MECH3610

ADVANCED THERMOFLUIDS

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Contact details and consultation times for course convenor

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Only use email as a last resort. I would prefer you see me after the lecture if you have a problem.

Credit Points

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

Aims of the course

The aims of the course are to obviously to advance your knowledge of thermodynamics, fluid mechanics and to introduce you to the discipline of heat transfer.

It is generally agreed that our planet is running out of fossil fuels and that the anthropocentric emissions of carbon is causing it to warm. Surely, this is not news to students studying advanced thermofluids! Either of these situations ought to provide enough motivation to students to really try to understand this subject.

I know from my connections overseas that exergy analysis and the idea of entropy generation minimization are becoming very important. I therefore want to place a greater emphasis on these ideas so that we, in this part of the world, can make a contribution.

The student outcomes listed below will give more of an idea of what I am to teach you.

Student learning outcomes

"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**

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 conduction, convection and radiation modes of heat transfer, and the development of exergy analysis from the 1st and 2nd laws of thermodynamics.	PE1.1, PE2.1
2	Understand the concept of irreversibility and its relation to inefficiencies.	PE1.1, PE1.3, PE2.1
3	Analyse steady-state and sometimes transient conduction and/or convection heat transfer problems and find solutions.	PE1.1, PE1.3, PE1.4
4	Understand when to use compressible flow analysis.	PE2.1, PE2.2
5	Understand heat exchanger design and analysis, compressible flows, and combustion chemistry	PE1.1, PE1.3, PE1.5, PE2.1
6	Understand the effect of attractive (van der Waals) forces on the behaviour on gases.	PE1.1, PE1.3
7	Develop and understanding of combustion reactions and their energy release. Understand chemical equilibrium and le Chatelier's principle.	PE1.1, PE1.2, PE2.1
8	Understand the idea of radiation as a heat transfer mode.	PE1.1 PE1.3

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General
Lectures are designed to cover the core concepts listed in the course schedule. The material is presented so as to offer an approach to the complex engineering calculations required by industry.

Demonstrations
Demonstrations enable you to test your conceptual framework on problems that are as close to reality as you are liable to get.

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1.	Exergy analysis of closed and steady-state, steady-flow, open systems.
2.	Introduction to heat transfer (conduction, convection & radiation). 1st law and Fourier's law combined to give the conduction equation. Extention to Cartesian, cylindrical and spherical coordinate systems. Thermal resistance. Convection equation. Composite walls and the overall heat transfer coefficient. Radiation.
3.	Heat transfer applied to the engine cycle engine analysis. Curzon-Ahlborn analysis. Introduction to statistical mechanics, the concept of entropy on the microscopic scale and the partition function.
4.	Gas mixtures and real gas analysis. Van der Waal's and Berthelot's equations. The virial coefficients, Maxwell's relations.
5.	Heat transfer from extended (finned) surfaces. Long fins, finite length fin (with insulated tip), the effect of adding heat transfer through the tip.
6.	More on statistical mechanics. Boltzmann's distribution. The partition functions for translational, rotational and vibrational modes of energy storage for calculation of specific heat capacities.
7.	Forced convection. Laminar boundary layers and heat transfer from a plate in external flow. Turbulent boundary layers. Cylinders in cross flow, etc. Analytical solutions and experimental solutions.
8.	Internal compressible flows. Convergent and convergent-

9. Free convection.
Benard instability. The logistic equation, chaos theory and the idea of sensitive dependence on initial condition, irreversibility

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Required textbooks

- Moran, M.J., Shapiro, H.N., Boettner, D.D. & Bailey, M.B. (2011), Fundamentals of Engineering Thermodynamics, 7th Edition, John Wiley & Sons.
- Holman, J.P. (2010), Heat Transfer, 10th Edition, McGraw Hill.
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Additional materials provided on Moodle

This course has a Moodle page. Here, you will find demonstration problems, assignments and other notices.

Recommended internet sites

First, a warning. We discovered this year in 1st session that some universities, frustrated by students submitting solutions they find on the internet for assignments, are deliberately

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

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