

CIV E 631 Engineering Fluid Mechanics

Fall 2024 - September 03 to December 09

Class time: Wednesday, Friday 15:30-16:50 Location: NRE 2-122

Instructor:

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ICE 7-289
Office Hours: TBD

Course Description:

*3.5 (fi) (either term, 3-0-1) Navier-Stokes equations and viscous flow. Turbulence and Reynolds equations. Potential flow. Boundary layers. Flow around bodies. Jets and wakes. Related Lab experiments

Course synchronous and asynchronous content delivery schedule:

The lectures, quizzes and final exam will all be synchronous. One or two demonstration labs will also be synchronous.

Course Objectives & General Content:

The primary objective of the course is to significantly increase students' knowledge of engineering fluid mechanics.

Students will learn to derive exact solutions to the Navier-Stokes equations and to apply potential flow theory to solve fluid flow problems.

They will also acquire deeper understanding of boundary layer theory, vorticity and turbulence.

Learning Outcomes:

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

1. Understand the principles of mass, momentum and energy conservation as they apply to incompressible flows.
2. Solve inviscid flow problems using potential flow theory and superposition
3. Sketch streamlines, pathlines and streaklines and use these concepts to elucidate flows
4. Derive exact solutions to the Navier-Stokes equations for incompressible flows
5. Predict the behaviour of turbulent flows using theory and empirical methods

Marking Scheme:

Activity	(A)Synchronous	Due/Scheduled	Weight
Assignments	Synchronous	Throughout the course	15%
Quizzes - two in total worth 15% each	Synchronous	TBD	30%
Final exam	Synchronous	5:30 PM Dec. 17, 2024	40%
Flow Visualization Experiment	Asynchronous	Dec. 6, 2024	15%

The Faculty recommended grade point average for a 600 level course is 3.3. Instructors have the leeway to deviate from this average and can assign grades based on their own scheme. All grades are approved by the department chair (or delegate). The office of the Dean has final oversight on all grades.

Term Work

All term work solutions will be posted no later than the last day of classes. All term work will be returned to students by the final day of classes, with the exception of major term work due in the last week of classes. The latter will be returned by the day of the final examination or the last day of the examination period if there is no final examination in the course as per university policy; instructors will make accommodations to return these term work. It is the responsibility of the student to pick up all their term work at the specified time and place. Any unreturned term work, shall be retained and then shredded six months after the deadline for reappraisal and grade appeals. Final examinations will be kept for one year as required by university guidelines and the Government of Alberta's Freedom of Information and Protection of Privacy Act.

Calculator Policy

There is no calculator policy in this course; students are free to use the calculator they wish for all assessments.

Text and References (Mandatory):

Fluid Mechanics, Fourth Edition, Pijush K. Kundu and Ira M. Cohen, Academic Press
Note this book is available through the U of A library as an ebook.

Text and References (Recommended):

Fluid Mechanics, James A. Liggett
A First Course in Turbulence. H. TENNEKES & J. LUMLEY
Viscous Fluid Flow, F.M. White
An Introduction to Fluid Dynamics, G.K. BATCHELOR
Boundary Layer Theory, H. Schlichting, K. Gersten, 8th ed.

Website:

eClass

Previous Examples of Evaluative Materials:

Example quiz and examination questions will be provided through eClass.

Lab Information:

Lab Topic	Date
Lab 1: Flow Visualization Project - 1 or 2 scheduled labs and then ad hoc	1900-01-01

Students will undergo WHMIS, CSTS, and lab specific safety training as a part of this course and are expected to follow appropriate lab safety procedures at all times.

Did you know that the University of Alberta has various low-to-no-cost services to help students succeed? Visit <http://www.deanofstudents.ualberta.ca/> for information about the academic, wellness, and various other support services available to U of A students. It's never too early or too late to seek help!

CIVE 631

Course Outline

I Introduction (Ch. 1-2)

- Importance and applications of fluid mechanics
- Solids, liquids and gases
- Transport phenomena
- Notation and operators

II Kinematics (Ch. 3)

- Eulerian/Lagrangian descriptions
- Streamlines, pathlines and streaklines
- Acceleration
- Translation, rotation and strain
- Vorticity and circulation
- Streamfunction

III Conservation Laws (Ch. 4)

- Conservation of mass
- Forces in fluids
- Conservation of momentum
- Momentum principle – fixed volume
- Constitutive equation
- Navier–Stokes Equations
- Exact solutions to the Navier-Stokes equations
- Mechanical energy equation

IV Vorticity (Ch. 5)

- Basic vortex flows
- Vortex lines and tubes
- Kelvin’s circulation theorem
- Vorticity equation

V Irrotational flow (Ch. 6)

- Velocity potential
- Elementary plane flow solutions
- Superposition of simple flows

VI Turbulent Flow (Ch. 12-13)

- Stability and transition
- Reynolds equations
- Kinetic energy budget of the mean and turbulent flows
- Turbulence production and cascade
- Energy cascade and energy spectrum

- Kolmogorov scales
- Turbulence models
- Turbulent flow in a wide rectangular channel
- Turbulent pipe flow
- Plane turbulent jet
- Turbulent Boundary Layers



University and faculty policies



Respect and professionalism



The Faculty of Engineering is committed to fostering and protecting an equitable, inclusive, and respectful work and study environment in line with University of Alberta policies and professional engineering industry standards.

The faculty prepares students to uphold industry standards to become a Professional Engineer (P.Eng). Therefore, respect, professionalism, and accountability must be upheld within the Faculty of Engineering and the University of Alberta.

Academic integrity

All students are expected to follow the University of Alberta's [Student Code of Behaviour](#) and [Student Conduct Policy](#). The faculty expects an environment free of harassment, discrimination, and bullying. We encourage you to talk to the [Office of Safe Disclosure and Human Rights](#) about experiences, questions, or concerns. Additional resources and support for students are attached below.

Engineering students studying in the province of Alberta must also follow the Code of Ethics set by the Association of Professional Engineers and Geoscientists of Alberta (APEGA).

Course outline policies, course requirements, evaluation and grading information can be found in the [University Calendar](#).

Safety during learning activities



In all Faculty of Engineering courses, labs, seminars or other learning activities, safety is of paramount importance. In some cases, laboratory work in a program requires high standards for risk management to keep potential hazards safely under control.

Anyone found to be unable to function safely in the class, lab, seminar or other learning activity may be asked to leave or be removed for their and the safety of other participants and instructors in alignment with the [Student Code of Behaviour](#) and [Student Conduct Policy](#). As members, or prospective members, of the engineering profession, it is your responsibility to identify and inform the proper authorities of unsafe work.

Audio and video recording



Audio or video recording, digital or otherwise, of lectures, labs, seminars or any other teaching environment by students is allowed only with the prior written consent of the instructor or as a part of an approved accommodation plan.

Student or instructor content, digital or otherwise, created and/or used within the context of the course is to be used solely for personal study and is not to be used or distributed for any other purpose without prior written consent from the content author(s).

Only those items specifically authorized by the instructor may be brought into the exam facility. Students must not bring any unauthorized electronic device into an examination room, including cell phones or other devices.



Student services and support

Health & Wellness Support

Counselling and Clinical Services

Free, short-term, appointment-based counselling and psychiatric services. Also offers drop-in workshops. Book an initial consultation. Visit uab.ca/CCS to learn more.

Wellness Supports Social Workers

Free one-on-one support for students in the areas of housing, finances, academics, personal wellness, life skill development, family dynamics, system navigation, and any area of life where there is a desire to invite change. Visit uab.ca/wellness to learn more.

Sexual Assault Centre

Free, anonymous, and confidential drop-in counselling. Visit uab.ca/UASAC to learn more.

The Office of Safe Disclosure & Human Rights (OSDHR)

The OSDHR advises confidentially on sensitive issues you may not feel comfortable solving on your own. Contact the OSDHR if you want to get help or to make a report while keeping your privacy. Visit uab.ca/OSDHR to learn more.

HIAR (Helping Individuals at Risk)

If you're worried about someone, contact HIAR, who can help assess risk and connect individuals to support. Learn more at uab.ca/HIAR.

Immediate External Supports

Health Link Alberta: 811

Suicide Crisis Helpline: 988





Academic support



Academic Success Centre

Access to a variety of services to maximize your academic success. Learn more at uab.ca/ASC.



Accessibility Resources

Connects students with disabilities to accommodations. Learn more at uab.ca/Access under accommodations + accessibility.



Decima Robinson Support Centre

Academic support for 100- or 200-level introductory calculus, linear algebra and statistics courses. Visit uab.ca/DSC to learn more.



Engineering Student Success Centre

The Faculty of Engineering provides drop-in tutoring for first-year courses. Visit uab.ca/ESSC to learn more.



Office of the Student Ombuds

Call for complex problems and conflict mediation. Learn more at uab.ca/ombuds.



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Financial support



Student Service Centre

For awards and other funding support. Learn more at uab.ca/ask.



Campus Food Bank

The Campus Food Bank Society is an independent charity supporting University of Alberta students, faculty, staff, and alumni for up to five years. For additional information visit their website at campusfoodbank.com.



CIV E 631 Additional Course Information

Course Delivery

All course components this year will be delivered in-person.

Homework Assignments: There will be 5 homework assignments during the term. The assignments will be submitted as hard copies..

Appropriate and Inappropriate Collaboration on Homework Assignments: *Even though the assignments are not being graded for correctness they must still be completed individually.* What this means is that you must complete the assignment on your own, but it is acceptable to discuss the concepts with your classmates before working on it. If two or more CIV E 631 students submit an identical or nearly identical homework assignment claiming it is their own, this is clear evidence that they have been collaborating inappropriately. It is an academic offence to copy all or even a portion of another person's assignment and submit it as your own. It is also an academic offence to copy a homework problem solution from previous years and submit it as your own.

Additional guidance on this topic can be found at: <https://www.ualberta.ca/current-students/academic-resources/academic-integrity/collaboration>

Laboratory Activities: There will be one or two laboratory demonstrations early in the term so that students can become familiar with the lab and the available apparatus and equipment. The main laboratory activity will be the Flow Visualization Project. This project will be completed in groups of two or three. Each group will conduct experiments to visualize an interesting fluid flow and present their results in an oral presentation. The timing of the laboratory demonstrations will be determined based on everyone's schedule so that all can attend.

Required safety training for the lab component includes two online courses:

1. WHMIS 2022 - Workplace Hazardous Materials Information System
2. CSTS - Concepts in Safety Leadership – Engineering

These courses can be found at this link:

<https://www.ualberta.ca/human-resources-health-safety-environment/environment-and-safety/training/index.html>

Quiz and Exam Format

Quizzes and the final exam will be in-person and have two parts. Part I will be a closed book exam with written short answer questions. Part II will be an open book exam with problems similar to the homework assignments.

Final Exam: The final exam has been scheduled by the Office of the Registrar on Dec. 17, 2024, at 5:30 PM. The exam will be two hours in duration.