Course Outline

Semester 1 2016

Never Stand Still | Engineering | Mechanical and Manufacturing Engineering

MMAN2700

THERMODYNAMICS

Contents

1. Staff Contact Details

Contact details and consultation times for course convenor

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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.

2. Course details

Credit Points:

This is a 6 unit-of-credit (UoC) course, and involves three hours per week (h/w) of face-to-face contact.

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. There is no parallel teaching in this course.

Contact Hours

	Day	Time	Location
Lectures	Monday	1pm - 3pm	Physics Theatre
	Friday	9am – 10am	Law Theatre G04
Laboratories	Laboratory timetable is at the end of the document		
Demonstrations	Consultation timetable is at the end of the document		

- **Two hour laboratory period.**
  There are 4 compulsory 2-hour laboratories periods on the weeks indicated for your group in the attached laboratory timetable.

- The laboratory periods take place in the Willis Annexe, Room 116.

- **Dr John Olsen is only available for consultation on:** TBA.

- **Consultation periods with demonstrators:** You have already enrolled in consultation periods and so you already have the details.

Summary 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 which is 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.

Aims of the Course

The objectives of the course are to:

- familiarise students with the terminology associated with thermodynamics. I would like students to 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;
- teach students to identify whether a thermodynamic system is open, closed or isolated;
- familiarise students with both the 1st and 2nd laws of thermodynamics and teach students how to apply these laws;
- teach students how to use tabulated thermodynamic data for vapours, liquids and solids. Also to recognise under which circumstances it is best to use this data or the ideal gas laws;
- familiarise students with air standard cycle analysis of reciprocating piston engines like spark ignition engines and compression ignition engines;
- familiarise students with air standard cycle analysis for gas turbine engines;
- familiarise students with the analysis of vapour power cycles for large power plants, and finally;
- familiarise students with the analysis of vapour compression refrigeration cycles.

Student learning outcomes

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 how to 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

3. 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 so that the students know how to approach complex engineering calculations required in industry.
- To 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.

4. Course schedule

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

Week	Topic	Text Reference
1	1. *Basic Concepts and Definitions* • Systems, property, state, path, process, cycle • Units, Specific volume, density and pressure • Temperature and the zeroth law • The equation of state for a perfect gas • P-v-T surfaces for a perfect gas	Read Chapters 1, 2 , 3 and 4
2	2. *Work and Heat* • Definition of work • Work processes • Work done at the moving boundary of a closed system • Definition of heat • Examples of work and heat	
3	3. *First Law of Thermodynamics for a Closed System* • The first law • Internal energy and enthalpy- thermodynamic • properties, specific heats and property relations	
4	4. *Properties of a Pure Substance* • 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	
5	5. *First Law of Thermodynamics for an Open System* • Energy entering the system, enthalpy • The first law • Steady flow steady state system - examples	
5	6. *Analysis of Open and Closed Systems* • Throttling process, Joule-Thomson experiment • Closed system applications • Steady flow applications • Filling and discharging of rigid vessels	

6-8	*7. Second Law of Thermodynamics* • Definitions • Clausius and Kelvin-Planck statements • Carnot's principle, Carnot cycle • Clausius Inequality • Entropy as a property, irreversible processes • δQ = Tds equation • Property relations of entropy • Temperature-entopy and enthalpy-entropy diagrams • Ideal and actual processes, isentropic efficiencies • Carnot cycle • Entropy change of an ideal gas • T-s and h-s diagrams • Isentropic efficiencies	Chapters 5 and 6.
9-11	*8. Air-standard power cycles* • Reciprocating engine analysis • Otto, Diesel and dual cycles • Gas turbine analysis • Simple Brayton cycle	Chapter 7.4, 7.5, 7.6 and 7.8.
12	9. *Vapour cycles* • Rankine, reheat and regenerative cycles • Basic refrigeration cycle	Chapter 7 Chapter 8.1-8.2.

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

5. Assessment

Assessment Overview

Assessment	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Marks returned
Laboratories	2 hours each	4 x 2.5%	1, 2, 3, & 4	Lecture material	On the day of your assigned laboratories. See schedule in Appendix B.	On the day
Class test	1 hour	15%	1, 2.	All lecture material up to the date of the test.	April 15	April 29
Class test	1 hour	15%	3, 4	All lecture material up to the date of the test.	May 6	May 20
Final exam	3 hours	60%	1, 2, 3 & 4.	All course content from weeks 2-12 inclusive.	Exam period	Upon release of final results

Assignments

There are no assignments in Thermodynamics MMAN2700.

Examinations

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 and November for Semester 2.

Provisional Examination timetables are generally published on myUNSW in May for Semester 1 and September for Semester 2

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.

6. 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 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 readings

M. J. Moran, H. N. Shapiro, D. D. Boettner & M. B. Bailey, (2012) Fundamentals of Engineering Thermodynamics, SI version, 7^{th} Edition, John Wiley & Sons.

Y. A. Çengel and M. A. Boles, (2005) *Thermodynamics, an engineering approach*, 4^{th}, 5^{th} or 6^{th} Edition, McGraw Hill Higher Education.

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

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 2^{nd} 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.

These 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);
- a Mollier diagram.

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.

One starting point for assistance is: www.library.unsw.edu.au/servicesfor/students.html.

Please be aware of: http://info.library.unsw.edu.au/web/services/services.html

7. Course evaluation and development

Feedback on the course is gathered periodically using various means, including the Course and Teaching Evaluation and Improvement (CATEI) 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.

More markers will be used this year to speed up the return of class tests to students.

8. 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.

9. Administrative Matters

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

Dr John Olsen
February, 2016

Appendix A: Engineers Australia (EA) Professional Engineer Competency Standards

	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

		Week number and date at beginning of week							
01 MONDAY 15:00 – 17:00	GROUP	3 14/3	5 4/4	6 11/5	7 18/4	9 2/5	10 9/5	11 16/5	10 22/5
	1	T1		T2		T3		T4	
	2		T1		T2		T3		T4

02 TUESDAY 15:00 – 17:00		**Week number and date at beginning of week**							
	GROUP	**3** 14/3	**5** 4/4	**6** 11/5	**7** 18/4	**9** 2/5	**10** 9/5	**11** 16/5	**10** 22/5
	1	T1		T2		T3		T4	
	2		T1		T2		T3		T4

03 WEDNESDAY 10:00 – 12:00		**Week number and date at beginning of week**							
	GROUP	**3** 14/3	**5** 4/4	**6** 11/5	**7** 18/4	**9** 2/5	**10** 9/5	**11** 16/5	**10** 22/5
	1	T1		T2		T3		T4	
	2		T1		T2		T3		T4

04 WEDNESDAY 12:00 – 14:00		**Week number and date at beginning of week**							
	GROUP	**3** 14/3	**5** 4/4	**6** 11/5	**7** 18/4	**9** 2/5	**10** 9/5	**11** 16/5	**10** 22/5
	1	T1		T2		T3		T4	
	2		T1		T2		T3		T4

05 THURSDAY 9:00 – 11:00		**Week number and date at beginning of week**							
	GROUP	**3** 14/3	**5** 4/4	**6** 11/5	**7** 18/4	**9** 2/5	**10** 9/5	**11** 16/5	**10** 22/5
	1	T1		T2		T3		T4	
	2		T1		T2		T3		T4

0T THURSDAY 11:00 – 13:00		**Week number and date at beginning of week**							
	GROUP	**3** 14/3	**5** 4/4	**6** 11/5	**7** 18/4	**9** 2/5	**10** 9/5	**11** 16/5	**10** 22/5
	1	T1		T2		T3		T4	
	2		T1		T2		T3		T4

07 FRIDAY 10:00 – 12:00		**Week number and date at beginning of week**							
	GROUP	**3** 14/3	**5** 4/4	**6** 11/5	**7** 18/4	**9** 2/5	**10** 9/5	**11** 16/5	**10** 22/5
	1	T1		T2		T3		T4	
	2		T1		T2		T3		T4

T1 Thermodynamics Processes
T2 Reciprocating Air Compressor
T3 2nd Law of Thermodynamics
T4 Refrigeration

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. The laboratory demonstrators will mark your preliminary work at the start of the laboratory period and mark your data collection and analysis at the end of the laboratory period. Ensure that your work is marked before you leave the laboratory and that your mark is entered in the class record and your laboratory book and initialled by the demonstrator. **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.**

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 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 your lecturer as soon as possible so that you may be reassigned to that experiment at a later date.

Transfer from other groups. The laboratory groups are large so transfers between groups must be arranged through the lecturer.

Assessment of laboratory reports will contribute 10% to the final mark. Marks will be allocated for completion of preliminary analysis, results obtained and calculations made during the laboratory period (2 marks for preliminary work, 3 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.

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. **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.

Appendix C: Consultation Periods

Group	Day	Time	Location
1	Monday	15:00 – 16:00	RedC M032
2	Tuesday	17:00 – 18:00	Ainsworth102
3	Wednesday	13:00 – 14:00	Ainsworth102
4	Wednesday	15:00 – 16:00	OMB150
5	Thursday	11:00 – 12:00	Ainsworth102
T	Thursday	12:00 – 13:00	Ainsworth102
7	Friday	13:00 – 14:00	AinsworthG02

Consultation periods start in week 2 and finish in week 13.