UNSW Course Outline

ZEIT4003 Computational Fluid Dynamics - 2024

Published on the 11 Feb 2024

General Course Information

Course Code : ZEIT4003
Year : 2024
Term : Semester 1
Teaching Period : Z1
Is a multi-term course? : No
Faculty : UNSW Canberra
Academic Unit : School of Engineering and Technology
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : UNSW Canberra at ADFA
Campus : UNSW Canberra
Study Level : Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

This is a 6 unit of credit (6UOC) course providing a hands-on introduction to Computational Fluid Dynamics using Matlab (and/or other languages such as Fortran and C/C++) and a variety of commercial CFD codes such as Fluent or CFX (as part of the Ansys software package).

Treatment of different flow physics such as incompressible/compressible, steady/unsteady, laminar/turbulent is examined. Numerical techniques such as panel methods, finite difference and finite volume methods are developed. Numerical error, stability, convergence, and boundary conditions are examined in the application of CFD to engineering problems.

Primarily intended for those students intending to use CFD analysis as part of their final-year engineering thesis, the course provides a working proficiency in the Ansys software package; however the lessons learned are general and are applicable to all CFD packages including in-house codes.

Course Aims

The aim of this course is to provide a hands-on introduction to Computeration Fluid Dyamics using Matlab and a variety of commercial CFD codes such a Fluent, CFX, or Flowizard.

Relationship to Other Courses

ZEIT2500 Thermofluids

ZEIT2503 Fluid Mechanics or ZEIT2602 Hydraulic Engineering

ZEIT3503 Aerodynamics is also required for those students wishing to perform aerodynamics-based CFD analyses.

Course Learning Outcomes

Course Learning Outcomes	Engineers Australia - Engineering Technologist (Stage 1)
CLO1 : To develop a good knowledge of the CFD methods applicable to various flow conditions, their theoretical background and limitations.	• ET1.1 : Systematic, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the technology domain • ET1.2 : Conceptual understanding of the, mathematics, numerical analysis, statistics, and computer and information sciences which underpin the technology domain • ET1.3 : In-depth understanding of specialist bodies of knowledge within the technology domain
CLO2 : To learn how to verify and validate achieve high-quality CFD solutions	• ET1.5 : Knowledge of engineering design practice and contextual factors impacting the technology domain
CLO3 : To learn how to apply a commercial CFD package and/or an in-house solver to be able to analyse fluid flows for typical engineering problems (e.g. determine the drag of a racing car body).	• ET2.1 : Application of established engineering methods to broadly-defined problem solving within the technology domain

Course Learning Outcomes	Assessment Item
CLO1 : To develop a good knowledge of the CFD methods applicable to various flow conditions, their theoretical background and limitations.	• Assignment One • Assignment Two • Final Project
CLO2 : To learn how to verify and validate achieve high-quality CFD solutions	• Assignment Three • Assignment One • Assignment Two • Final Project
CLO3 : To learn how to apply a commercial CFD package and/or an in-house solver to be able to analyse fluid flows for typical engineering problems (e.g. determine the drag of a racing car body).	• Assignment Three • Assignment Two • Final Project

Learning and Teaching Technologies

Moodle - Learning Management System

Learning and Teaching in this course

The Learning Management System

Moodle is the Learning Management System used at UNSW Canberra. All courses have a Moodle site which will become available to students at least one week before the start of semester. Please find all help and documentation (including Blackboard Collaborate) at the Moodle Support page.

UNSW Moodle supports the following web browsers:

» Google Chrome 50+
» Safari 10+
** Internet Explorer is not recommended

** Addons and Toolbars can affect any browser's performance.

Operating systems recommended are:

Windows 7, 10, Mac OSX Sierra, iPad IOS10

For further details about system requirements click here.

Log in to Moodle here.

If you need further assistance with Moodle:

For enrolment and login issues please contact:
IT Service Centre
Email: itservicecentre@unsw.edu.au
Phone: (02) 9385-1333
International: +61 2 9385 1333

For all other Moodle issues please contact:
External TELT Support
Email: externalteltsupport@unsw.edu.au
Phone: (02) 9385-3331
International: +61 2 938 53331

Opening hours:

Monday – Friday 7:30am – 9:30 pm

Saturday & Sunday 8:30 am – 4:30pm

Other Professional Outcomes

This course contributes to the following Program Learning Outcomes of the Bachelor of Engineering (Hons) (Aeronautical):

1. Students will be able to relate a quantitative, theory-based understanding of the sciences and fundamentals of aeronautical engineering (encompassing aerodynamics, structural mechanics, instrumentation, propulsion and control of aeronautical and space systems).
2. Students will be able to appropriately select and apply the mathematical, statistical, programming and computational tools and techniques which underpin aeronautical engineering.
3. Students will define, conduct experiments on and analyse complex, open-ended problems and apply appropriate methods for their solution.
4. Students will demonstrate independence, creativity and ethical conduct, and explain the importance of user-focused and sustainable solutions.

A complete mapping of courses to Program Learning Outcomes can be found online here.

Additional Course Information

Academic Integrity and Plagiarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW staff and students have a responsibility to adhere to this principle of academic integrity. All students are expected to adhere to UNSW's Student Code of Conduct https://www.gs.unsw.edu.au/policy/documents/studentcodepolicy.pdf

Plagiarism undermines academic integrity and is not tolerated at UNSW. *It is defined as using the words or ideas of others and passing them off as your own, and* can take many forms, from deliberate cheating to accidental copying from a source without acknowledgement.

For more information, please refer to the following:

https://student.unsw.edu.au/plagiarism

Referencing

In this course, students are required to reference following the APA 7 / Chicago NB referencing

style. Information about referencing styles is available at: https://guides.lib.unsw.adfa.edu.au/c.php?g=472948&p=3246720

Study at UNSW Canberra

https://www.unsw.adfa.edu.au/study

Study at UNSW Canberra has lots of useful information regarding:

- Where to get help
- Administrative matters
- Getting your passwords set up
- How to log on to Moodle
- Accessing the Library and other areas.

Additional Information as required

CRICOS Provider no. 00098G

The University of New South Wales Canberra.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates	Engineers Australia - Engineering Technologist (Stage 1)
Assignment One Assessment Format: Individual	15%	Start Date: In week 3 Due Date: Week 3: 11 March - 15 March	• ET1.2 : Conceptual understanding of the, mathematics, numerical analysis, statistics, and computer and information sciences which underpin the technology domain
Assignment Two Assessment Format: Individual	25%	Start Date: Not Applicable Due Date: Week 6: 01 April - 05 April	
Assignment Three Assessment Format: Group	25%	Start Date: Not Applicable Due Date: Week 9: 06 May - 10 May	
Final Project Assessment Format: Individual	35%	Start Date: Not Applicable Due Date: Exam week	

Assessment Details

Assignment One

Course Learning Outcomes

- CLO1 : To develop a good knowledge of the CFD methods applicable to various flow conditions, their theoretical background and limitations.
- CLO2 : To learn how to verify and validate achieve high-quality CFD solutions

Detailed Assessment Description

This is individual assignment due by week 3. It includes class Q&A (5 points) and a list of problems (10 points).

Assessment Length

N/A

Submission notes

Electric version via Moodle.

Assignment submission Turnitin type

Not Applicable

Hurdle rules

A minimum mark of 40% must be achieved in each assignment to pass the course.

Assignment Two

Course Learning Outcomes

- CLO1 : To develop a good knowledge of the CFD methods applicable to various flow conditions, their theoretical background and limitations.
- CLO2 : To learn how to verify and validate achieve high-quality CFD solutions
- CLO3 : To learn how to apply a commercial CFD package and/or an in-house solver to be able to analyse fluid flows for typical engineering problems (e.g. determine the drag of a racing car body).

Detailed Assessment Description

This is individual assignment due by week 6. It includes tutorial tasks (5 points) and one or two programming tasks (20 points).

Assignment submission Turnitin type

Not Applicable

Hurdle rules

A minimum mark of 40% must be achieved in each assignment to pass the course.

Assignment Three

Course Learning Outcomes

- CLO2 : To learn how to verify and validate achieve high-quality CFD solutions
- CLO3 : To learn how to apply a commercial CFD package and/or an in-house solver to be able to analyse fluid flows for typical engineering problems (e.g. determine the drag of a racing car body).

Detailed Assessment Description

This is group assignment due by week 9. It includes tutorial tasks (5 points) and a few modelling tasks (20 points).

Assignment submission Turnitin type

Not Applicable

Hurdle rules

A minimum mark of 40% must be achieved in each assignment to pass the course.

Final Project

Course Learning Outcomes

- CLO1 : To develop a good knowledge of the CFD methods applicable to various flow conditions, their theoretical background and limitations.
- CLO2 : To learn how to verify and validate achieve high-quality CFD solutions
- CLO3 : To learn how to apply a commercial CFD package and/or an in-house solver to be able to analyse fluid flows for typical engineering problems (e.g. determine the drag of a racing car body).

Detailed Assessment Description

This is individual assignment due by week 13 (or exam week). It includes a list of problems (35 points).

Assignment submission Turnitin type

Not Applicable

Hurdle rules

A minimum mark of 40% must be achieved in each assignment to pass the course.

General Assessment Information

Assessment 1 will be submitted in week 3, grades and worked solutions will be given to students during week 4

Assessment Criteria: Compulsory components or minimum performance standards

Marking of assignments will be on the basis of 75% for the correctness of the method, and 25% for accuracy, clear and logical presentation of the answer.

Late Submission of Assessment

Unless prior arrangement is made with the lecturer or a formal application for special consideration is submitted, a penalty of 5% of the total available mark for the assessment will apply for each day that an assessment item is late up to a maximum of 5 days (120 hours) after which an assessment can no longer be submitted and a grade of 0 will be applied.

Use of Generative AI in Assessments

For this assessment task, you may use standard editing and referencing software, but not Generative AI. You are permitted to use the full capabilities of the standard software to answer the question (e.g. you may wish to specify particular software such as Microsoft Office suite, Grammarly, etc.). If the use of generative AI such as ChatGPT is detected, it will be regarded as serious academic misconduct and subject to the standard penalties, which may include 00FL, suspension and exclusion.

Grading Basis

Standard

Requirements to pass course

A minimum mark of 40% must be achieved in each assignment to pass the course. Students are allowed to resubmit if they fail in any item. But resubmissions can only achieve a maximum grade of 50%.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 26 February - 1 March	Lecture	Tue: What is CFD? The CFD process, reasons to use, limitations, effective use; Thu: Mathematical description of problem: equations of fluid flow. Conservation laws, auxiliary conditions, generalised transport equations, classification of behaviour of partial differential equations.
Week 2 : 4 March - 8 March	Lecture	Tue: Introduction to the Finite Volume method. Direct and iterative methods, residuals and convergence.
	Tutorial	Thu: Basic matlab usage.
Week 3 : 11 March - 15 March	Tutorial	Tue: Introduction to the Ansys software package. Geometry creation in Ansys Design Modeller. Assignment 1 is due this week.
	Tutorial	Thu: Solver for steady heat transfer
Week 4 : 18 March - 22 March	Lecture	Tue: Discretisation, order of a method, and error sources and effects. Verification and validation.
	Tutorial	Thu: Testing of solver for steady heat transfer; Meshing in Ansys Mesher.
	Tut-Lab	Fri: Meshing in Ansys Mesher.
Week 5 : 25 March - 29 March	Lecture	Tue: Unsteady problems. Explicit and implicit methods, stability analysis, Courant and diffusion numbers.
	Tutorial	Thu: Introduction to Ansys/Fluent Fri: Good Friday
Week 6 : 1 April - 5 April	Tutorial	Tue: Solver for unsteady convection-diffusion equation Assignment 2 is due this week.
	Tutorial	Thu: Ansys/Fluent
	Tut-Lab	Fri: Ansys/Fluent
Week 7 : 22 April - 26 April	Tutorial	Tue: Ansys/Fluent Thu: No teaching - ANZAC Day Holiday
	Tut-Lab	Fri: Ansys/Fluent
Week 8 : 29 April - 3 May	Lecture	Tue: Incompressible flows. Pressure based methods, artificial compressibility methods. Thu: Introduction to turbulence modelling. Direct numerical simulation (DNS), large eddy simulation (LES), Reynolds Averaged Navier Stokes (RANS) approaches, and boundary layers.
	Tut-Lab	Fri: Ansys/Fluent
Week 9 : 6 May - 10 May	Lecture	Tue: Boundary conditions, Immersed boundary method Assignment 3 is due this week.
	Tutorial	Thu: Ansys/Fluent Fri: Military Training Day
Week 10 : 13 May - 17 May	Lecture	Tue: Compressible flows. Euler equation, Navier Stokes equation, flux vector splitting, shocktube canonical problem. Low Mach number flows and preconditioning.
	Tutorial	Thu: Ansys/Fluent
	Tut-Lab	Fri: Ansys/Fluent
Week 11 : 20 May - 24 May	Tut-Lab	Tue: Flow solver Thu: Ansys/Fluent
Week 12 : 27 May - 31 May	Tutorial	Tue: Compensation Day – Monday Timetable Thu: Ansys/Fluent
Week 13 : 3 June - 7 June	Tutorial	Tue: Flow solver Thu: Ansys/Fluent

Attendance Requirements

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

General Schedule Information

The course coordinator reserves the right to add or delete topics from the course schedule list and/or to change their order based on the learning progress or requirement from students.

Friday is PC-Lab-Tutorial, and only 5 sessions are arranged.

Course Resources

Prescribed Resources

Compulsory Text

- *Tu, J., Yeoh, G.H. and Liu, C. 'Computational Fluid Dynamics: A Practical Approach', Butterworth-Heinemann, Oxford, UK.*

Course materials (lectures, tutorials, and other resources) will be available online via Moodle.

Recommended Resources

Recommended Readings

- *Versteeg, H.K., and Malalasekera, W. 'An*

Introduction to Computational Fluid Dynamics: The Finite Volume Method', Addison-Wesley.

- *Anderson, John D. Jr., 'Computational Fluid Dynamics: The Basics With Applications', McGraw-Hill, New York.*

Additional Costs

N/A

Course Evaluation and Development

One of the key priorities in the 2025 Strategy for UNSW is a drive for academic excellence in education. One of the ways of determining how well UNSW is progressing towards this goal is by listening to our own students. Students will be asked to complete the myExperience survey towards the end of this course.

Students can also provide feedback during the semester via: direct contact with the lecturer, the "On-going Student Feedback" link in Moodle, Student-Staff Liaison Committee meetings in schools, informal feedback conducted by staff, and focus groups. Student opinions really do make a difference. Refer to the Moodle site for this course to see how the feedback from

previous students has contributed to the course development.

Important note: Students are reminded that any feedback provided should be constructive and professional and that they are bound by the Student Code of Conduct Policy

https://www.gs.unsw.edu.au/policy/documents/studentcodepolicy.pdf

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Lecturer	Fangbao Tian		Room 216 Building 17	+61251145212	Monday 10am-12pm	No	Yes

Other Useful Information

Academic Information

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Equitable Learning Services (ELS)

Students living with neurodivergent, physical and/or mental health conditions or caring for

someone with these conditions may be eligible for support through the Equitible Learning Services team. Equitable Learning Services is a free and confidential service that provides practical support to ensure your mental or physical health conditions do not adversely affect your studies.

Our team of dedicated **Equitable Learning Facilitators** (ELFs) are here to assist you through this process. We offer a number of services to make your education at UNSW easier and more equitable.

Further information about ELS for currently enrolled students can be found at: https://www.student.unsw.edu.au/equitable-learning

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Submission of Assessment Tasks

Special Consideration

Special Consideration is the process for assessing and addressing the impact on students of short-term events, that are beyond the control of the student, and that affect performance in a specific assessment task or tasks.

Applications for Special Consideration will be accepted in the following circumstances only:

- Where academic work has been hampered to a substantial degree by illness or other cause;
- The circumstances are unexpected and beyond the student's control;

- The circumstances could not have reasonably been anticipated, avoided or guarded against by the student; and either:

(i) they occurred during a critical study period and was 3 consecutive days or more duration, or a total of 5 days within the critical study period; or

(ii) they prevented the ability to complete, attend or submit an assessment task for a specific date (e.g. final exam, in class test/quiz, in class presentation)

Applications for Special Consideration must be made as soon as practicable after the problem occurs and at the latest within three working days of the assessment or the period covered by the supporting documentation.

By sitting or submitting the assessment task the student is declaring that they are fit to do so and cannot later apply for Special Consideration (UNSW 'fit to sit or submit' requirement).

Sitting, accessing or submitting an assessment task on the scheduled assessment date, after applying for special consideration, renders the special consideration application void.

Find more information about special consideration at: https://www.student.unsw.edu.au/special/consideration/guide

Or apply for special consideration through your MyUNSW portal.

Late Submission of assessment tasks (other than examinations)

UNSW has a standard late submission penalty of:

- 5% per day,
- capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, and
- no permitted variation.

Students are expected to manage their time to meet deadlines and to request extensions as early as possible before the deadline.

Electronic submission of assessment

Except where the nature of an assessment task precludes its electronic submission, all assessments must be submitted to an electronic repository, approved by UNSW or the Faculty, for archiving and subsequent marking and analysis.

Release of final mark

All marks obtained for assessment items during the session are provisional. The final mark as published by the university following the assessment review group meeting is the only official mark.