Course outline

Semester 1 2017

Never Stand Still | Engineering | Mechanical and Manufacturing Engineering

MMAN2700

THERMODYNAMICS

Contents

1. Staff contact details

Contact details and consultation times for course convenor
Name: Phil Howlin
Office: J17 Ainsworth Building Room 208A
Tel: (02) 9385 4390
Email: p.howlin@unsw.edu.au

There will be time for content and course related questions at the end of each Monday lecture. If questions continue beyond when the lecture theatre is available, discussions can continue in J17/208A.

All non-private content or course related queries should be directed to Moodle forums first – a problem you are having is unlikely to be unique in a large class and posing a question in the 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 additional lecturers/demonstrators/lab staff

Head Demonstrators

Problem Solving Sessions	***Laboratories***
Shervin Arani	Tzi-Chieh (Monica) Chi
Email: s.karimkashiarani@unsw.edu.au	Email: t.chi@unsw.edu.au

Consultation with Head Demonstrators can be arranged by email.

Other Demonstrators

Problem Solving Sessions	***Laboratories***
Shervin Arani	Tzi-Chieh (Monica) Chi
Rasel Mahamud	Philippe Gentillon
Harshad Ranadive	Yashar Shoraka
Chaoyang Jiang	Shervin Arani
Azadeh (Azy) Lotfi	Duncan Poon
Moustafa Ali	Chris Miller
Joshua Pham	

Other demonstrators will be available during their rostered Problem Solving Sessions and Laboratories and will answer Moodle forums but will not generally be available for consultation outside of those times.

2. Course details

Credit Points

This is a 6 unit-of-credit (UoC) course, and involves an average of 5 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.

Contact hours

	Day	**Time**	**Location**
Lectures *(Week 1 to 13)*	Monday	11:00 - 13:00	Law Theatre G04 (K-F8-G04) Web Stream[‡]
	Tuesday	17:00 - 18:00	Ainsworth G03 (K-J17-G03) Web Stream[‡]
Demonstrations *(Week 2 to 13)*	Tue	10:00 - 11:00	Ainsworth 102 (K-J17-102)
	Tue	13:00 - 14:00	Red Centre Central Wing M032 (K-H13-M032)
	Wed	10:00 - 11:00	Ainsworth 102 (K-J17-102)
	Wed	15:00 - 16:00	Red Centre Central Wing M032 (K-H13-M032)
	Thu	14:00 - 15:00	Webster 256 (K-G14-256)
	Thu	15:00 - 16:00	Webster 256 (K-G14-256)
	Fri	12:00 - 13:00	Ainsworth 102 (K-J17-102
Laboratories *(Week 3 to 11) Attend every 2^{nd} Week[¥]*	Mon	14:00 - 16:00	Willis Annexe 116C UG Lab (K-J18-116C)
	Tue	15:00 - 17:00	
	Wed	11:00 - 13:00	
	Wed	13:00 - 15:00	
	Wed	16:00 - 18:00	
	Thu	12:00 - 14:00	
	Fri	10:00 - 12:00	

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 compulsory 2-hour laboratories. See *Appendix B: Laboratory Timetable* for attendance requirements.

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 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

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 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	Recognise that heat and work are methods by which energy is transferred.	PE1.1
2	Use the first law of thermodynamics to solve steady-state and transient problems on closed and open systems.	PE1.1, PE1.2, PE1.3
3	Demonstrate knowledge of the second law of thermodynamics by solving steady-state problems on closed and open systems.	PE1.1, PE1.2, PE1.3
4	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
5	Identify links between theoretical analysis methods learned in class and actual performance of thermodynamics machines and devices	PE1.3, PE2.2

3. 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 see some of the theories in action and the laboratory report encourages students to fuse theory with what occurs in practice.

Thermodynamics is a subject that can easily be taught in a way that makes students good at looking up tables and applying formulas without connecting theoretical learning to the real world. The Assignment is an opportunity to investigate the application of engineering thermodynamics further and make these ties to the real world.

Since all of this primarily teaches the subject from one point of view, students are encouraged to seek other learning resources and share them through the Leganto platform for the benefit of all.

Moodle forum discussions provide an opportunity to further explore and discuss content.

4. 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 & J17-G03	Systems, property, state, path, process, cycle Units, Specific volume, density and pressure 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 & J17-G03	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 & J17-G03	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
4		First Law, Open Systems Open and Closed Systems	F8-G04 & J17-G03	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	

5	Second Law of Thermodynamics	F8-G04 & J17-G03	Carnot's principle, Carnot cycle Entropy as a property	Chapter 5
6		F8-G04 & J17-G03	δQ = Tds equation Property relations of entropy Isentropic efficiencies	Chapter 6
7	Thermodynamic Cycles	F8-G04 & J17-G03	Otto cycle Diesel cycle Simple Brayton cycle Rankine cycle Vapour refrigeration cycle	Chapter 7 & 8
8		F8-G04 P/H Tuesday		
9		F8-G04 & J17-G03		
10	Further Thermodynamic Cycles	F8-G04 & J17-G03	Improved Rankine Cycle Dual Cycle	
11	Review and Application	F8-G04 & J17-G03	Applications of Thermodynamics	Review of all Chapters
12		F8-G04 & J17-G03	Applications of Thermodynamics	

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

See *Appendix B: Laboratory Timetable* for the schedule of laboratories.

5. Assessment

Assessment overview

Assessment	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
Concept Tests (2)	40 minutes each	0%	Nil	Understanding of thermodynamic concepts.	5pm Tuesday Week 1 28/02/2017 5pm Tuesday Week 12 23/05/2017	N/A	No Marks Results discussed in class
Laboratories (4)	2 hours each + report	15% (4 x 2.5% + 5%)	1, 2, 3, & 4	Completion of Preliminary Work and Lab Analysis. Demonstrated understanding of physical phenomena.	On the day of your assigned laboratories. See schedule in Appendix B Final Report 5pm Friday Week 12 26/05/2017	Sunday 28/05/2017	Labs marks given on the day. Report marks given two weeks after submission
Assignment	8 pages of body content	15%	4 and 5	Understanding of application of theoretical thermodynamics to real world device.	5pm Friday Week 11 19/05/2017	Monday 22/05/2017	Friday Week 13 02/06/2017
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, 03/04/2017 6pm Monday Week 9, 01/05/2017	N/A	2 weeks after test
Final exam	2 hours	40%	1, 2, 3 and 4	All course content from weeks 2-12 inclusive.	Exam period, date TBC	N/A	Upon release of final results

Concept Tests

Two non-compulsory ‘zero weighted’ tests will be run this session: One at the beginning of the session in week 1 and one near the end of the session. These tests focus on conceptual knowledge rather than calculation. The results of these tests will be used to better understand the knowledge that the student cohort approaches the subject with and to identify strengths and weaknesses in teaching.

Attendance at these tests is not compulsory and non-attendance will not affect student grades. They are however encouraged since such tests have been shown to be valuable for students and academics. The tests will be taken during lecture time in the normal lecture location – Ainsworth G03 (K-J17-G03). Web stream students are invited to attend.

Laboratories

Attendance

There are 4 laboratories to be performed over 8 weeks. Students enrolled in a laboratory slot will be split into 2 groups, A and B. Group A will attend laboratories in odd numbered weeks (3, 5, 7, 9, 11); group B will attend laboratories in even numbered weeks (4, 6, 8, 10) with a slight variation due to public holidays in weeks 7 and 8. This is shown in *Appendix B: Laboratory Timetable* at the end of this document, along with other laboratory requirements.

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.

A suggested template will be supplied with the assignment details which may be used to assist with organising material you gather for the assignment. Deviation from the supplied template will not be penalised if you clearly fulfil the assignment requirements.

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). An extension may only be granted in exceptional circumstances. Where an assessment task is worth less than 20% of the total course mark and you have a compelling reason for being unable to submit your work on time, you must seek approval for an extension from the course convenor ***before the due date***. Special consideration for assessment tasks of 20% or greater 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 per the marking guidelines provided.

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.

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.

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 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 is from *Reisel*. Although *Reisel* contains a set of steam tables, it lacks any refrigerant data. This is required for later in the course.

Suggested alternate information sources and additional readings

The library tool 'Leganto' is being used to compile the list of recommended readings and alternative information sources. Leganto may be accessed through links in the Moodle page for the course.

Students are encouraged to review the Leganto reading list for this course and suggest contributions to this list – books, journals, websites and videos – as they come across them in their studies.

While items in this alternate list are not mandatory or recommended for purchase, they may expose the student to alternative explanations of complex concepts to help understanding.

Additional materials provided in UNSW Moodle

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

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 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 restructuring the Consultation sessions into more interactive Problem Solving Sessions and greater use of Moodle.

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

Phil Howlin
February 2017

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

		Week number and date at beginning of week								
GROUP	**3** 13/3	**4** 20/3	**5** 27/3	**6** 3/4	**7** 10/4	**Break** 17/4	**8** 24/4	**9** 1/5	**10** 8/5	**11** 15/5

Lab 1, Monday 14:00 – 16:00

GROUP	3	4	5	6	7	Break	8	9	10	11
L1GA	T1		T2		T3				T4	
L1GB		T1		T2			T3			T4

Lab 2, Tuesday 15:00 – 17:00

GROUP	3	4	5	6	7	Break	8	9	10	11
L2GA	T1		T2		T3				T4	
L2GB		T1		T2			P/H	T3		T4

Lab 3, Wednesday 11:00 – 13:00

GROUP	3	4	5	6	7	Break	8	9	10	11
L3GA	T1		T2		T3				T4	
L3GB		T1		T2			T3			T4

Lab 4, Wednesday 13:00 – 15:00

GROUP	3	4	5	6	7	Break	8	9	10	11
L4GA	T1		T2		T3				T4	
L4GB		T1		T2			T3			T4

Lab 5, Wednesday 16:00 – 18:00

GROUP	3	4	5	6	7	Break	8	9	10	11
L5GA	T1		T2		T3				T4	
L5GB		T1		T2			T3			T4

Lab 6, Thursday 12:00 – 14:00

GROUP	3	4	5	6	7	Break	8	9	10	11
L6GA	T1		T2		T3				T4	
L6GB		T1		T2			T3			T4

Lab 7, Friday 10:00 – 12:00

GROUP	3	4	5	6	7	Break	8	9	10	11
L7GA	T1		T2		P/H			T3	T4	
L7GB		T1		T2			T3			T4

T1 - Thermodynamics Processes
T3 - 2nd Law of Thermodynamics

T2 - Reciprocating Air Compressor
T4 - Refrigeration

Resources Required

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. **You will not be admitted to the laboratory unless you have a laboratory book, a calculator and present the assigned preliminary work.**

Laboratory Pre-Work

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. The laboratory demonstrators will mark your preliminary work at the start of the laboratory period

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

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 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.

Assessment

Assessment of the laboratory component of the course will contribute 15% to the final mark. 10% of this mark 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). Ensure that your work is marked and your laboratory book is initialled by the demonstrator before you leave the laboratory.

The remaining 5% will be assessed in the form of a formal report due to be submitted through Moodle on Friday of Week 12. Further guidance on this report will provided during the session.