THE UNIVERSITY OF NEW SOUTH WALES
SCHOOL OF MECHANICAL AND MANUFACTURING ENGINEERING

MMAN2700 THERMODYNAMICS (6 credits)

COURSE OUTLINE

for Session 1, 2009

CONTENTS

MMAN2700 THERMODYNAMICS

STAFF INVOLVED IN THE COURSE

Course Convenor:
Dr John Olsen,
Room M38, Willis Annexe,
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Additional lecturers - tutorial/laboratory teaching staff:
Dr Chris Meninctas,
Refrigeration laboratory.

INFORMATION ABOUT THE COURSE

How the course relates to other course offerings in the discipline

This course introduces the student to the terminology, principles and methods used in engineering thermodynamics.

Thermodynamics is a subject which deals with energy, which is essential for sustenance of life, and 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, Internal Combustion Engines, Refriferation and Air Conditioning and Solar Energy.

The objectives of the course

The objectives of the course are to:

- Familiarise you with the terminology associated with thermodynamics.
- To cover the basic principles of thermodynamics.
- Familiarise you with the use of thermodynamic data for gases and fluids.
- Understand the application of the first and second laws of thermodynamics.
- Familiarise students with the analysis of closed and open systems.
- Have you develop an intuitive understanding of thermodynamics by emphasizing the physics and physical arguments.
- Familiarise students with air standard cycle analysis of internal combustion engines, vapour cycle analysis for power plants and refrigeration cycle analysis.

The teaching strategies that will be used include:

- 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

Suggested approaches to learning in the course

Suggested approaches to learning in this course include:

- Careful reading, discussion and understanding of the material presented in lectures.
- Additional reading on and about the material presented in lectures to broaden the knowledge base.
- Paying attention throughout the tutorials, and asking questions when anything is not understood.
- Conscientiously working through ALL the tutorial problems.
- Learning the lecture material in preparation for examinations.

Expected learning outcomes; their association with the teaching strategies and with the suggested approaches to learning

On completion of the course, it is expected that you will:

- Be familiar with the terminology associated with thermodynamics.
- Be able to use thermodynamic data for gases and fluids for complex calculations .
- Be able to use of the first and second laws of thermodynamics in the analysis of closed and open systems.
- Have developed an intuitive understanding of thermodynamics by emphasizing the physics and physical arguments.

Student-centred and self-directed learning (expectations of the students)

This course involves two and a half hours per week of face-to-face contact, and it is expected that you will put in, on average, an additional two-and-a-half hours per week of your own time (including stuvac and exams). This time should be spent in revising the lecture material and further reading, completing the set assignments, and revising and learning for the examinations.

The time budget above indicates the time expected to be spent on various course activities for an average student aiming for a credit grade. Various factors, such as ability, target grade, etc., will influence the time needed in your case. The time available is based on a total of 40 hours per week spent on 24 units of credit (including both in-class and out-of-class time) for an effective 16 weeks (fourteen weeks of session, plus stuvac, plus one effective exam week). Some students spend much more, but you should aim to spend not less than 40 h/w on coursework for 24 UoC.

ASSESSMENT IN THE COURSE

Overall rationale for assessment components and their association with course objectives.

You are assessed by way of a mid-session test, laboratory work and examination which involve both calculations and descriptive material. These assessments test your grasp of the principles involved, and are typical of the calculations you will be expected to perform as graduate mechanical engineers.

TEXTS:

M. J. Moran and H. N. Shapiro, (2008) Fundamentals of Engineering Thermodynamics, 6th Edition, John Wiley & Sons.
Y.R. Mayhew and G.F.C. Rogers, *Thermodynamic and Transport Properties of Fluids*, S.I. Units, Basil Blackwell.

FURTHER USEFUL REFERENCES:

Y. A. Cengel and M. A. Boles, (2005) *Thermodynamics, an Engineering Approach*, 4th or 5th 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.
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.

COURSE DESCRIPTION AND TEXT REFERENCE:

Topic	Text Reference
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 and 2 and sections 9, 12, 13 and 15 from Chapter 3.
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. *First Law of Thermodynamics for a Closed System* • The first law • Internal energy and enthalpy- thermodynamic • properties, specific heats and property relations ------	
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	Sections 1, 2, 3, 4, 5 and 6 of Chapter 3.
5. *First Law of Thermodynamics for an Open System* • Energy entering the system, enthalpy • The first law • Steady flow steady state system - examples	Chapter 4.
6. *Analysis of Open and Closed Systems* • Throttling process, Joule-Thomson experiment • Closed system applications • Steady flow applications • Filling and discharging of rigid vessels	All of the above along with section 5.3 of Chapter 11.

Continued over page

Topic	Text Reference
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 • Adiabatic efficiencies	Chapters 5 and 6.
8. Air-standard power cycles • Reciprocating engine analysis • Otto, Diesel and dual cycles • Gas turbine analysis • Simple Brayton cycle	Sections 1, 2, 3, 4, 5,6 and 11 of Chapter 9.
9. *Vapour cycles* • Rankine, reheat and regenerative cycles • Basic refrigeration cycle	Sections 1, 2, 3 and 4 of Chapter 8 as well as sections 1 and 2 of Chapter 10.

GENERAL ARRANGEMENT

CLASS CONTACT

The class contact will include the following sessions:

- **Lecture periods**
  Tuesday 12:00pm to 2:00pm (Mathews Theatre A)
  Thursday 9:00am to 10:00am (Keith Burrows Theatre)

  A two hour mid-session test in week 8 will take place in the Tuesday lecture period.
- **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 L211.
- **Consultation period with lecturer.**
  To Be Announced
- **Tutorial sessions with tutors.**
  See laboratory time table for details

TUTORIAL WORK

It is essential that you make full use of the consultation periods and attempt relevant tutorial problems as soon as possible after a topic has been covered in lectures and tutorial periods. The tutorial problems are essential to consolidate understanding of the subject and to reveal aspects of the course which you have not understood. The problems in the mid-session tests will be similar to the tutorial problems. You should use a notebook for your worked solutions.

ASSESSMENT

Evaluation of progress in each subject will be based on a mid-session test of 1 hour and 40 minute duration and a final examination of three hours duration. The mid-session test will be held in week 8 during the two hour lecture period. The questions will be similar to the tutorial problems.

Break up of marks

4 × laboratories	**10%** of final mark (2.5% each)
1 × mid-session exam	**30%** of final mark
1 × final exam	**60%** of final mark
	100%

CALCULATORS

You will be only be allowed to use the:
Scientific Casio *fx*-911W,
in the mid-session and final exams.

LABORATORY WORK

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.

Examination procedures and advice concerning illness or misadventure

Equity and diversity

Students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equity and Diversity Unit (9385 4734 or www.equity.unsw.edu.au/disabil.html). Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

LABORATORY AND TUTORIAL TIMETABLE

LABORATORY 01 WEDNESDAY 9am - 11am Tutorial 9am – 10am ME405		Week number and date at beginning of week							
	GROUP	3 23/3	4 30/3	5 20/4	6 27/4	7 4/5	8 11/5	9 25/5	10 27/5
	1	T1		T2		T3		T4	
	2		T1		T2		T3		T4

LABORATORY 02 WEDNESDAY 11am – 1pm Tutorial 11am – 12pm ME405		Week number and date at beginning of week							
	GROUP	3 23/3	4 30/3	5 20/4	6 27/4	7 4/5	8 11/5	9 25/5	10 27/5
	1	T1		T2		T3		T4	
	2		T1		T2		T3		T4

LABORATORY 03 WEDNESDAY 2pm – 4pm Tutorial 2pm – 3pm ME401		Week number and date at beginning of week							
	GROUP	3 23/3	4 30/3	5 20/4	6 27/4	7 4/5	8 11/5	9 25/5	10 27/5
	1	T1		T2		T3		T4	
	2		T1		T2		T3		T4

LABORATORY 04 FRIDAY 9am – 11am Tutorial 9am – 10am ME501		Week number and date at beginning of week							
	GROUP	3 23/3	4 30/3	5 20/4	6 27/4	7 4/5	8 11/5	9 25/5	10 27/5
	1	T1		T2		T3		T4	
	2		T1		T2		T3		T4

LABORATORY 05 FRIDAY 11am – 1pm Tutorial 11am – 12pm ME501		Week number and date at beginning of week							
	GROUP	3 23/3	4 30/3	5 20/4	6 27/4	7 4/5	8 11/5	9 25/5	10 27/5
	1	T1		T2		T3		T4	
	2		T1		T2		T3		T4

LABORATORY 06 THURSDAY 4pm– 6pm Tutorial 4pm – 5pm ME501		Week number and date at beginning of week							
	GROUP	3 23/3	4 30/3	5 20/4	6 27/4	7 4/5	8 11/5	9 25/5	10 27/5
	1	T1		T2		T3		T4	
	2		T1		T2		T3		T4

LABORATORY 07 MONDAY 1am– 3am Tutorial 1am – 2am ME405		Week number and date at beginning of week							
	GROUP	3 23/3	4 30/3	5 20/4	6 27/4	7 4/5	8 11/5	9 25/5	10 27/5
	1	T1		T2		T3		T4	
	2		T1		T2		T3		T4

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

Academic honesty (including misconduct, plagiarism)

What is Plagiarism?

Plagiarism is the presentation of the thoughts or work of another as one's own.*
Examples include:

- direct duplication of the thoughts or work of another, including by copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person's assignment without appropriate acknowledgement;
- paraphrasing another person's work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
- piecing together sections of the work of others into a new whole;
- presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and
- claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.†

For the purposes of this policy, submitting an assessment item that has already been submitted for academic credit elsewhere may be considered plagiarism.

Knowingly permitting your work to be copied by another student may also be considered to be plagiarism.

Note that an assessment item produced in oral, not written, form, or involving live presentation, may similarly contain plagiarised material.

The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does *not* amount to plagiarism.

The Learning Centre website is main repository for resources for staff and students on plagiarism and academic honesty. These resources can be located via:

www.lc.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

- correct referencing practices;
- paraphrasing, summarising, essay writing, and time management;
- appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students 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 items.

* Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle

† Adapted with kind permission from the University of Melbourne.