Carleton University
Department of Mechanical and Aerospace Engineering

MAAE 2300 Fluid Mechanics I

Section: F

Winter 2024

Weekly Lecture Times: TR 835 - 955

Instructor

Karen Taylor
Email: KarenTaylor@cunet.Carleton.ca
Office Location: MC3052
Office Hours: By appointment
Please provide a copy of your course schedule with your email request for office hours. This way, I can ensure to suggest a time that works for both of our schedules.

Calendar Description

Fluid properties. Units. Kinematics, dynamics of fluid motion: concepts of streamline, control volume, steady and one-dimensional flows; continuity, Euler, Bernoulli, steady flow energy, momentum, moment of momentum equations; applications. Fluid statics; pressure distribution in fluid at rest; hydrostatic forces on plane and curved surfaces; buoyancy.

Includes: Experiential Learning Activity

Prerequisite(s): Second-year status in Engineering.

Lectures three hours a week, laboratory and problem analysis three hours a week.

Graduate Attributes and Accreditation

The Canadian Engineering Accreditation Board (CEAB) requires graduates of undergraduate engineering programs to possess 12 graduate attributes (GAs). Every course in our program impart some component of these attributes. In addition, the CEAB expects the content of every program to have certain minimum numbers of hours in various Curriculum Content categories. The CEAB Curriculum Content, Learning Objectives and GAs for this course are described in the following sections.

CEAB Curriculum Content

Math	Natural Science	Complementary Studies	Engineering Science	Engineering Design
	35%		65%	

Learning Objectives

Learning Objective	Graduate Attribute (if applicable)
Obtain fluid properties: density, dynamic & kinematic viscosity. Perform unit conversion to work with different systems	GA1: Knowledgebase
Understand basic equation for a pressure field, obtain pressure at a point and variation in a incompressible & compressible fluid at rest	GA1: Knowledgebase
Understand pressure measurements with manometry, Absolute and Gauge Pressure; & Atmospheric Change of Pressure with Altitude	GA1: Knowledgebase
Obtain pressure field and pressure distribution for fluid undergoing rigid body motion experiencing linear acceleration or angular motion	GA1: Knowledgebase; GA2: Problem Analysis
Understand Bernoulli's Equation and its application for Measurement of Flow Rate: Inlet, Venturi, Orifice Meter, Stagnation Tube	GA1: Knowledgebase; GA2: Problem Analysis; GA3: Investigation
Apply Continuity equation for Steady and unsteady Flows with Multiple Inlets/Outlets and cases with Accumulation of Fluid	GA1: Knowledgebase; GA2: Problem Analysis
Apply RTT for Linear Momentum to Analyze Forces on Fluids: Internal and External, Conservation of Momentum	GA1: Knowledgebase; GA2: Problem Analysis; GA3: Investigation
Use Reynold's Number to identify flow regimes and calculate Viscous Effects: Minor Losses: Bends, Valves, Expansions/Contractions	GA1: Knowledgebase; GA2: Problem Analysis
Obtain Pressure distribution in a fluid at rest and calculate Forces on Plane and Curved	GA1: Knowledgebase; GA2: Problem Analysis

Surfaces; understand Centre of Pressure	
Obtain Hydrostatic forces on planar and curved submerged surfaces, buoyancy forces, discuss Floating Stability & Meta-Centre	GA1: Knowledgebase; GA2: Problem Analysis

Graduate Attributes

Graduate Attribute	Taught at Level (Introductory, Developed, or Applied)	Assessed (yes/no)
GA1: Knowledgebase	Introductory	Yes
GA2: Problem Analysis	Developed	No
GA3: Investigation	Developed	No
GA7: Communication Skills	Developed	No

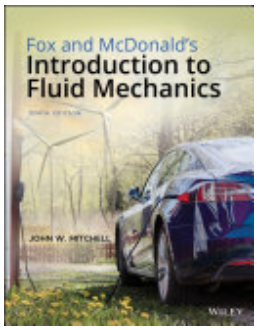
In addition, many courses evaluate students' progress towards acquiring the GAs. Aggregate data (typically, the data collected in all sections of a course during an academic year) is used for accreditation purposes and to guide improvements to our programs. Some of the assessments used to measure GAs may also contribute to final grades; however, the GA measurements for individual students are not used to determine the student's year-to-year progression through the program or eligibility to graduate. The following GA measurements are made in this course.

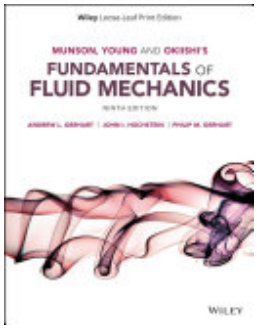
Evaluated GA Indicators

GA Indicator	Assessment Tool
1.9.M - Knowledge base: Discipline-specific concept MAE-6: Thermofluids	Quiz/Exam Questions

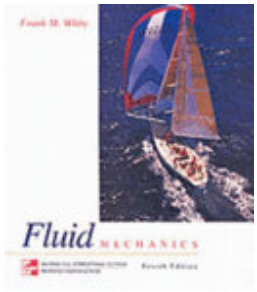
Recommended Texts

Title: Fox and McDonald's Introduction to Fluid Mechanics
ISBN: 9781119721024
Authors: Robert W. Fox, Alan T. McDonald, John W. Mitchell
Publisher: John Wiley & Sons
Publication Date: 2020-06-30





Title: Munson, Young and Okiishi's Fundamentals of Fluid Mechanics
ISBN: 9781119597308
Authors: Andrew L. Gerhart, John I. Hochstein, Philip M. Gerhart
Publisher: John Wiley & Sons
Publication Date: 2020-12-03



Title: Fluid Mechanics
Authors: Frank M. White
Publication Date: 1999-01-01

Course Schedule

Brief Outline of Lectures: Events beyond the control of the instructor may require changes to this outline.

Week	Book Sections	Materials
1	1.1-1.6	**Orientation,** Some Characteristics of Fluids, Units, Analysis of Fluid Behavior
		Introduction, Measures of Fluid Mass and Weight, Ideal Gas Law, Viscosity
2	1.7-1.9 2.1-2.3	Compressibility of Fluids, Vapor Pressure, Surface Tension
		Pressure at a Point, Basic Equation for Pressure Field, Pressure Variation in a Fluid at Rest
3	2.4-2.7 4.1-4.2	Measurement of Pressure, Manometry, U-Tube Manometer
		Fluid dynamics. Velocity Field, Flow Patterns: Streamlines, Pathlines, and Streaklines, Steady flow. Eulerian and Lagrangian Flow Description
4	3.1-3.4	Euler and Bernoulli Equations. Bernoulli Equation as an Energy Equation
		Static, Stagnation, Dynamic, and Total Pressure
5	3.5-3.8 4.3-4.4	Examples, Energy Line and Hydraulic Grade Line, Flow rate Measurement
		Control Volume and System Representations, The Reynolds Transport Theorem
6	5.1	**Midterm I (Up to End of Chapter 3)**
		Conservation of Mass—The Continuity Equation
7		**Winter Break**
8	5.2.1- 5.2.2	Linear Momentum Equation for a Control Volume
		Application of Linear Momentum to Steady Flows
9	5.2.3- 5.2.4	The Moment-of-Momentum Equations
		Application of the Moment-of-Momentum Equation
10	5.3.1- 5.3.3	First Law of Thermodynamics—The Energy Equation
		Application of the Energy Equation
11	8.1 8.4-8.5	General Characteristics of Pipe Flow, Pipe Flow Losses via Dimensional Analysis
		Major Losses, Minor Losses, Pipe Flow Examples (Three Types)
12	2.9-2.10	**Midterm II (Chapters 1- 5 and 8)**
		Fluid Statics. Pressure Prism, Hydrostatic Force on a Curved Surface
13	2.11- 2.12	Buoyancy, Flotation, and Stability
		Linear Motion, Rigid-Body Rotation
14		**Review Lecture**

Laboratory Experiments:

Students will be required to submit their laboratory reports individually through Brightspace or, in exceptional circumstances, to the Teaching Assistant (TA) responsible for that lab, two weeks after performing the laboratory exercise. **Students must include the name of the TA, names of their lab partners, and date the experiment was performed on their laboratory cover page**. See the section on Laboratory Exercises in the course manual for details on laboratory report preparation.

Students who have successfully completed the laboratory work during a previous registration in the course may NOT request an exemption from the laboratory work.

A late penalty of 25% per day will be incurred to all late submissions of reports up to 4 days after the submission date. As a course requirement, the grade of each lab report should be above

50%.

Labs			
Exp#	**Topic**	**Date**	**Report Due**
First	Flow Through a Venturi Meter	Week of February 12th	2 weeks after experiment
Second	Jet Pump	Week of March 4th	2 weeks after experiment
Third	Flow Measurement	Week of March 18th	2 weeks after experiment

Problem Sessions with TAs

The mid-term and final examinations will be problem oriented. Problem solving proficiency will be essential in order to succeed in the course. We will focus on developing problem solving skills in the problem sessions that are listed above. However, the range of possible problems in fluid mechanics is enormous. Possible problems cannot be categorized into a few “standard” types. Adaptability is essential and it is therefore extremely important to develop a sound understanding of the subject matter. To develop the necessary understanding and proficiency at solving problems it is essential to do a substantial number of problems and to do them relatively independently. Problems are provided for this purpose in the course manual. During the term, students are expected to complete all suggested problems. To assist you as much as possible, weekly sessions with the TAs have been arranged to help you as you work through these problems. All students are expected to attend the sessions. A few selected example problems will also be solved in detail.

The office locations/hours of TAs will be announced on Brightspace.

PA #	Week	Content	Chapter
	Week 1 (Jan 8 – 12)	No PA Session	
1	Week 2 (Jan 15 – 19)	Characteristics of Fluids	1
2	Week 3 (Jan 22 – 26)	Surface Tension Pressure at a Point	1 & 2
3	Week 4 (Jan 29 – Feb 2)	Measurement of Pressure Velocity Field	2 & 4
4	Week 5 (Feb 5 – 9)	Euler and Bernoulli Equations	3
5	Week 6 (Feb 12 – 16)	Application of Bernoulli Equation, Control Volume and System	3 & 4
6	Week 8 (Feb 26 – Mar 1)	Conservation of Mass	5
7	Week 9 (Mar 4 - 8)	Linear Momentum Equation	5
8	Week 10 (Mar 11 – 15)	Moment-of-Momentum Equations	5
9	Week 11 (Mar 18 – 22)	Energy Equation	5
10	Week 12 (Mar 25 – 29)	General Characteristics of Pipe Flow	8
11	Week 13 (Apr 1 – 5)	Hydrostatic Force on a Surface	2
12	Week 14 (Apr 8 – 10)	Buoyancy, Linear Motion, Rigid-Body Rotation	2

Evaluation and Marking Scheme

Grading

The final grade for the course will be derived as follows:

Mid-term test I: 15%

Mid-term test II: 15%

Final examination (TBA): 55%

Laboratory experiments: 15%

The final examination is for evaluation purposes only and answer booklets will not be returned to the students. **You must pass the final exam to pass the course**. No alternate, supplemental or make-up term test will be given.

Please note that successful completion of laboratory work is an important requirement of professionally, accredited engineering programs. **Failure to submit any laboratory report or to receive average passing grade for all reports will result in a grade of FND (failure no deferred) for the course.**

Please note: *All laboratory work will take place in the Mackenzie Building as outlined in the course manual. Laboratory group sign-up and schedule will be posted on Brightspace after the first classes have occurred. Because of equipment access and space restrictions, you can only sign-up for a laboratory in the section in which you are registered. However, you are free (and encouraged) to attend any and all of the tutorial sessions listed above.*

Term work

Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately informing the instructor concerned and for making alternate arrangements with the instructor and in all cases, this must occur no later than three (3) days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule. Consult section 4.4 of the University Calendar: https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/examinations/#deferred-term-work

Final Examination

Final exams are for evaluation purpose and will not be returned to students. Students who are unable to write the final examination because of a serious illness/emergency or other circumstance beyond their control may apply for accommodation by contacting the Registrar's office. Consult the Section 4.3 of the University Calendar:

https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/examinations

Self-Declaration Form and Deferred Term Work

Contact the instructor with the completed self-declaration form no later than 3 days after the date/deadline of term work including test/midterm, labs, assignments.

Final Examination Policy

i) Final exams are for evaluation purpose and will not be returned to students.

ii) Students who are unable to write the final examination because of a serious illness/emergency or other circumstances beyond their control may apply for accommodation by contacting the Registrar's office. Consult Section 4.3 of the University Calendar: https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/examinations/

Academic Dates

Students should be aware of the academic dates (eg. last day for academic withdrawal) posted on the Registrar's office web site https://carleton.ca/registrar/registration/dates/academic-dates/

Academic Integrity and Plagiarism

a) Please consult the Faculty of Engineering and Design information page about the Academic Integrity policy and our procedures: https://carleton.ca/engineering-design/current-students/fed-academic-integrity Violations of the Academic Integrity Policy will result in the assignment of a penalty such as reduced grades, the assignment of an F in a course, a suspension or, expulsion.

b) One of the main objectives of the Academic Integrity Policy is to ensure that the work you submit is your own. As a result, it is important to write your own solutions when studying and preparing with other students and to avoid plagiarism in your submissions. The University Academic Integrity Policy defines plagiarism as "presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one's own." This includes reproducing or paraphrasing portions of someone else's published or unpublished material, regardless of the source, and presenting these as one's own without proper citation or reference to the original source.

Examples of violations of the policy include, but are not limited to:

- Any submission prepared in whole or in part, by someone else;
- Using another's data or research findings without appropriate acknowledgement;
- Submitting a computer program developed in whole or in part by someone else, with or without modifications, as one's own; and
  failing to acknowledge sources of information through the use of proper citations when using another's work and/or failing to use quotations marks.
- Submitting text generated by AI tools as your own.
- Unauthorized assistance in midterm or final exams, including communications with others during the test, or accessing unauthorized materials (notes, books, websites, etc.) during the test.

Copyright

Academic Accommodation

Academic accommodation refers to educational practices, systems and support mechanisms designed to accommodate diversity and difference. The purpose of accommodation is to enable students to perform the essential requirements of their academic programs. At no time does academic accommodation undermine or compromise the learning objectives that are established by the academic authorities of the University.

Types of accommodation include those for recognized disabilities, pregnancy, religious obligation, survivors of sexual violence and student activities.

For disability accommodations, you must contact the Paul Menton Centre for Students with Disabilities (PMC) at 613-520-6608 or pmc@carleton.ca at the start of term, and you must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation.

For other accommodations, please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist.

Full details of the processes and resources for academic accommodation requests are available here.

Statement on Student Mental Health

As a University student you may experience a range of mental health challenges that significantly impact your academic success and overall well-being. Carleton's Wellness Services Navigator https://wellness.carleton.ca/navigator/ is designed to help students connect with mental health and wellness resources. If you need to talk to someone, please reach out for assistance: https://carleton.ca/health/emergencies-and-crisis/.

Statement on Equity, Diversity and Inclusion

Carleton University acknowledges the location of its campus on the traditional, unceded territories of the Algonquin nation. In doing so, Carleton acknowledges it has a responsibility to the Algonquin people. The Centre for Indigenous Support and Community Engagement at Carleton was created to support students, staff and faculty by providing culturally safe spaces for dialogue and learning. The Ojigkwanong Indigenous Student Centre is a place where First Nation, Métis and Inuit students can study, socialize, and participate in academic and cultural programming.