Manufacturing Engineering
- Course Outlines
- Student intranet
- UNSW Mechanical and Manufacturing Engineering Facebook
- UNSW Handbook

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, plus laboratories.

The UNSW website states “The normal workload expectations of a student are approximately 25 hours per semester for each UoC, including class contact hours, other learning activities, preparation and time spent on all assessable work. Thus, for a full-time enrolled student, the normal workload, averaged across the 16 weeks of teaching, study and examination periods, is about 37.5 hours per week.”

This means that 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**	**Location**
Lectures *(Week 1 to 13) (All students access all lectures)*	Tuesday	10:00 - 12:00	Law Theatre G04 (K-F8-G04) Web Stream[‡]
	Wednesday	15:00 - 16:00	Rex Vowels Theatre (K-F17-LG3) Web Stream[‡]
Problem Solving Sessions *(Week 2 to 13)*	Tue	16:00 - 17:00	Red Centre Central Wing M032 (K-H13-M032)
	Tue	17:00 - 18:00	Red Centre Central Wing M032 (K-H13-M032)
	Wed	11:00 - 12:00	Civil Engineering G1 (K-H20-G1)
	Wed	12:00 - 13:00	Webster 256 (K-G14-256)
	Wed	16:00 - 17:00	Red Centre Central Wing M032 (K-H13-M032)
	Thu	13:00 - 14:00	Webster 256 (K-G14-256)
	Thu	14:00 - 15:00	Webster 256 (K-G14-256)
Laboratory T2 & T4[¥] *(Week 6 or 7 and 10 or 11)*	Tue	12:00 - 14:00	Willis Annexe 116C UG Lab (K-J18-116C)
	Wed	09:00 - 11:00	
	Wed	13:00 - 15:00	
	Thu	09:00 - 11:00	Willis Annexe 116C UG

	Day	Time	Location
Laboratory T2 & T4¥ *(Week 6 or 7 and 10 or 11)*	Thu	11:00 - 13:00	Lab (K-J18-116C)
	Thu	14:00 - 16:00	
	Thu	16:00 - 18:00	

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

ǂ: Web Stream:
Web Streaming will be used to provide a live presentation of lecture content online. This presentation will incorporate a 'chat' interface for participating in the classroom. The live Web Stream is intended to be used by students enrolled in the 'Web' lecture option. A link to the Web Stream will be provided on Moodle more than 24 hours before the lecture.

Links to downloadable recordings of each lecture will be posted on Moodle within 24 hours of the conclusion of the lecture.

¥: Laboratory Attendance:
There are 4 laboratories for this subject: Lab T1, Lab T2, Lab T3 and Lab T4. Lab T1 will be scheduled by students using a scheduling tool in Moodle. Access to this tool will be made available after the student has completed a pre-lab quiz. Lab T3 will re-use data gathered in Lab T1, and has no attendance requirements. Students will attend laboratories Lab T2 and Lab T4 according to their enrolment.

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

The learning in this class will take place throughout all activities associated with the course.

Primary learning of the theoretical aspects of thermodynamics will be through Lectures and Problem Solving Sessions. Laboratories provide the opportunity for students to compare specific parts of the theory to results of thermodynamic processes in a controlled environment. This encourages students to consider the practical implications of their learning.

The Assignment provides students with the opportunity to investigate the application of engineering thermodynamics to real world engineered devices. Completing the assignment prevents thermodynamics from being a subject that only teaches students to look at tables and apply formulas without connecting their learning to the real world.

The Microsoft Teams forum discussions provide an opportunity to further explore and discuss content. Students are encouraged to seek other learning resources and share them on the Microsoft Teams platform for the benefit of all.

5. Course schedule

All lectures in this course are given by the course convenor.

Week	Section	Topic	Location	Content	Suggested Readings
1	Introductory Concepts	Basic Concepts and Definitions	F8-G04 & F17-LG3	Introductions Systems, property, state, path, process, cycle Properties and Units Temperature and the zeroth law The equation of state for an ideal gas P-v-T surfaces for an ideal gas	Chapter 1
2		Work and Heat	F8-G04 & F17-LG3	Definition of work Work processes Work done at the moving boundary of a closed system Definition of heat Examples of work and heat	Chapter 2
3	Further Concepts	First Law, Closed Systems Properties of a Pure Substance	F8-G04 & F17-LG3	The first law Internal energy and enthalpy- thermodynamic properties, specific heats and property relations Vapour-liquid equilibrium in a pure substance P-v-T surfaces for real substances Tables of Thermodynamic properties (steam) Equations of state for real substances	Chapter 3 & 4

Week	Section	Topic	Location	Content	Suggested Readings
4	Further Concepts	First Law, Open Systems Open and Closed Systems	F8-G04 & F17-LG3	Energy entering the system, enthalpy The first law Steady flow steady state system – examples Closed system applications Steady flow applications Filling and discharging of rigid vessels	Chapter 3 & 4
5	Second Law of Thermodynamics		F8-G04 & F17-LG3	Carnot's principle, Carnot cycle Entropy as a property	Chapter 5
6			F8-G04 & F17-LG3	δQ = Tds equation Property relations of entropy Isentropic efficiencies	Chapter 6
7	Thermodynamic Cycles		F8-G04 & F17-LG3	Otto cycle Diesel cycle Simple Brayton cycle Rankine cycle Vapour refrigeration cycle	Chapter 7 & 8
8			F8-G04 P/H Wed		
9			F8-G04 & F17-LG3		
10	Further Thermodynamic Cycles		F8-G04 & F17-LG3	Improved Rankine Cycle Dual Cycle	
11	Review and Application		F8-G04 & F17-LG3	Applications of Thermodynamics	Review of all Chapters
12			F8-G04 & F17-LG3	Applications of Thermodynamics	

The table above should be viewed as a guide only and is subject to change without notice.

Refer to comments in Section 6. Assessment for the scheduling information about laboratories.

6. Assessment

Assessment overview

Assessment	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
Laboratories (4)	2 hours each + report	15% (2%+2% +1%+2% +8%)	1, 2, 3, & 4	Completion of Preliminary Work and Laboratory Analysis. Demonstrated understanding of physical phenomena.	On the day of your assigned laboratories. Final Report 5pm* Friday Week 13 01/06/2017	5pm Sunday 03/06/2017	Labs marks given on the day. Report marks given two weeks after submission
Class Tests (2)	1 hour each	30% (2 x 15%)	1, 2 and 3	All lecture material up to the date of the test.	6pm Monday Week 6, 09/04/2017 6pm Monday Week 9, 30/04/2017	N/A	Two weeks after test
Assignment *(Groups of 2)*	10 pages of body content	15%	4 and 5	Understanding of application of theoretical thermodynamics to real world device.	5pm* Friday Week 11 18/05/2017	5pm Monday 21/05/2017	Two weeks after submission
Final exam	2 hours	40%	1, 2, 3 and 4	All course content from weeks 1-12 inclusive.	Exam period, date TBC	N/A	Upon release of final results

* The Laboratory Report and Assignment are due at 5pm but may be submitted as late as 11:55pm without penalty. See ‘Submission’ below.

To pass the course, you must achieve an overall mark of at least 50%.

See pages following for additional assessment information.

Laboratories

Assessment

Assessment of the laboratory component of the course will contribute 15% to the final course mark. 7% of this mark will be allocated for completion of preliminary analysis, results obtained, and calculations made during the laboratory period (2 marks for Lab T1, Lab T2 and Lab T4 split equally between preliminary work and data gathering; 1 mark for Lab T3 for data calculation).

The remaining 8% will be assessed through submission of a report due to be submitted through Moodle towards the end of session. Further guidance on this report will provided during the session in class and on Moodle

Overview of Laboratories

There are 4 laboratories to be performed during the session. Lab T1 will be conducted by the students. Two laboratories (Lab T2 and Lab T4) will be conducted by Laboratory Demonstrators, with students observing and taking notes. Lab T3 will reuse data gathered in Lab T1 and draw an additional insight about entropy.

Attendance of Lab T1

Attending Lab T1 will require students to schedule use of the equipment. Scheduling will be done in Moodle through use of the 'Scheduler' tool. The scheduling tool will become visible once students have watched the pre-lab video and completed the pre-lab quiz.

It is recommended that you complete the pre-work and schedule a time slot early. There are twice as many timeslots as required, however popular times are sure to fill quickly and ***a mark of zero (0) will be awarded*** to a student who fails to attend a laboratory, even when due to the unavailability of a laboratory time. Once you have scheduled a time slot to attend, be careful to attend that time as you may not attend an alternate time slot.

Attendance of Lab T2 and Lab T4

Students have already enrolled in their laboratory slot when enrolling in the subject. Lab T2 will take place in Week 6 or Week 7, Lab T4 will be conducted in Week 10 or Week 11. Students are either enrolled in Week 6 and 10, or in Week 7 and 11. Please be careful to attend the session in which you are enrolled. Please contact the Head Demonstrator to arrange an alternative laboratory time slot in the event of an unforeseen need to attend at another time. The Head Demonstrator may decline requests of this nature at their discretion.

During Lab T2 and Lab T4, the demonstrator will check and initial your laboratory book, including data recorded from the previous experiment. Ensure that during Lab, your work is marked before you leave the laboratory.

Resources Required

You are required to obtain a laboratory book to record results of each experiment and analysis carried out whilst in the laboratory. The book is to be stapled or bound (not spiral bound). Alternate lined and graph pages are recommended, however graph paper on every page is acceptable. **You will not be admitted to Lab T2 or T4 unless you have a laboratory book, a calculator and present the assigned preliminary work.** You also need the laboratory book to perform pre-work and record results in Lab T1 and Lab T3.

Attending a laboratory session without a laboratory book, or with a non-compliant book, may result in you being awarded zero for that laboratory.

Laboratory Pre-Work

Preparation prior to the laboratory periods is essential. This will include study of the laboratory notes and watching the laboratory video where it is available so that you know what the experiment is about in advance of each laboratory session. The laboratory demonstrators will mark your preliminary work at the start of Lab T2 and T4. If you arrive without the necessary preparation you may not be allocated the laboratory mark. **Submission of preliminary work which is not your own, or copying during the laboratory period, will result in a mark of 0 for the laboratory.**

Safety

All staff and students must observe all safety requirements in the laboratory. You must come to the laboratory dressed for work: **NO LOOSE OR BAGGY CLOTHING, NO SANDALS OR BARE FEET**. Before beginning any experiment, inspect all equipment you will use for potential hazards. While using laboratory equipment, keep alert for any developing hazard, e.g. unusual noise, vibration, unusual data trends etc.

Laboratory Operation

For Lab T1 you will be required to operate the equipment as a small team. It is imperative that you read the laboratory notes and watch the video before you arrive as you only have a limited time to complete the experiment and record results.

For Lab T2 and Lab T4, the laboratory demonstrators will be present to give instructions on how to operate the equipment and will explain what is required of you. **If in doubt**, ask. It is important that you fully understand the experiment at the time it is being carried out, when instruction is available. In some experiments, you are only required to take readings at intervals; use the intermediate time to ask questions and find out what other members of your group are doing. Little is learned merely by sitting waiting to make a measurement - much is learned by inquiry and discussion.

Attendance

Attendance at all laboratory experiments to which you are assigned is compulsory and a register is taken. If you are unable to attend, due to illness, it is important that you

inform the head demonstrator as soon as possible so that you may be reassigned to a later experiment.

Group Transfer

The laboratory groups are large, so transfers between groups must be arranged through the head demonstrator.

Assignment

Brief

You are required to investigate a real-world device that operates on a thermodynamic cycle. This could be a cycle directly learned in lectures or may be another device of your choice. More detail will be given when the assessment is released.

You may work in pairs of your own choosing to complete this assessment; however marks will be equally distributed so choose a partner carefully.

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

The submission of online material should follow the instructions given on the appropriate Moodle page. No cover sheet is required as the assignment will be identified through your Moodle account.

The assignment is due by 5pm on the due date. An additional allowance will be granted automatically to submit until 11:55pm without penalty, but you accept any risk of technical difficulties with submission. If you try to submit between 5pm and 11:55pm and Moodle does not accept the submission for any reason, the assignment will be considered late.

Late submissions will be penalised 5 marks per calendar day (including weekends), applied at 5pm each day. An extension may only be granted in exceptional circumstances. Special consideration for assessment tasks must be processed through student.unsw.edu.au/special-consideration.

It is always worth submitting late assessment tasks when possible. Completion of the work, even late, may be taken into account in cases of special consideration.

Where there is no special consideration granted, the ‘deadline for absolute fail’ in the table above indicates the time after which a submitted assignment will not be marked and will achieve a score of zero for the purpose of determining overall grade in the course.

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

Class Test 1 & 2

Class Tests for this course are held on Monday evening in Week 6 and 9. These are timetabled activities and you are expected to attend.

General

You must be available for all tests and examinations. Final examinations for each course are held during the University examination periods, which are June for Semester 1.

Provisional Examination timetables are generally published on myUNSW in May for Semester 1.

For further information on exams, please see the Exams section on the intranet.

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 shown 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 School Office or the Engineering Student Centre prior to the examination. Calculators not bearing an "Approved" sticker will not be allowed into the examination room.

Special consideration and supplementary assessment

For details of applying for special consideration and conditions for the award of supplementary assessment, see the School intranet, and the information on UNSW's Special Consideration page.

7. Attendance

You are required to attend a minimum of 80% of all classes, including lectures, labs and seminars. It is possible to fail the course if your total absences equal to more than 20% of the required attendance. Please see the School intranet and the UNSW attendance page for more information.

8. Expected resources for students

Textbooks

J. R. Reisel, (2016) Principles of Engineering Thermodynamics, S.I. Edition, Cengage Learning

Y.R. Mayhew and G.F.C. Rogers, *Thermodynamic and Transport Properties of Fluids*, S.I. Units, Basil Blackwell

Both are available in the UNSW bookshop. Cengage also publish an e-Book version of *Principles of Engineering Thermodynamics*, which is sold as a 5-year license for roughly half the price of the printed book.

You really must buy these books. As a professional engineer, you will need references in the future. Most questions and reference material are from *Reisel*. Although *Reisel* contains a set of steam tables, it lacks any refrigerant data. This is required for later in the course.

Additional materials provided in UNSW Moodle

This course has a website on UNSW Moodle which includes laboratory notes and problem solving session questions.

Moodle: 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/

9. 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 making laboratories more 'hands-on', making resources available on Moodle and having more interactive problem solving sessions.

10. 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: 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

Further information on School policy and procedures in the event of plagiarism is available on the intranet.

11. 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, Participation and Class Etiquette
- UNSW Email Address
- Computing Facilities
- Assessment Matters (including guidelines for assignments, exams and special consideration)
- Academic Honesty and Plagiarism
- Student Equity and Disabilities Unit
- Health and Safety
- Student Support 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