



# MECH4620

## Computational Fluid Dynamics

Term Three // 2020

## Course Overview

### Staff Contact Details

#### Convenors

Name	Email	Availability	Location	Phone
Victoria Timchenko	v.timchenko@unsw.edu.au	Consultation times: Thursday 3-4pm	Room 401C, J17	(02) 9385 4148

#### Lecturers

Name	Email	Availability	Location	Phone
Anthony Chun Yin Yuen	c.y.yuen@unsw.edu.au	Consultation times: Wednesday 2-3pm	Room 401E, J17	(02) 9385 4763

#### Demonstrators

Name	Email	Availability	Location	Phone
Timothy Chen	timothy.chen@unsw.edu.au	Communication preference: Email	Room 401E, J17	(02) 9385 4763

### School Contact Information

#### Location

UNSW Mechanical and Manufacturing Engineering

Ainsworth building J17, Level 1

Above Coffee on Campus

#### Hours

9:00–5:00pm, Monday–Friday\*

\*Closed on public holidays, School scheduled events and University Shutdown

#### Web

[School of Mechanical and Manufacturing Engineering](#)

[Engineering Student Support Services](#)

[Engineering Industrial Training](#)

[UNSW Study Abroad and Exchange](#) (for inbound students)

[UNSW Future Students](#)

#### Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

(+61 2) 9385 4097 – School Office\*\*

\*\*Please note that the School Office will not know when/if your course convenor is on campus or available

## **Email**

[Engineering Student Support Services](#) – current student enquiries

- e.g. enrolment, progression, clash requests, course issues or program-related queries

[Engineering Industrial Training](#) – Industrial training questions

[UNSW Study Abroad](#) – study abroad student enquiries (for inbound students)

[UNSW Exchange](#) – student exchange enquiries (for inbound students)

[UNSW Future Students](#) – potential student enquiries

- e.g. admissions, fees, programs, credit transfer

[School Office](#) – School general office administration enquiries

- NB: the relevant teams listed above must be contacted for all student enquiries

## Course Details

**Credit Points 6**

### 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. The aims of this course are: (i) *Use of CFD in the context of a useful design tool for industry and a vital research tool for thermos-fluid research*, (ii) *Familiarize with the basic steps and terminology associated with CFD which includes developing 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*, (iii) *Develop practical expertise of solving CFD problems with commercial CFD codes* and (iv) *Develop an awareness of the power and limitations of CFD*.

### Course Aims

*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.*

### Course Learning Outcomes

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 Computational Fluid Dynamics (CFD).	PE1.1, PE1.2, PE1.4
2. The ability to develop CFD models for "real world" engineering problems.	PE2.1, PE2.2
3. The technical ability to address complex problems using CFD;	PE1.3, PE1.5

Learning Outcome	EA Stage 1 Competencies
specifically with practical skills in using a commercial CFD package, ANSYS CFX.	
4. The ability to interpret computational results and to write a report conveying the results of the computational analysis.	PE3.1, PE3.3, PE3.6

## 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.*

## Additional Course Information

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

# Assessment

## Assessment Tasks

Assessment task	Weight	Due Date	Student Learning Outcomes Assessed
Tutorial style problems	15%	T1 - 4 pm Friday, Week 4 (09/10), T2 -Week 8 (06/11), T3 - Week 10 (20/10) via Moodle	1, 2, 3, 4
Group Project	35%	16/11/2020 12:58 AM	1, 2, 3, 4
Final Examination	50%	Not Applicable	1, 2, 3, 4

## Assessment Details

### Assessment 1: Tutorial style problems

**Start date:** 28/09/2020 06:00 PM

#### Details:

The short assignments containing 3 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.

### Assessment 2: Group Project

**Start date:** Week 2

#### Details:

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 purpose. 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.

### Assessment 3: Final Examination

**Start date:** Not Applicable

**Details:**

A two-hour examination at the end of the semester.

## Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

## Course Schedule

[View class timetable](#)

### Timetable

Date	Type	Content
0 Week: 8 September - 9 September		
Week 1: 14 September - 18 September	Lecture	
	Tut-Lab	Backward facing step exercise  Problem setup
Week 2: 21 September - 25 September	Lecture	<ul style="list-style-type: none"> <li>• Introduction to ANSYS CFX and Fluent</li> <li>• Defining a CFD problem</li> <li>• Creating and/or Importing Geometry</li> </ul>
	Tut-Lab	
	Assessment	Release: group allocation for group project
Week 3: 28 September - 2 October	Lecture	
	Tut-Lab	<ul style="list-style-type: none"> <li>• Lab work on creating geometry and meshing</li> <li>• Heat exchanger exercise: Meshes</li> <li>• Discussions of group project topics</li> </ul>
	Assessment	Release: group project topics
Week 4: 5 October - 9 October	Lecture	
	Tut-Lab	<ul style="list-style-type: none"> <li>• Discussions of group project topics</li> <li>• T1 work</li> </ul>
	Assessment	<b>Due: T1: conservation laws (5%)</b>
Week 5: 12 October - 16 October	Lecture	<ul style="list-style-type: none"> <li>• Initial and boundary conditions: practical guidelines</li> <li>• Post-processing – analysis of results. Validation and verification.</li> </ul>
	Tut-Lab	<ul style="list-style-type: none"> <li>• Backward facing step exercise: Characterization of boundary conditions</li> <li>• Heat exchanger exercise: Characterisation of boundary conditions</li> </ul>
	Assessment	
Week 6: 19 October - 23 October	Reading	
Week 7: 26 October - 30 October	Lecture	
	Tut-Lab	<ul style="list-style-type: none"> <li>• Backward facing step exercise: Convergence and Discretisation, Turbulence models</li> <li>• T2 work</li> </ul>

Week 8: 2 November - 6 November	Lecture	
	Tut-Lab	<ul style="list-style-type: none"> <li>• Group project</li> <li>• T2 work</li> </ul>
	Assessment	<b>Due: T2: turbulence (5%)</b>
Week 9: 9 November - 13 November	Lecture	Computational methods – discretisation
	Tut-Lab	<ul style="list-style-type: none"> <li>• Group project</li> <li>• Computational method online tutorial</li> <li>• T3 work</li> </ul>
	Assessment	<b>Due: Group project report (35%)</b>  Feedback: T2: turbulence
Week 10: 16 November - 20 November	Lecture	
	Tut-Lab	<ul style="list-style-type: none"> <li>• Revision/consultation</li> <li>• Consultation for exams</li> </ul>
	Assessment	<b>Due: Tut 3 Discretization (5%)</b>  Feedback: Group project report

## Resources

### Prescribed Resources

Not available

### Recommended Resources

#### [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 and in the UNSW bookshop*:

<https://www.library.unsw.edu.au/>

<https://www.bookshop.unsw.edu.au/details.cgi?ITEMNO=9780081011270>

<https://www.bookshop.unsw.edu.au/details.cgi?ITEMNO=9780131274983>

## 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 on assignment activities during lab sessions.

# Submission of Assessment Tasks

## Assessment submission and marking criteria

Should the course have any non-electronic assessment submission, these should have a standard School cover sheet.

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.

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.

## Late policy

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:

1. Weekly online tests or laboratory work worth a small proportion of the subject mark, or
2. Online quizzes where answers are released to students on completion, or
3. Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date, or
4. Pass/Fail assessment tasks.

## Examinations

You must be available for all quizzes, tests and examinations. For courses that have final examinations, these 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.

## Special Consideration

If you have experienced an illness or misadventure beyond your control that will interfere with your

assessment performance, you are eligible to apply for Special Consideration prior to submitting an assessment or sitting an exam.

UNSW now has a [Fit to Sit / Submit rule](#), which means that if you attempt an exam or submit a piece of assessment, you are declaring yourself fit enough to do so and cannot later 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](#).

**Please note** that students will **not** be required to provide **any** documentary evidence to support absences from any classes missed **because of COVID-19 public health measures such as isolation**. UNSW will **not** be insisting on medical certificates from anyone deemed to be a positive case, or when they have recovered. Such certificates are difficult to obtain and put an unnecessary strain on students and medical staff.

Applications for special consideration **will** be required for assessment and participation absences – but no documentary evidence **for COVID 19 illness or isolation** will be required in T3.

## 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](http://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](http://www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf)

## Academic Information

### Credit points

Course credit is calculated in Units-Of-Credit (UOC). The normal workload expectation for one UOC is approximately 25 hours per term. This includes class contact hours, private study, other learning activities, preparation and time spent on all assessable work.

Most coursework courses at UNSW are 6 UOC and involve an estimated 150 hours to complete. Each course includes a prescribed number of hours per week (h/w) of scheduled face-to-face and/or online contact. Any additional time beyond the prescribed contact hours should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

### On-campus class attendance

Public distancing conditions must be followed for all T3 face-to-face classes. To ensure this, only students enrolled in those classes will be allowed in the room. Class rosters will be attached to corresponding rooms and circulated among lab demonstrators. No over-enrolment is allowed in face-to-face class. Students enrolled in online classes can swap their enrolment from online to other additional, **but limited**, number of on-campus classes by Sunday, Week 1. Please refer to your course's Microsoft Teams and Moodle sites for more information about class attendance for in-person and online class sections/activities.

Your health and the health of those in your class is critically important. You must stay at home if you are sick or have been advised to self-isolate by [NSW health](#) or government authorities. Current alerts and a list of hotspots can be found [here](#). **You will not be penalised for missing a face-to-face activity due to illness or a requirement to self-isolate.** We will work with you to ensure continuity of learning during your isolation and have plans in place for you to catch up on any content or learning activities you may miss. Where this might not be possible, an application for fee remission may be discussed. Further information is available on any course Moodle or Teams site.

In certain classroom and laboratory situations where 1.5 metres physical distancing cannot be maintained or there is a high risk that it cannot be maintained, face masks will be considered **mandatory PPE** for students and staff.

For more information, please refer to the FAQs: <https://www.covid-19.unsw.edu.au/safe-return-campus-faqs>

## Other Matters

### Guidelines

All students are expected to read and be familiar with UNSW guidelines and policies. In particular, students should be familiar with the following:

- [Attendance](#)
- [UNSW Email Address](#)
- [Special Consideration](#)
- [Exams](#)

- [Approved Calculators](#)
- [Academic Honesty and Plagiarism](#)

## Important Links

- [Moodle](#)
- [Lab Access](#)
- [Health and Safety](#)
- [Computing Facilities](#)
- [Student Resources](#)
- [Course Outlines](#)
- [Engineering Student Support Services Centre](#)
- [Makerspace](#)
- [UNSW Timetable](#)
- [UNSW Handbook](#)
- [UNSW Mechanical and Manufacturing Engineering](#)
- [Equitable Learning Services](#)

## Image Credit

Synergies in Sound 2016

## CRICOS

CRICOS Provider Code: 00098G

## Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

## Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	✓
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	✓
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	✓
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	✓
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	✓
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering 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	
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	✓
PE3.2 Effective oral and written communication in 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	✓