ENGG*4440 Computational Fluid Dynamics

Winter 2019
Section(s): C01

School of Engineering
Credit Weight: 0.50
Version 1.00 - January 06, 2019

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1 Course Details

1.1 Calendar Description

Computational methods for fluid mechanics form the core of the course. The concepts of modelling are covered including numerical analysis, the governing equations for fluid problems and finite discretization methods. Mathematical models for turbulence are presented and the student is exposed to the use of commercial software for the solution of complex problems in fluid dynamics.

Pre-Requisite(s): ENGG*2230, ENGG*3370

1.2 Course Description

The goal of this course is to introduce the field of computational solutions to complex fluid flows. Students will be exposed to the nature of complex fluid flows, various numerical methods for solving the non-linear governing equations, and techniques for using commercially available CFD software. There is a focus on building and solving physical models in practical fluid dynamic applications.

1.3 Timetable

Lectures

Monday, Friday
8:30 AM - 9:50 AM MCKN 233

Laboratory

Sec 01: Monday 12:30PM - 2:20PM THRN 1313

Sec 02: Thursday 2:30PM - 4:20PM THRN 1313

1.4 Final Exam

No final exam for this course.

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2 Instructional Support

2.1 Instructional Support Team

Instructor: Mostafa Elsharqawy Ph.D., P.Eng
Email: melsharq@uoguelph.ca
Telephone: +1-519-824-4120 x58973
Office: RICH 3513
Office Hours: Friday 11 AM – 1 PM or by appointment

2.2 Teaching Assistant(s)

Teaching Assistant: Mohamed Hussein
Email: husseinm@uoguelph.ca
Office Hours: TBA on CourseLink

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3 Learning Resources

3.1 Required Resource(s)

Course Website (Website)
News, announcements, and grades will be regularly posted to the ENGG*4440 CourseLink site. You are responsible for checking the site regularly.

An Introduction to Computational Fluid Dynamics (Textbook)
H.K. Versteeg and W. Malalasekera, 2nd Edition Pearson, 2007.

3.2 Recommended Resources

- Suhas Patankar, Numerical Heat Transfer and Fluid Flow, CRC Press, 1980.
- John Wendt, and John Anderson, Computational Fluid Dynamics: An Introduction. Springer, 2009.
- M.B. Abbott, and D.R. Basco, Computational Fluid Dynamics: An Introduction for Engineers, John Wiley & Sons, Inc., New York, 1990.

3.2 Additional Resources

Lecture Information: Some lecture notes will be posted on the course website on CourseLink throughout the semester. You will be granted access to the website when you register for the course.

Lab Information: All necessary information for the lab sessions will be posted on the web page. Make sure you check the course website for relevant information before each session.

Assignments: Download the assignments according to the schedule given in the CourseLink website.

Miscellaneous Information: Lectures are the main source of material which includes important discussions and worked examples that might not be found elsewhere. Other information related to this course will be posted on CourseLink.

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4 Learning Outcomes

4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Comprehend, appreciate, and apply the physics of complex fluid flow
2. Build computational models to analyze complex fluid flows
3. Articulate the major approximations in CFD analysis and control the associated errors, recognizing the limits of the tool and assessing the validity of the conclusion
4. Interpret and communicate computational results in coherent and understandable ways with both graphs and words

4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome	Learning Outcome(s)
1	Knowledge Base	1, 2
1.3	Recall, describe and apply fundamental engineering principles and concepts	1, 2
2	Problem Analysis	1, 2
2.1	Formulate a problem statement in engineering and non-engineering terminology	1, 2

#	Outcome	Learning Outcome(s)
2.2	Identify, organize and justify appropriate information, including assumptions	1, 2
2.3	Construct a conceptual framework and select an appropriate solution approach	1, 2
2.4	Execute an engineering solution	1, 2
2.5	Critique and appraise solution approach and results	1, 2
3	Investigation	3, 4
3.4	Assess validity of conclusions within limitations of data and methodologies	3, 4
5	Use of Engineering Tools	2, 3, 4
5.2	Demonstrate proficiency in the application of selected engineering tools	2, 3, 4
7	Communication Skills	4
7.1	Identify key message(s) and intended audience in verbal or written communication as both sender and receiver	4
7.2	Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode	4
7.3	Construct the finished elements using accepted norms in English, graphical standards, and engineering conventions, as appropriate for the message and audience	4
7.4	Substantiate claims by building evidence-based arguments and integrating effective figures, tables, equations, and/or references	4
7.5	Demonstrate ability to process oral and written communication by following instructions, actively listening, incorporating feedback, and formulating meaningful questions	4

5 Teaching and Learning Activities

5.1 Lecture

Topic(s): Why CFD?
Reference(s): Chapter 1

Topic(s): The Operational Steps of CFD
Reference(s): Chapter 1

Topic(s): Fluids and the Fundamental Equations
Reference(s): Chapter 2-3

Topic(s): The Finite Volume Method (Diffusion)
Reference(s): Chapter 4

Topic(s): The Finite Volume Method (Convection)
Reference(s): Chapter 5

Topic(s): Iterative Convergence
Reference(s): Chapter 6-7

Topic(s): Boundary Conditions and Grids
Reference(s): Chapter 9

Topic(s): Turbulence Modelling
Reference(s): Chapter 3

Topic(s): Errors and Uncertainty
Reference(s): Chapter 10

Topic(s): Project Introduction

Topic(s): Applications

Topic(s): Concluding Words

5.2 Lab

Topic(s): Introduction to Commercial CFD
Assignment #1

Topic(s): Developing Duct Flow
Assignment #2

Topic(s): Flow over Backward Step
Assignment #3

Topic(s): Post Processing
Assignment #3

Topic(s): Finite Volume Method
Assignment #4

Topic(s): Mesh Refinement
Assignment #4

Topic(s): Iterations and Time Steps
Assignment #5

Topic(s): Convergence
Assignment #5

Topic(s): Turbulence Modelling
Final Project

Topic(s): Work on Project
Final Project

5.3 Other Important Dates

Monday, January 07, 2019: First day of class

Monday, February 18, 2019 – Friday, February 22, 2019: Winter Break
Friday, March 8, 2019: drop date – 40th class
Friday, April 5, 2019: last day of class

5.4 Disclaimer

The instructor reserves the right to change any or all of the above in the event of appropriate circumstances, subject to the University of Guelph Academic Regulations.

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6 Assessments

6.1 Marking Schemes & Distributions

Name	Scheme A (%)
Assignments	30
Midterm	30
Final Project	40
Total	100

6.2 Assessment Details

Assignments (40%)
Learning Outcome(s): 1,2
To be submitted electronically through CourseLink Dropbox.

Assignment 1 – January 25 (6%)

Assignment 2 – February 8 (6%)

Assignment 3 – March 1 (6%)

Assignment 4 – March 15 (6%)

Assignment 5 – March 29 (6%)

Midterm (30%)
Date: Mon, Mar 4, 8:30 AM - 9:50 AM
Learning Outcome(s): 1,2
30% on March 4, Monday, in class, 8:30 – 9:50 am

Final Project Report (20%)
Learning Outcome(s): 2,3,4
Due Friday, April 5– to be submitted electronically on CourseLink.

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7 Course Statements

7.1 Course Grading Policies

Missed Assessments: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml

Passing grade: In order to pass the course, you must obtain a grade of 50% or higher.

Missing Midterm: If you are unable to write the midterm due to medical, psychological, or compassionate reasons or religious obligation, please email the course instructor for possible alternative arrangements.

Lab Work: You must attend all laboratories. If you miss a laboratory due to grounds for granting academic consideration or religious accommodation, alternative arrangements must be made.

Late Assignments: Late submissions of assignments or project will not be accepted.

7.2 Relationships with other Courses & Labs

Previous Courses:

ENGG*2230: An introduction to many aspects of fluid properties, fluid motion, and engineering applications that involve fluid mechanics.

ENGG*3370: Relevant application of fluid mechanics.

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8 School of Engineering Statements

8.1 Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

8.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

8.3 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

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9 University Statements

9.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

9.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Graduate Calendar - Grounds for Academic Consideration
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

9.3 Drop Date

Courses that are one semester long must be dropped by the end of the fortieth class day; two-semester courses must be dropped by the last day of the add period in the second semester. The regulations and procedures for course registration are available in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml

Graduate Calendar - Registration Changes
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml

9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance and not later than the 40th Class Day.

More information can be found on the SAS website
https://www.uoguelph.ca/sas

9.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community-faculty, staff, and students-to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

Graduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

9.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

9.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars
https://www.uoguelph.ca/academics/calendars