UNSW AUSTRALIA

Course outline

Semester 2 2016

Never Stand Still | Engineering | Mechanical and Manufacturing Engineering

MECH 4620

COMPUTATIONAL FLUID DYNAMICS

Contents

1. Staff contact details

Contact details and consultation times for course convenor

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2. Course details

Credit Points

This is a 6 unit-of-credit (UoC) course, and involves 3 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 of this course.

Contact hours

Lectures	**Day**	**Time**	**Location**
	Friday	9:00AM – 10:30AM	Chemical Sc M17
Laboratories	**Day**	**Time**	**Location**
	Friday	10:30AM – 12:00PM	Ainsworth Building 203 and 204

Summary 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 to many other courses you are currently taking.

Aims of the course

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;
- Familiarise students with the basic steps and terminology associated with CFD. This include developing students' understanding of the conservation laws applied to fluid motion and heat transfer and basic computational methods including explicit, implicit methods, discretization schemes and stability analysis;
- Develop practical expertise of solving CFD problems with a commercial CFD code, ANSYS CFX;
- Develop an awareness of the power and limitations of CFD.

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

Student learning outcomes

This course is designed to address the below learning outcomes 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 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

3. 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.

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.

4. Course schedule

Week	***Lecturer***	***Topic***	***Work during laboratory session***	***DUE (Friday)***
1	GHY	Introduction to CFD and ANSYS CFX	Backward facing step exercise Problem setup	
2	GHY	• Defining a CFD problem • Creating and/or Importing Geometry in Design Modeler	Lab sessions on creating geometry and meshing	
3	VT	Kinematic properties of fluids and conservation laws	• Lab sessions on creating geometry and meshing • Heat exchanger exercise: Meshes • Discussions about projects	
4	VT	N-S equations and similarity	• Lab work on conservation laws (T1) • Discussions about projects	Project proposal
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: Characterization of boundary conditions	T1: conservation laws

6	GHY	Turbulence: basics and introduction	• Backward facing step exercise: Convergence and Discretization, Turbulence models, T2 work	
7	GHY	Turbulence: applications of models	Major assignment work, T2 work	T2: turbulence
8	VT	Computational methods – discretisation	Major assignment work, T3 work	Initial assignment for literature review and mesh
9	VT	Solution Procedures	Major assignment work, T3 work	T3: Computational methods
10	VT	Post Processing – analysis of results. Validation and Verification	Major assignment work	
11	GHY	Multiphase modelling and combustion	Major assignment work	
12	GHY,VT	Revision	Major assignment work	Assignment due
13	GHY, VT	Consultation		

5. Assessment

You will be assessed by way of 3 sets of tutorial-style problems, one major assignment and a three-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.

Tutorial-style problems

The short assignments containing sets of tutorial-style problems (T1, T2 and T3) are listed in the Course Schedule. They will involve theoretical work and calculations. Assignments will be available on the Moodle website.

Major assignment

The major assignment involves a complete cycle of a CFD analysis, from the initial concept through to CAD, meshing, pre-processing, solving, and post-processing the results. The subject of your CFD investigation will be of your own choosing – if you are doing a CFD-related thesis you will be allowed to work on something that relates to that project if you wish. Otherwise, choose something you are interested in or you think may relate to the kind of work you'd like to do when you graduate (i.e. HVAC-style problem, flow around an aircraft wing, racing car exhaust, wind study around a building, flow in an artery, etc.).

The report you submit 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: you will write and 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.

Assessment task	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date, time, and submission requirements	Marks returned
Tutorial style problems	2 weeks	15%	1 and 4	Understanding of lecture material	4 pm Friday, Week 5, Week 7 and Week 9, via assignment boxes	1 week after due date
Major Assignment	10 weeks	35%	2, 3 and 4	See below	4 pm Friday, Week 12 via Moodle	2 weeks after due date
Final exam	3 hours	50%	1	All course content from weeks 2-12	Exam period, date TBC	During exam period

Assignments

Presentation

A standard specification is available from the School office to aid presentation of your assignments (in all courses). All submissions should have a standard School cover sheet which is available from this subject's Moodle page. All submissions are expected to be neat, and clearly set out. Your results are the pinnacle of all your hard work. Presenting them clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect.

The preferred set-out of any numerical calculation is similar to the following:

$P_E = R_T v$ (Equation in symbols)

$= 203.7 \times 20.58$ (Numbers substituted)

$= 4192$ kW (Answer with units)

Submission

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 https://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.

Assessment Criteria

The following broad criteria will be used to grade assignments, while the major assignment will have more specific criteria incorporated into the report template when issued:

For report-style assignments the following criteria will be used:

- Identification of key facts and the integration of those facts in a logical development.
- Clarity of communication—this includes development of a clear and orderly structure and the highlighting of core arguments.
- Sentences in clear and plain English—this includes correct grammar, spelling and punctuation.
- Correct referencing in accordance with the prescribed citation and style guide.

All other assignments involve numerical calculations, for which the following criteria will be used:

- Accuracy of numerical answers.
- Use of diagrams, where appropriate, to support or illustrate the calculations.
- Use of graphs, were appropriate, to support or illustrate the calculations.
- Use of tables, where appropriate, to support or shorten the calculations.
- Neatness.

Examinations

There will be a three-hour examination at the end of the Semester.

You must be available for the examination. Final examination is held during the University examination period, November for Semester 2.

Provisional Examination timetables are generally published on myUNSW in 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

Suggested textbooks (either):

1. J.Y. Tu, G.H. Yeoh, and C. Liu, Computational Fluid Dynamics: A Practical Approach, 2nd Edition, 2012.
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 website:
http://info.library.unsw.edu.au/web/services/services.html

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.

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.

7. Course evaluation and development

The course has been redesigned in 2015 and will be evaluated at the end of this semester. 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.

In this course, recent improvements resulting from student feedback include a reduction in the amount of code-writing required and also the introduction of a major assignment with the topic of the student's choice.

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

GH Yeoh and V Timchenko
July 2016

10. Appendix A: Engineers Australia (EA) 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