



Mechanical and Manufacturing Engineering

Course Outline

Term 1 2020

MMAN2700

THERMODYNAMICS

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1. Staff contact details

Contact details and consultation times for course convenor

Dr John Olsen
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Tel (02) 9385 5217
Fax (02) 9663 1222
Email j.olsen@unsw.edu.au

Consultation with me concerning this course will be available at a time to be decided.
Consultation by email should only be used as a last resort as it is clumsy and inefficient.

Contact details and consultation times for additional lecturers/demonstrators/lab staff

Please see the course [Moodle](#).

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

This is a 6 unit-of-credit (UoC) course, and involves three 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.

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. There is no parallel teaching in this course.

Contact Hours

	Day	Time	Location
Lectures	Monday	14:00 - 16:00	Mathews Theatre A (K-D23-201)
	Thursday	14:00 - 16:00	Mathews Theatre A (K-D23-201)
Laboratories	See Appendix B: Laboratory timetable		
Demonstrations	See Appendix C: Consultation Periods		
Class Test Week 7	Thursday	14:00 - 16:00	Mathews Theatre A (K-D23-201); Electrical Engineering G22 (K-G17-G22); Colombo Theatre B (K-B16-LG04) **See Moodle for the room you will be allocated to

Two-hour laboratory period

There are 2 compulsory 2-hour laboratories periods in the weeks indicated for your group in the attached laboratory timetable (see **Appendix B: Laboratory timetable**), and they take place in the Willis Annexe (J18).

Consultation periods with demonstrators

You are enrolled in consultation periods (this is a hidden booking, so it may not appear in your timetable). The timetable/locations for these consultations are located in **Appendix C: Consultation Periods**.

Summary and Aims of the course

The word “thermodynamics” was coined by Lord Kelvin from Greek words for heat (therme) and power (dynamis). Given that power is the rate at which work is performed, it follows that the word thermodynamics captures two of the most important ways in which *energy* is transferred, i.e. through heat and work. The subject of thermodynamics is therefore about *energy* and its transformations.

In this introductory course, you will be introduced to the basic concepts of thermodynamics. You will be shown how to apply the 1st and 2nd laws of thermodynamics to both closed and open thermodynamic systems. This groundwork will enable you later progress to the analysis of refrigeration systems, internal combustion engines and other power generation systems.

To end the course, I will introduce you to exergy (availability) analysis. Here we combine both the 1st and 2nd laws of thermodynamics to identify sources of inefficiency.

Students will be able to:

- be conversant with the terminology associated with thermodynamics. They will develop an understanding of the deeper meanings of familiar words like *energy*, heat, work, temperature, reversible & irreversible as well as not so familiar words like entropy and exergy;
- identify whether a thermodynamic system is open, closed or isolated;
- apply both the 1st and 2nd laws of thermodynamics;
- use tabulated thermodynamic data for vapours, liquids and solids, and also to recognise under which circumstances it is best to use this data or the ideal gas laws; and
- carry out an exergy analysis to a thermodynamic system.

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	Understand that heat and work are methods by which energy is transferred.	PE1.1.
2	Understand the concept of the first law of thermodynamics and how to apply it to closed and open systems (steady-state and transient)	PE1.1, PE1.2, PE1.3.
3	Understand the concept of the second law of thermodynamics and how to apply it to closed and open systems (steady-state)	PE1.1, PE1.2, PE1.3.
4	Understand the concept of exergy and how to apply it to closed and open systems (steady-state)	PE1.1, PE1.2, PE1.3.

4. Teaching strategies

“Give a man a fish and you feed him for a day. Teach him how to fish and you feed him for a lifetime.” **Lao Tzu**

Presentation of the material in lectures and discussions enables students to know how to approach complex engineering calculations required in industry. Lectures also present a wealth of real-world engineering examples to give students a feel for how thermodynamics is applied in engineering practice

Consultation periods are designed to provide you with feedback and discussion on the problems that I would like you to do.

5. Course schedule

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

APPROXIMATE WEEK	TOPIC
1	Basic concepts and definitions
2	Heat and work
3	1 st law of thermodynamics for closed systems
4	Properties of pure substances
5	1 st law of thermodynamics for open systems
6-9	2 nd law of thermodynamics for both closed and open systems
9-10	Exergy analysis.

The schedule shown may be subject to change at short notice to suit exigencies.

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
Laboratories	No	2 hours each	20% (2 x 10%)	1, 2 & 3	Lecture material	On the day of your assigned laboratories. See Appendix B: Laboratory timetable.	N/A	On the day
Class test in Lecture Theatre	No	1 hour	30%	1, 2 & 3	All lecture material up to the date of the test.	Week 7 Monday March 30	N/A	Two weeks later
Final exam	No	3 hours	50%	1, 2, 3 & 4	All course content from weeks 2-12 inclusive.	Exam period	N/A	Upon release of final results

Laboratories

You are required to obtain a bound laboratory book (alternate lined and graph pages) to record results of each experiment and analysis carried out whilst in the laboratory.

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.

The laboratory demonstrators will 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 apply for Special Consideration and inform your lecturer as soon as possible so that you may be reassigned to that experiment at a later date.

Transferring between groups

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

Marking

Marking guidelines for laboratory submissions will be provided at the same time as laboratory report details to assist with meeting assessable requirements. Submissions will be marked according to the marking guidelines provided.

Laboratory demonstrators will mark your preliminary work at the start of the laboratory period and your data collection and analysis at the end of the laboratory period. Ensure that 1) your work is marked before you leave the laboratory, 2) your mark is entered in the class record and 2) your laboratory book has been initialed by the demonstrator.

Assessment of laboratory reports will contribute 20% to the final mark. Marks will be allocated for completion of preliminary analysis, results obtained and calculations made during the laboratory period (4 marks for preliminary work, 6 marks for measurements, data analysis and conclusions). You do not have to submit a formal report; results of any calculations must be shown to the laboratory demonstrators for checking during the laboratory period.

Submission of preliminary work which is not your own, or copying during the laboratory period, will result in a mark of zero for the laboratory.

Preparation

Preparation prior to the laboratory periods is essential. Study the laboratory notes so that you know what the experiment is about in advance of each laboratory session. If you arrive without the necessary preparation, you may not be allocated the laboratory mark.

Bring a calculator to all laboratory periods.

You will not be admitted to the laboratory unless you are appropriately dressed for safe working, have a laboratory book, a calculator and present the assigned preliminary work.

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.

Examinations

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 Support Services Centre](#) prior to the examination. Calculators not bearing an “Approved” sticker will not be allowed into the examination room.

Late 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.

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

Textbooks

Y.A. Cengel, M.A. Boles & M. Kanoglu, (2019) Thermodynamics, an engineering approach, 9th, S.I. Edition, McGraw Hill Education..

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

Both of these are available in the UNSW bookshop.

You really must buy these books. If you are going to be a professional engineer, you will need references in the future. Some of the questions you are expected to try are in the first reference. Although the first reference contains a set of steam tables, they are of a different type to those found in Mayhew & Rogers. You will be required to be able to use those found in Mayhew & Rogers as these will be supplied in the final exam.

Suggested additional reading

M. J. Moran, H. N. Shapiro, D. D. Boettner & M. B. Bailey, (2018) *Fundamentals of engineering thermodynamics*, S.I. version, 9th Edition, John Wiley & Sons.

R. Scruton, (2012) *Green Philosophy. How to think seriously about the planet*, Atlantic Books London.

Schmidt, (2019) *Technical thermodynamics for engineers, basics and applications*, Springer.

A. Bejan, (2006) *Advanced engineering thermodynamics*, 3rd edition, John Wiley & Sons.

R.E. Sonntag and G.J. Van Wylen, (1991) *Introduction to thermodynamics classical and statistical*, 3rd Edition, John Wiley & Sons.

D.S. Lemons, (2013) *A students guide to entropy*, Cambridge University Press.

J.R. Reisel, (2016) *Principles of engineering thermodynamics*, S.I. edition, Cengage Learning.

P.W. Atkins, (2008) *Four laws that drive the universe*, Oxford University Press, or

P.W. Atkins, (2010) *The laws of thermodynamics. A Very Short Introduction.*, Oxford University Press. They are the same book.

P.W. Atkins, (1994) *The 2nd Law, energy, chaos & form*, Scientific American Publications.

P.W. Atkins, (2003) *Galileo's finger, the ten great ideas of science*, Oxford University Press (Chapters 3 & 4).

H.C. von Baeyer, (1999) *Warmth disperses and time passes, the history of heat, (previously published as Maxwell's demon)*, The Modern Library, New York.

Most of these titles are all available in the UNSW Library and are useful as additional reading material, giving good descriptions.

Additional materials provided in UNSW Moodle

This course has a website on UNSW Moodle which includes:

- the laboratory handouts;
- consultation notes (questions and numerical answers);

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

Recommended internet sites

Be very careful when looking at websites that discuss thermodynamics. The sign conventions used in thermodynamics are not uniform around the world, and some of these websites can therefore **strongly mislead students**. For example, the following website gives a very good definition of temperature:

<http://www.chemistryexplained.com/St-Te/Temperature.html>.

You should read this sometime.

But if you go to:

<http://www.chemistryexplained.com/Te-Va/Thermodynamics.html>

you will notice that the first law (equation (1)) is not written with the sign convention we use here in Australia. This may get students into a lot of trouble. The best approach for beginners is to use the texts recommended for the course.

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: <https://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.

The course has undergone considerable change since last year.

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 policies. 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](#)

Dr John Olsen
February 2020

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

Appendix B: Laboratory timetable

01 THURSDAY 9:00 – 11:00 WILLIS ANNEXE (J18) UTL	Week number and date at beginning of week							
	GROUP/SECTION	5 16/3	6 23/3		8 6/4	9 13/5		
	1: H09A		1		2			
2: H09B		1			2			

02 THURSDAY 11:00 – 13:00 WILLIS ANNEXE (J18) UTL	Week number and date at beginning of week							
	GROUP/SECTION	5 16/3	6 23/3		8 6/4	9 13/5		
	1: H11A		1		2			
2: H11B		1			2			

03 MONDAY 16:00 – 18:00 WILLIS ANNEXE (J18) UTL	Week number and date at beginning of week							
	GROUP/SECTION	5 16/3	6 23/3		8 6/4	9 13/5		
	1: M16A		1		2			

04 WEDNESDAY 9:00 – 11:00 WILLIS ANNEXE (J18) UTL	Week number and date at beginning of week							
	GROUP/SECTION	5 16/3	6 23/3		8 6/4	9 13/5		
	1: W09A		1		2			
2: W09B		1			2			

05 WEDNESDAY 11:00 – 13:00 WILLIS ANNEXE (J18) UTL	Week number and date at beginning of week							
	GROUP/SECTION	5 16/3	6 23/3		8 6/4	9 13/5		
	1: W11A		1		2			
2: W11B		1			2			

0T WEDNESDAY 13:00 – 15:00 WILLIS ANNEXE (J18) UTL	Week number and date at beginning of week							
	GROUP/SECTION	5 16/3	6 23/3		8 6/4	9 13/5		
	1: W13A		1		2			
2: W13B		1			2			

Laboratory Schedule Notes

- Lab 1: Thermodynamics Processes
- Lab 2: Reciprocating Air Compressor
- Groups are separated by class section. Please check your enrolment for the Section and Group you are in.

Appendix C: Consultation Periods

Class Section	Day	Time	Location
H09A	Thursday	9:00 – 10:00	Webster 256
H09B	Thursday	9:00 – 10:00	Quad G045
H11A	Thursday	11:00 – 12:00	Law 276
H11B	Thursday	11:00 - 12:00	RedC 2061
M16A	Monday	16:00 – 17:00	Webster 250
W09A	Wednesday	9:00 – 10:00	Ainsworth 101
W09B	Wednesday	9:00 – 11:00	Ainsworth G01
W11A	Wednesday	11:00 – 12:00	RedC 3037
W11B	Wednesday	11:00 – 12:00	RedC 2035
W13A	Wednesday	13:00 – 14:00	Quad G031
W13B	Wednesday	13:00 – 14:00	Law G17

Consultation periods start in week 2 and finish in week 11.