UNIVERSITY of GUELPH

ENGG*4440 Computational Fluid Dynamics

01

Winter 2021
Section(s): C01

School of Engineering
Credit Weight: 0.50
Version 2.00 - January 21, 2021

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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-Requisites: 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, Wednesday
11:30 AM - 12:50 PM WebEx

Laboratory

Sec 01: Wednesday 3:30 - 5:20 PM WebEx

Sec 02: Monday 3:30 - 5:20 PM WebEx

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:	By appointment

2.2 Teaching Assistants

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

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3 Learning Resources

3.1 Required Resources

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.

ANSYS Workbench (Software)
https://enggsoftware.uoguelph.ca/software-access-methods/entry/576/
ANSYS Workbench software. Please follow the instructions in the following link to download and install ANSYS software. https://enggsoftware.uoguelph.ca/software-access-methods/entry/576/.

MATLAB and Excel (Software)
https://remotelab.soe.uoguelph.ca/soe.rca/
We will use MATLAB and Excel to solve finite volume codes. The software are available in all school of engineering lab computers.

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 and upload a softcopy of your solution to the Dropbox folder.

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
1	Knowledge Base	1, 2

#	Outcome	Learning Outcome
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
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

Week 1

    Topics: Introduction to CFD and course outline
                                      The CFD Process

    References: Chapter 1

Week 2

    Topics: Finite Volume Method (FVM)

                                        Steady Diffusion Problems

    References: Chapter 4

Week 3

    Topics: Governing Equations in CFD

    References: Chapter 2

Week 4

    Topics: The Finite Volume Method (Convection)

                                        Laminar Flow in Pipe

    References: Chapter 5

Week 5

    Topics: Convection-Diffusion Upwind Scheme
                                      Boundary Layer Theory
                                      Steady Convection-Diffusion cont.

    References: Chapter 5

Week 6

    Topics: Pressure-Velocity Coupling

FVM for Unsteady Diffusion

References: Chapters 6 & 8

Week 7

   Topics: FVM for Unsteady Diffusion cont
                         Modeling Turbulent Flow

   References: Chapters 8 & 3

Week 8

   Topics: Modeling Turbulent Flow & Review
                         Midterm Exam (30 %)

   References: Chapter 3

Week 9

   Topics: Modeling Turbulent Flow cont.
                         Turbulent Flow in Pipe

   References: Chapter 3

Week 10

   Topics: Geometry and Mesh in ANSYS
                         Boundary Conditions & Physics

   References: ANSYS Manual

Week 11

   Topics: Properties and Misc. Models
                         Guest Lecture

   References: ANSYS Manual

Week 12

    Topics: Project Presentation (5%)

5.2 Lab

Week 1

    Topics: No Labs this week

Week 2

    Topics: Lab 1 Introduction to ANSYS Workbench

Week 3

    Topics: Lab 2 Steady Diffusion Problems

Week 4

    Topics: Lab 3 Laminar Flow in Pipe

Week 5

    Topics: Lab 4 Flow over Flat Plate

Week 6

    Topics: Lab 5 2D Steady Convection

Week 7

    Topics: Lab 6 Unsteady Diffusion

Week 8

    Topics: Lab 7: Lab Test

Week 9

    Topics: Lab 8 Flow Over Cylinder

Week 10

| **Topics:** | Lab 9 Turbulent Flow in Pipe |

Week 11

| **Topics:** | Lab 10 Flow and Heat in a Mixing Elbow |

Week 12

| **Topics:** | Lab 11 Project Help |

5.3 Other Important Dates

Monday, January 11, 2021: First day of classes

Monday, February 15, 2021 – Friday, February 19, 2021: Winter Break

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	25
Midterm	30
Final Project	30
Lab Test	10
Lab quizzes	5
Total	100

6.2 Assessment Details

Assignments (25%)
Learning Outcome: 1, 2
To be submitted electronically through CourseLink Dropbox.

Assignment 1 – Due 29 January (5%)

Assignment 2 – Due 12 February (5%)

Assignment 3 – Due 5 March (5%)

Assignment 4 – Due 19 March (5%)

Assignment 5 – Due 2 April (5%)

Midterm (30%)
  Date: Wed, Mar 10, 11:30 AM - 12:50 PM
  Learning Outcome: 1, 2
  30% weight on March 10, Wednesday, on CourseLink during class time (11:30 am – 12:50 pm)

Lab Test (10%)
  Date: Week 8, CourseLink
  10% on CourseLink in week #8 (during scheduled lab time)

Lab quizzes (5%)
  Date: Different weeks, CourseLink
  5% weight in-lab mini-quizzes through the semester

Project (30%)
  Date: Fri, Apr 9
  Learning Outcome: 2, 3, 4
  Due Friday, April 9th 2021 – 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

Missed midterm or quiz: If you miss the mid-term or a quiz due to grounds for granting academic consideration, ___the weight of the missed test/quiz will be added to the final exam___. There will be no makeup test or quiz.

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

10% mark deduction will be applied for every one hour late submission after the first hour.

Passing Grades: The passing grade is 50%.

Questions Concerning Grades: If you have questions about the grade of your test/assignment received, please ask your TA within _one week_ of the grade being released.

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.

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.

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

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions
https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml

9.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic 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

Associate Diploma Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.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.

For Guelph students, information can be found on the SAS website
https://www.uoguelph.ca/sas

For Ridgetown students, information can be found on the Ridgetown SAS website
https://www.ridgetownc.com/services/accessibilityservices.cfm

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

9.9 Disclaimer

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings and academic schedules. Any such changes will be announced via CourseLink and/or class email. All University-wide decisions will be posted on the COVID-19 website (https://news.uoguelph.ca/2019-novel-coronavirus-information/) and circulated by email.

9.10 Illness

The University will not normally require verification of illness (doctor's notes) for fall 2020 or winter 2021 semester courses. However, requests for Academic Consideration may still require medical documentation as appropriate.
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