UNSW SYDNEY
Australia's Global University

Mechanical and Manufacturing Engineering

Course Outline

Term 1 2019

MECH4620

COMPUTATIONAL FLUID DYNAMICS

Contents

1. Staff contact details

Contact details and consultation times for course convenors

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

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For more information, please see the course Moodle.

2. Important links

- Moodle
- Lab Access
- Computing Facilities
- Student Resources
- Course Outlines
- Engineering Student Support Services Centre

3. Course details

Credit points

This is a 6 unit-of-credit (UoC) course and involves 3.5 hours per week (h/w) of face-to-face contact.

Contact hours

	Day	**Time**	**Location**
Lectures	Tuesday	12noon – 1:30pm	Webster Theatre B
(Web stream)	Any	Any	Moodle
Lab	Tuesday	2pm – 4pm	Ainsworth 203
	Tuesday	2pm – 4pm	Ainsworth 204
	Tuesday	4pm – 6pm	Ainsworth 204

Please refer to your class timetable for the learning activities you are enrolled in and attend only those classes.

Summary and Aims of the course

This course will focus on the terminology, principles and methods of CFD – Computational Fluid Dynamics.

CFD can be applied in many areas of engineering, including aerodynamics, hydrodynamics, air-conditioning and minerals processing, and you will find relevance towards many other courses you are currently taking.

The aims of the course are to:

- Place CFD in the context of a useful design tool for industry and a vital research tool for thermos-fluid research across many disciplines;
- Familiarize students with the basic steps and terminology associated with CFD. This includes developing students' understanding of the conservation laws applied to fluid motion and heat transfer and basic computational methods including explicit, implicit methods, discretisation schemes and stability analysis;

- Develop practical expertise in solving CFD problems with a commercial CFD code, ANSYS CFX; and
- Develop an awareness of the power and limitations of CFD.

This course builds on knowledge gained in other courses such as Fluid Mechanics, Thermodynamics, and Numerical Methods.

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.	An underlying understanding of the theoretical basis of CFD	PE1.1, PE1.2, PE1.4
2.	The ability to develop a CFD model for "real world" engineering problems	PE2.1, PE2.2
3.	The technical ability to address complex problems using CFD with the specific focus on developing practical skills in using a commercial CFD package, ANSYS CFX	PE1.3, PE1.5
4.	The ability to interpret computational results and to write a report conveying the result of the computational analysis	PE3.1, PE3.2, PE3.3

4. Teaching strategies

Lectures in the course are designed to cover the terminology and core concepts and theories in CFD. They do not simply reiterate the texts, but build on the lecture topics using examples taken directly from industry to show how the theory is applied in practice and the details of when, where and how it should be applied. The WEB stream version of the course will also be available. This provides students with the opportunity to learn the lecture content online interactively in their own time.

Lab sessions are designed to provide you with feedback and discussion on the assignments, and to investigate problem areas in greater depth to ensure that you understand the application and can avoid making the same mistake again.

5. Course schedule

Week	Lecturer	Topic	Work during laboratory session	Assignment Activity
1	GHY	Introduction to CFD and some examples of CFD	• Backward facing step exercise • Problem setup	
2	GHY	• Introduction to ANSYS CFX and Fluent • Defining a CFD problem • Creating and/or Importing Geometry in Design Modeler	• Lab work on creating geometry and meshing	Due: Group allocation questionnaire
3	AY	Mass and momentum conservation and Navier-Stokes equations	• Lab work on creating geometry and meshing • Heat exchanger exercise: Meshes • Discussions of group and major project topics	
4	AY	Kinematic properties of fluids, dynamic similarity and energy conservation	• Lab work on conservation laws (T1) • Discussions of group and major project topics	Due: T1: conservation laws
5	GHY	Initial and boundary conditions: practical guidelines	• Lab work on conservation laws (T1) • Backward facing step exercise: Characterization of boundary conditions • Heat exchanger exercise: • Characterisation of boundary conditions	Feedback: T1: conservation laws
6	GHY	Turbulence: basics and introduction	• Backward facing step exercise: Convergence and Discretisation, Turbulence models, T2 work	
7	GHY	Turbulence: applications of models	• Group and major project work, T2 work	Due: T2: turbulence
8	AY	Computational methods – discretisation	• Group and major project work • Computational method online tutorial	Due: Group project report Feedback: T2: conservation laws
9	AY	Solution Procedures	• Group and major project work	Feedback Group project report
10	AY	Post processing – analysis of results. Validation and verification	• Major project work	Due: Individual project report
11	GHY, AY	Revision and Consultation	• Major project work	Feedback Individual project report

6. Assessment

Assessment overview

You will be assessed by way of 2 sets of tutorial-style problems, one group project and one individual project and a two-hour examination at the end of the session. Details of each assessment component, the marks assigned to it, the criteria by which marks will be assigned, and the dates of submission are given below.

Assessment task	Group Project?	If Group, number of Students per group	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date, time, and submission requirements	Deadline for absolute fail	Marks returned
Tutorial-style problems	No	N/A	2-3 pages	10% (2x 5% each)	1 and 4	Understanding of lecture material	4 pm Friday, Week 4, Week 7 via Moodle	Same as assignment deadline	1 week after due date
Group Project	Yes	5	15 pages	20%	2, 3 and 4	See below	4 pm Friday, Week 8 via Moodle	4 pm Monday, Week 9	1 weeks after due date
Individual Project	No	N/A	15 pages	20%	2, 3 and 4	See below	4 pm Friday, Week 10 via Moodle	4 pm Wednesday, Week 11	1 weeks after due date
Final exam	No	N/A	2 hours	50%	1	All course content from weeks 1-10	Exam period, date TBC	N/A	During exam period

Assignments

Tutorial-style problems

The short assignments containing 2 sets of tutorial-style problems (T1 and T2) are listed in the Course Schedule. They will involve theoretical work and calculations related to the Course materials. Assignments will be available on the Moodle website.

Group project

The group project involves a complete CFD analysis, from the initial concept through to CAD, meshing, pre-processing, solving, and post-processing the results. The project description will be available on Moodle.

In Week 2, students need to complete a Moodle questionnaire for group allocation purposes. The groups and allocated project topics will be announced in Week 3.

The report to be submitted will be a technical report in the style of a journal article or industrial project report for a client familiar with CFD; a template will be provided to you which will also contain a structured marking criteria. The report will involve you writing an abstract/executive summary, and you will be required to conduct a short review of some similar CFD you are able to find in relevant journal papers. Following this, you will write a discussion of your chosen numerical method and assumptions, and then sections relating to mesh convergence, turbulence modelling, and presentation of key results – these reflect the topics which will be covered in depth in the lectures and labs and comprise the typical structure of a research report.

Individual project

The individual project focuses on assesseing the individual skills in CFD anaylsis, in particular the capability of using the CFD simulation data to describe the physical bahaviors involved in the flow. The subject of the CFD investigation will be the selection from of one of the three set problems provided in Moodle.

The report of the individual major project should be of similar quality as the group project report, but is to be written individually. The report is due at 4pm on Friday, Week 10. Additional details may be found in the template of the Individual project on Moodle.

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.

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.

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 according to the marking guidelines provided.

Examinations

There will be a two-hour examination at the end of the semester.

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 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

If you have experienced an illness or misadventure beyond your control that has interfered with your assessment performance, you are eligible to 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

Recommended textbooks

1. J.Y. Tu, G.H. Yeoh, and C. Liu, Computational Fluid Dynamics: A Practical Approach, 3rd Edition, 2018, **or**
2. H.K. Versteeg and W. Malalasekera, An introduction to Computational Fluid Dynamics. The Finite Volume Method, 2nd Edition

Other references

1. J.D. Anderson, Computational Fluid Dynamics.
2. P.J. Roache, Fundamentals of Computational Fluid Dynamics.
3. P.J. Roache, Verification and Validation in Computational Science and Engineering.
4. J.C. Tannehill, D.A. Anderson and R.H. Pletcher, Computational Fluid Mechanics and Heat Transfer.
5. S.V. Patankar, Numerical Heat Transfer and Fluid Flow.
6. D.C. Wilcox, Turbulence modelling for CFD.

All of the above textbooks can be found in the UNSW Library:
https://www.library.unsw.edu.au/

Recommended Internet sites

www.ansys.com
www.cfd-online.com

Additional materials provided in UNSW Moodle

This course has a website on UNSW Moodle which includes:

- copies of assignments (as they are issued, in case you missed the hand-out in class);
- tutorial-style problems;
- discussion forum;
- links to any useful material discussed in class.

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

The discussion forum is intended for you to use with other enrolled students. The course convenor and/or demonstrators will occasionally look at the forum, monitor any inappropriate content, and take note of any frequently-asked questions, but will only respond to questions on the forum at their discretion. If you want help from the convenor, then direct contact is preferred.

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.

In this course, recent improvements resulting from student feedback include the introduction of a group project to encourage collaborative learning experiences. Also, demonstrators are now required to provide more comprehensive feedback to assignment activities during lab sessions.

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 School guidelines and polices, available on the intranet. In particular, students should be familiar with the following:

- Attendance
- UNSW Email Address
- Computing Facilities
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Student Equity and Disabilities Unit
- Health and Safety
- Lab Access
- Makerspace
- UNSW Timetable
- UNSW Handbook
- UNSW Mechanical and Manufacturing Engineering

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